



THE UNIVERSITY *of* EDINBURGH

This thesis has been submitted in fulfilment of the requirements for a postgraduate degree (e.g. PhD, MPhil, DClinPsychol) at the University of Edinburgh. Please note the following terms and conditions of use:

This work is protected by copyright and other intellectual property rights, which are retained by the thesis author, unless otherwise stated.

A copy can be downloaded for personal non-commercial research or study, without prior permission or charge.

This thesis cannot be reproduced or quoted extensively from without first obtaining permission in writing from the author.

The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the author.

When referring to this work, full bibliographic details including the author, title, awarding institution and date of the thesis must be given.

Moving messages:

Building the evidence base on physical activity
messaging to inform research and policy, and improve
practice

Chloë Williamson



THE UNIVERSITY
of EDINBURGH

Thesis submitted for the degree of Doctor of Philosophy

Institute for Sport, Physical Education and Health Sciences

Moray House School of Education and Sport

This work is protected by copyright and other intellectual property rights,
which are retained by the thesis author, unless otherwise stated.

University of Edinburgh

January 2022

Declaration

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree or professional qualification. I confirm that the work submitted is my own, except where work that has formed part of jointly authored publications has been included. I am first author of all of these publications, and my contribution and those of the other authors to this work have been explicitly stated below. I confirm that appropriate credit has been given within this thesis where reference has been made to the work of others.

Chapter 5

The work presented in Chapter (5) was published in the International Journal of Behavioral Nutrition and Physical Activity (IJBNPA) in April 2020 as “Get the message? A scoping review of physical activity messaging” by Chloë Williamson (CW), Paul Kelly (PK), Graham Baker (GB), Nanette Mutrie (NM), and Ailsa Niven (AN). This study was conceived by myself and my supervisor PK. The search strategy was designed by me with help from my supervisors PK and GB. Screening was carried out by myself, PK, GB and AN, and I carried out data extraction. I led analysis of results with input from PK, GB, AN and NM. I drafted the full manuscript and all other authors reviewed and approval before submission to IJBNPA.

Citation: Williamson, C., Baker, G., Mutrie, N. *et al.* Get the message? A scoping review of physical activity messaging. *Int J Behav Nutr Phys Act* **17**, 51 (2020). <https://doi.org/10.1186/s12966-020-00954-3>

Chapter 7

The work presented in Chapter (7) was published in the IJBNPA in August 2021 as “A modified Delphi study to enhance and gain international consensus on the Physical Activity Messaging Framework (PAMF) and Checklist (PAMC)” by Chloë Williamson, Paul Kelly (PK), Jennifer R. Tomasone, Adrian Bauman, Nanette Mutrie, Ailsa Niven, Justin Richards and Graham Baker (GB). I conceived this study. The study and recruitment strategy were designed by me with guidance from my supervisors PK and GB. All authors provided feedback on the study protocol and survey materials. I carried out data analysis with help from PK and GB, and framework and checklist amendments between survey rounds were led by me with input from all authors. I drafted the full manuscript and all authors reviewed and approved before submission.

Citation: Williamson, C., Kelly, P., Tomasone, J.R. *et al.* A modified Delphi study to enhance and gain international consensus on the Physical Activity Messaging Framework (PAMF) and Checklist (PAMC). *Int J Behav Nutr Phys Act* **18**, 108 (2021). <https://doi.org/10.1186/s12966-021-01182-z>

Chapter 8

The work presented in Chapter (8) was published in IJBNPA in December 2021 as “The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC): International consensus statement and user guide” by Chloë Williamson, Graham Baker (GB), Jennifer R. Tomasone, Adrian Bauman, Nanette Mutrie, Ailsa Niven, Justin Richards and Paul Kelly (PK) on

behalf of the full author group. I conceived the study that led to the development of the PAMF and PAMC, and the decision to write this user guide as a separate manuscript was made by myself, with advice from my supervisors PK and GB. All authors generated ideas that led to the construction of the manuscript. I drafted the full manuscript and all other authors reviewed and approved before submission.

Citation: Williamson, C., Baker, G., Tomasone, J.R. *et al.* The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC): International consensus statement and user guide. *Int J Behav Nutr Phys Act* **18**, 164 (2021). <https://doi.org/10.1186/s12966-021-01230-8>

Chloë Williamson

January 2022

Acknowledgements

I have many people to thank for helping me complete this PhD and enjoy the journey. First, thank you to my exceptional supervisors: Dr Graham Baker, Dr Paul Kelly, and Professor Nanette Mutrie MBE. You have given me more of your time and energy than I could have expected or hoped for, and I will always be grateful. You have not only helped guide my PhD research but have helped shape who I am as an academic. In the future I hope to be an inspiring and empathetic mentor to others, as you all have been to me. I am happy to finish this PhD with you all not only as supervisors, but as colleagues and friends.

Next, to my wonderful colleagues and fellow PhD students at the Physical Activity for Health Research Centre: thank you so much for making me feel so at home in this team. Your academic guidance, support, encouragement have been invaluable throughout the PhD process, even virtually through a global pandemic! I'd particularly like to thank Dr Ailsa Niven and Dr Josie Booth for their constructive criticism at my first-year progression board.

I'd also like to thank my advisory group: Professor Mary Brennan, Flora Jackson, Mary Allison, Professor Adrian Davis, and Jocelyn Moar. Your generous input is greatly appreciated and has undoubtedly improved my research. I am also grateful for the insights gained from colleagues from my field that I have met with and collaborated with, particularly Professor Charlie Foster, Dr James Nobles, Professor Adrian Bauman, Dr Justin Richards and

Dr Jennifer Tomasone. I have learned so much from all of you. Our conversations were highly influential in deciding the trajectory of my PhD. Thank you also to all participants of my studies. Your insights were so valuable, and this simply wouldn't have been possible without you.

To my Mum, Dad and siblings who are always checking in with me and egging me on. To my Pops whose own thesis planted the seeds for me to consider doing my own PhD one day. To my incredible friends who are my biggest cheerleaders. And to Ethan and Maisie, you are just the best.

Lay summary

How do we, the public, know that that we shouldn't smoke? Or that we should eat five portions of fruit and vegetables a day? Why is it that we frown upon people for not wearing a seatbelt or drink driving? The success of communication techniques that target people's attitudes, beliefs and social norms about various health behaviours is clear. Yet when it comes to physical activity, it seems that we've so far failed to effectively communicate this behaviour in a way that meaningfully changes behaviour. Many people don't know what 'counts' as physical activity, and only around 5% of people in Scotland know what the physical activity guidelines for health are. Physical activity is important for physical and mental health, and so improving levels of physical activity is a priority in public health.

Physical activity guidelines exist that tell people how much and what type of physical activity they should do for good health. But physical activity guidelines themselves do not 'double up' as effective physical activity messages, and it's only really in recent years we have come to realise this. In 2020, for the first time, the World Health Organization and the UK Chief Medical Officers have included a focus on not just development of physical activity guidelines, but also on effective messaging of these guidelines. However, the problem is we don't know what the best practice for effective physical activity messaging is. So, my thesis aimed to further our understanding of how we can best promote physical activity through messaging.

I began by doing an evidence review in which I pulled together and summarised the findings from over 120 studies. This review showed that messages should be positive, highlighting benefits of being active. Specifically, messages should focus on mental and social health benefits, rather than long term physical health benefits that we often see in physical activity messages. This review also found that many physical activity messages were created without identifying a clear aim or considering how the message might actually work, without involving the target audience of the message, and without drawing on relevant theory to inform message development.

Building on this, the next thing I did was develop a framework that can be used to create new messages, help plan how these messages can be tested, and help to understand existing messages. The framework encourages the user to establish clear message aims, consider how the message will achieve its aim, and to involve the target audience in message development. In 2020, this framework was used as a starting point in my second PhD study in which the framework was further developed and improved based on expert feedback, and agreement was ultimately reached from a group of 40 international experts.

A key next step from this study was to see how this framework works in the real world. So, in my final PhD study I used it to conduct interviews with new mothers to explore their preferences for physical activity messages. In agreement with the evidence review, new mothers showed a preference

for positive messages that focus on the social and short-term mental health benefits of being active, such as meeting other new mothers and feeling more relaxed.

If my framework is adopted by the field and used consistently, I think it has potential to improve both physical activity messaging research (by encouraging researchers to use certain terms the same way, and to consider various important elements of physical activity messaging) as well as improve physical activity messaging practice (by encouraging development of messages that are evidence-based and consider the target audience carefully). Improving both of these things will help us to be better at messaging physical activity guidelines and related information, and to therefore contribute to improving population physical activity levels.

Abstract

Physical activity (PA) is a leading cause of non-communicable disease, and global PA trends are not improving. To address this, a systems approach has been advocated. Such an approach acknowledges that, alongside changes to the physical environment and policy, we must also target social and individual factors, such as social norms, perceptions, and awareness of PA benefits. The importance of such approaches is reflected in the World Health Organization's Global Action Plan on Physical Activity (2018-2020). PA messaging is one approach that can target individual and social factors.

PA messaging can be defined as "the overall process of creating and delivering physical activity messages". PA messaging is a promising and scalable action that can be used to reach large numbers of people at a relatively low cost, help augment dissemination of PA research findings and guidelines, and may play an important role in a systems approach to improving population PA levels. Yet, existing evidence shows that PA messaging interventions to date have had limited effects on PA behaviour. Therefore, research to further our understanding of how to utilise PA messaging effectively is imperative to inform research and policy, and improve practice. This thesis aimed to (1) further our understanding of PA messaging and its role in improving population PA levels, and (2) contribute towards improving the PA messaging evidence base and practice.

The first study was a scoping review that summarised what is known about PA messaging and highlighted research gaps by collating findings from 123 studies. Key findings included that PA messaging is complex and multidimensional in nature, with numerous concepts to consider when creating messages. Findings also supported (1) the use of positive and gain-framed messages, particularly focusing on social and mental health benefits, (2) the use of tailoring or targeting to individuals or groups, and (3) the use of formative evaluation, psychological theory, and social marketing principles.

The first study also identified a need to organise the various PA messaging concepts into a usable format to encourage further understanding of this area and facilitate improved messaging practice. The second study therefore involved development of the Physical Activity Messaging Framework (PAMF) and Checklist (PAMC): tools which allow researchers, practitioners, and policymakers to design and plan evaluation for evidence-based and target audience-focused PA messages. Through a modified Delphi process, the PAMF and PAMC were revised and improved before ultimately gaining international expert consensus from a panel of 40 government officials and policymakers, healthcare and other professionals, and academics.

The third and final study involved applying the PAMF and PAMC in a real world setting to develop targeted messaging recommendations to a specific population subgroup. In collaboration with a stakeholder (Northumberland Healthcare Trust, England), qualitative interviews were

conducted with seven postpartum women to explore messaging preferences in line with the PAMF and PAMC. Potential message pathways and preferences in new mothers were identified, alongside key future directions for the PAMF and PAMC.

Although unlikely to change PA behaviour on its own, PA messaging has an important role to play in a systems approach to improving population PA levels. There is clear evidence that this research has contributed to our understanding of PA messaging and informed PA messaging research, practice, and policy in the UK and beyond. Findings from study 1 informed communication of the UK Chief Medical Officer PA guidelines and was cited in the International Society for Physical Activity and Health's eight investments that work for PA. The PAMF developed in study 2 has guided formative research for UK guideline communications and the dissemination strategy of the Canadian 24-hour movement guidelines. If the PAMF and PAMC are used consistently, they could improve PA messaging practice by encouraging evidence-based and target population-focused messages with clear aims and considerations of working pathways. They could also enhance the research base by harmonising key messaging terminologies, improving quality of reporting and aiding evidence synthesis.

Funding

This PhD was funded by a Principal's Career Development Scholarship from the College of Arts, Humanities and Social Sciences at the University of Edinburgh. This scholarship provided three years of funding beginning on October 1st, 2018. I was granted a three-month extension (to 1st January 2022) in May 2021 due to the impact of the COVID-19 pandemic on my research. As part of my scholarship, I have also carried out over 540 hours of career development during my PhD. These hours were made up of teaching, knowledge exchange and research (other than my own PhD research).

Word count

Abstract, acknowledgements, declarations, overview, table of contents etc	4308
Main text (Chapters 1-10):	64,293
• Non-published material	• 44,694
• Published papers	• 19,599
• Tables and figures	• 5756
References	13,569
Appendices	9057

Abbreviations

ACSM	American College of Sports Medicine
AHA	American Heart Association
BCW	Behaviour Change Wheel
BPNT	Basic Psychological Needs Theory
CDC	U.S. Centres for Disease Control and Prevention
CMO	Chief Medical Officer
COM-B Model	Capability, Opportunity, Motivation, Behaviour model
CREDES	Guidance on Conducting and Reporting Delphi Studies
CVD	Cardiovascular disease
GAPPA	Global Action Plan for Physical Activity
GP	General practitioner
HCP	Healthcare professional
ISPAH	International Society for Physical Activity and Health
LMIC	Low- to middle- income country
METs	Metabolic equivalent tasks
NCD	Non-communicable disease
NGT	Nominal Group Technique
NHS	National Health Service
OIT	Organismic Integration Theory
PA	Physical Activity
PAMC	Physical Activity Messaging Checklist

PAMF	Physical Activity Messaging Framework
SCT	Social Cognitive Theory
SDT	Self-Determination Theory
T2D	Type 2 Diabetes
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

Thesis overview

This thesis is formed of 10 chapters. Chapters 1-4 provide the necessary background and rationale to the thesis aims and objectives. Chapter 1 briefly provides rationale and context for the thesis. Chapter 2 describes the need for population physical activity promotion. Chapter 3 introduces the concept of physical activity messaging and discusses its potential role in physical activity promotion. Chapter 4 provides an overview of the theoretical underpinnings of physical activity messaging.

Chapter 5 is a scoping review of physical activity messaging. Chapters 6-8 detail the rationale for and development of a physical activity messaging framework and checklist, including a modified Delphi study with an international expert panel and a consensus statement and user guide. Chapter 5 (scoping review), 7 (modified Delphi study) and 8 (consensus statement and user guide) were published in peer-reviewed journals. These chapters follow a similar format of providing additional background and discussion before and after the published manuscript, including further reflections, findings, or insights.

Chapter 9 presents a third study in which the framework was used to investigate physical activity messaging preferences in the specific population subgroup of postpartum women. Chapter 10 discusses the main findings of this body of work, makes suggestions for future directions, details the impact of this thesis on research, policy and practice, discusses strengths and

limitations of this thesis, and provides conclusions. A list of publications and presentations of this work can be found in Appendix 1.

Table of contents

Declaration	2
Acknowledgements	5
Lay summary.....	7
Abstract.....	10
Funding.....	13
Word count	13
Abbreviations	14
Thesis overview	16
Table of contents	18
Table of tables.....	27
Table of figures	28
Chapter 1 Thesis context, supervision, timeline and aims	30
<i>Context</i>	<i>30</i>
<i>Supervisory arrangements and advisory group</i>	<i>32</i>
<i>Timeline</i>	<i>34</i>
<i>Thesis aims.....</i>	<i>36</i>
Chapter 2 The need for physical activity promotion.....	37
<i>Chapter outline</i>	<i>37</i>
<i>Physical activity definition.....</i>	<i>37</i>
<i>The relationships between physical activity and health</i>	<i>38</i>

<i>Physical activity guidelines, policy, and prevalence trends</i>	42
<i>A systems approach to improving population physical activity</i>	49
<i>Health communication in physical activity promotion</i>	53
<i>Chapter summary</i>	55
Chapter 3 Physical activity messaging: its role in physical activity promotion and key concepts	56
<i>Chapter outline</i>	56
<i>The overarching concept of physical activity communication</i>	56
<i>The potential role of physical activity messaging in PA promotion</i>	58
<i>Subconcepts of physical activity messaging</i>	63
Message content	63
Message delivery	67
<i>Chapter summary</i>	68
Chapter 4 Theoretical underpinnings of physical activity messaging	70
<i>Chapter outline</i>	70
<i>A brief history of communication models</i>	70
Linear, one-way communication models	71
Cyclical or circular communication models	72
Communication (input-output) persuasion model.....	73
<i>Theories and approaches in physical activity messaging</i>	74
The social cognitive framework.....	79
Social Cognitive Theory (including self-efficacy)	79
Health Belief Model.....	80
Diffusion Theory	81
Stages of Change (Transtheoretical Model).....	83

Theories of Reasoned and Planned Behaviour.....	83
Summary of the social cognitive framework	84
Humanistic/organismic framework and physical activity.....	85
Self-determination theory.....	85
Dual process framework and physical activity	88
Dual process theories	88
Theories of emotional or affective response	89
Socioecological framework and physical activity	90
<i>Social Marketing Theory.....</i>	<i>91</i>
<i>The Behaviour Change Wheel and COM-B Model</i>	<i>93</i>
<i>Theoretical approach of this thesis.....</i>	<i>97</i>
<i>Chapter summary.....</i>	<i>99</i>
Chapter 5 Physical activity messaging: a scoping review.....	100
<i>Chapter outline</i>	<i>100</i>
<i>Preamble</i>	<i>100</i>
<i>Published article</i>	<i>104</i>
Abstract	104
Introduction.....	105
Methods.....	108
Study design and protocol	108
Key definitions and position of messaging	108
Stage 1: Identifying the research question	111
Stage 2: Identifying relevant studies.....	112
Stage 3: Study selection	113
Stage 4: Charting the data.....	114
Stage 5: Collating, summarising and reporting	114
Results	115

Descriptive numerical analysis	115
Narrative summary of findings	118
Gaps in the literature	129
Discussion	131
Summary of principal findings	131
Comparison with literature and plausible explanations for findings	131
Future research and implications	134
Strengths and limitations	137
Conclusion	138
<i>Postamble</i>	139
Chapter 6 Rationale for and development of a framework for physical activity	
messaging	141
<i>Chapter outline</i>	141
<i>Rationale for developing a physical activity messaging framework</i>	141
<i>Existing frameworks and guidance</i>	143
<i>Preliminary work and framework development</i>	149
<i>Next steps</i>	160
Chapter 7 A modified Delphi study to enhance and gain international consensus on	
the Physical Activity Messaging Framework (PAMF) and Checklist (PAMC)	162
<i>Chapter Outline</i>	162
<i>Preamble</i>	162
Justification for study design	163
The Delphi technique	164
Modified Delphi	167
Use of guidance	167
Selection of expert panel.....	168

Step 1: Prepare an 'active recruitment' spreadsheet	170
Step 2: Populate 'active recruitment' spreadsheet with individual names	171
Step 3: Record interest to participate and nomination of additional experts (passive recruitment).....	172
Step 4: Assessing eligibility to take part	172
Step 4: Inviting experts to take part	173
Avoidance of Bias	173
<i>Published article</i>	175
Abstract	175
Introduction	176
Methods	178
Study design	178
Modified Delphi structure	178
Use of reporting guidelines	181
Selection and recruitment of expert panel.....	181
Sample size	181
Online surveys	182
Pilot testing of survey materials.....	182
Survey 1	182
Survey 2.....	183
Survey 3.....	184
Defining consensus	184
Data analyses	185
Framework amendments	186
Results	186
Participants	186
Survey 1	189
Survey 2.....	190
Survey 3.....	192

Discussion	203
Comparisons with and contributions to the literature	204
Strengths and limitations	205
Implications and future directions	207
Conclusion	208
<i>Postamble</i>	209
Chapter 8 The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC): international consensus statement and user guide	210
<i>Chapter overview</i>	210
<i>Preamble</i>	210
<i>Published article</i>	212
Abstract	212
Introduction	213
Aims	215
The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC)	215
Overview of the framework and checklist	215
Section 1: Who, when, what, how and why?	216
Section 2: Message content	219
Section 3: Message format and delivery	224
Ensuring equity, diversity and inclusivity in the messaging process	225
Application of the PAMF and PAMC	227
Using the PAMF and PAMC to create new messages	227
Using the PAMF and PAMC to evaluate messages	229
Using the PAMF and PAMC to understand and classify messages	230
Potential benefits of framework and checklist	231
Future directions	232
Conclusion	233

<i>Post-amble</i>	234
Chapter 9 Formative evaluation: Using the Physical Activity Messaging Framework to investigate physical activity messaging preferences in new mothers	237
<i>Chapter overview</i>	237
<i>Preamble</i>	237
<i>Study in journal format</i>	238
Abstract	238
Introduction.....	240
Methods.....	244
Ethics	244
Participants	245
Study design	245
Sample size	246
Recruitment, data collection and handling	248
Interviews	249
Data analysis	251
Results	254
Participants	254
Narrative summary of findings	255
Section 2: Exploring preferences for physical activity message content	262
Use of PAMF and PAMC to develop messaging recommendations.....	275
Discussion	276
Principal findings.....	276
Comparisons with and contributions to the literature	277
Strengths and limitations	284
Future directions	286
Conclusion	287
<i>Postamble</i>	287

Chapter 10 Discussion	291
<i>Summary of thesis aims, findings and outputs.....</i>	<i>291</i>
<i>Discussion of key findings and contributions to knowledge</i>	<i>293</i>
Key finding 1: Evidence supports the use of positive and gain-framed messages	294
Key finding 2: Evidence supports promotion of acute mental and social health benefits of physical activity	298
Key finding 3: The importance of message tailoring and targeting	301
Key finding 4: The importance of formative evaluation and co-production.....	302
Key finding 5: Insights into physical activity guideline messaging.....	303
<i>Impact</i>	<i>306</i>
Research uptake	306
Research use	308
Impact.....	309
<i>Reflections, strengths, and limitations.....</i>	<i>311</i>
<i>Is physical activity messaging enough?</i>	<i>315</i>
<i>Future directions.....</i>	<i>317</i>
<i>Conclusions</i>	<i>320</i>
References.....	321
Appendices.....	361
1. List of publications and presentations.....	361
2. Infographic of PA recommendations for various groups.....	365
3. Study 2 ethics approval.....	366
4. Study 3 ethics approval.....	367
5. Study 3 advertisement	368
6. Study 3 recruitment survey	369
7. Study 3 full interview schedule.....	387

8. Study 3 framework analysis matrix	391
8.1. Coding matrix for predetermined category of message aims and pathway	391
8.2. Coding matrix for pre-determined category of message content	404
8.3 Coding matrix for pre-determined category of message format and delivery ...	419
9. Study 3 PAMC.....	428
10. Letter of support from UK Chief Medical Officers	434
11. Letter of support from Jennifer Tomasone, Queens University	435
12. Letter of support from Flora Jackson, Public Health Scotland	437

Table of tables

Table 2-1: Summary of UK CMO Physical Activity Guidelines for Health	45
Table 4-1: Key Communication Models and their Implications for Physical Activity Messaging.....	71
Table 4-2: Key Models and Theories with Implications for Physical Activity Messaging 	77
Table 4-3: Mini Theories within Self-Determination Theory.....	86
Table 5-1: Working definitions for the purpose of this research.....	109
Table 5-2: Working definitions of key physical activity message content and delivery concepts.....	111
Table 5-3: Inclusion and exclusion criteria.....	113
Table 5-4: Working definitions of identified outcomes.....	118
Table 5-5: Physical activity message recommendations based on summary of findings 	136
Table 6-1: List of initial physical activity messaging concepts identified in scoping review	150
Table 7-1: Delphi study types and examples within the field of physical activity	166
Table 7-2: Knowledge Resource Nomination Worksheet.....	171
Table 7-3: Demographic characteristics of expert panel for each survey round	188
Table 7-4: The Physical Activity Messaging Checklist	196
Table 7-5: Working definitions of key concepts within the framework.....	202
Table 8-1: Examples of different information types in physical activity messages	221
Table 8-2: Types of evaluation	230
Table 9-1: Items impacting information power and sample size in qualitative research 	247
Table 9-2: Links between study objectives and interview schedule sections	251
Table 9-3: Section 1 themes and subthemes.....	256
Table 9-4: Section 2 themes and subthemes.....	263
Table 9-5: Section 3 themes and subthemes.....	271

Table of figures

Figure 1-1: Timeline of main work undertaken throughout thesis	35
Figure 3-1: Physical Activity Messaging as a Subtype of Wider Health Communication	60
Figure 4-1: The Behaviour Change Wheel (Michie et al., 2011)	95
Figure 5-1: A Practical Tool to Define Boundaries of this Research	103
Figure 5-2: Study selection flowchart.....	116
Figure 5-3: Gaps matrix displaying where evidence has accumulated and where gaps lie relating to physical activity messaging	130
Figure 6-1: CDC Framework for Health Communication (Adapted from Robert, 1995; William, 1993)	145
Figure 6-2: The Audience-Channel-Message-Evaluation (ACME) Framework for Health Communication Campaigns (adapted from Seth, 2012)	146
Figure 6-3: Model of Motivational Messages (Op Den Akker et al., 2015)	147
Figure 6-4: Planning Framework for Physical Activity Communication (Milton et al., 2020)	148
Figure 6-5: Version 0 of the Physical Activity Messaging Framework	151
Figure 6-6: Version 1 of PA Messaging Framework.....	153
Figure 6-7: Version 2 of the Physical Activity Messaging Framework	155
Figure 6-8: Preliminary Physical Activity Messaging Checklist to accompany Version 2 of the Framework	158
Figure 7-1: Overview of recruitment process	170
Figure 7-2: Overview of preliminary work and modified Delphi process	180
Figure 7-3: Participant flowchart.....	187
Figure 7-4: Levels of agreement with the physical activity messaging framework and checklist in survey 3	192
Figure 7-5: The Physical Activity Messaging Framework	195
Figure 8-1: Illustrative examples of combinations of tailored, targeted and personalised messages.....	223

Figure 9-1: Summary of physical activity messaging recommendations for new mums

.....277

Chapter 1 Thesis context, supervision, timeline and aims

This chapter briefly describes the overarching rationale for this body of work within the context of the field, explains what the supervisory arrangements were throughout the PhD, and shows a timeline of when the main work of the thesis was carried out. This chapter ends by outlining the overarching thesis aims.

Context

Physical inactivity is a significant contributor to the growing global burden of non-communicable disease (Lee et al., 2012). Improving effectiveness of physical activity (PA) promotion efforts is therefore of great interest to the public health field. PA promotion generally aims to help individuals and groups meet the PA guidelines for health. PA guidelines, such as those from the World Health Organization (WHO) (World Health Organization, 2020) or other national health agencies (Department of Health & Social Care, 2019) offer guidance on the amount and type of PA required to improve health outcomes (e.g., 150 minutes per week of moderate-to-vigorous PA). However, guidelines themselves are not intended to be public facing, and it is not the intention that they will motivate people to become or remain physically active simply through existing (Latimer et al., 2010).

Previous statistics on knowledge of PA guidelines reflect a failure to effectively communicate or message PA guidelines to date. For example, in Scotland specifically, only 5% of adults were able to accurately report the 150-minute message in 2012 (Scottish Government, 2012). It has therefore

become apparent that the importance of communication strategies (such as messaging) in disseminating and implementing PA guidelines has been overlooked, and that PA guidelines must be augmented with messages that make the guidelines and related information more meaningful and digestible to the public (Latimer et al., 2010).

At the time that the research proposal to obtain funding for this PhD was being written (2018), the UK Chief Medical Officers (CMOs) were planning the release of their updated PA guidelines. At that time, there was a lack of research aiming to understand PA messaging preferences of the public. There was also no existing guidance on how to create PA messages for various population groups. Thus, our understanding of how to best create and delivery PA messages, including dissemination of PA guidelines to various groups, was limited.

The need to address this had been recognised both nationally and internationally. For the first time, the UK CMOs were planning to form a communication expert committee to inform the communication strategy of the updated guidelines (which were due to be released in 2019). Internationally, the WHO had plans for updated global PA guidelines to be released in 2020 to include a focus on communication and messaging for the first time, and the importance of communication methods had been highlighted in WHO's Global Action Plan for Physical Activity (GAPPA) 2018-2030 (World Health Organization, 2019). This PhD thesis therefore sought to capitalise on this timely opportunity and attempt to fill knowledge gaps surrounding PA

messaging with the aim of informing ongoing decisions in research, policy, and practice.

Supervisory arrangements and advisory group

In year 1 of this PhD, I was jointly supervised by Dr Paul Kelly, Dr Graham Baker and Professor Nanette Mutrie MBE. Due to her phased retirement, Prof. Nanette Mutrie stepped down from her role as supervisor as I entered my 2nd year. Dr Paul Kelly and Dr Graham Baker acted as lead supervisor in years 2 and 3, respectively, with both supervisors contributing equally in supervision and in supporting my development as a researcher. Prof. Nanette Mutrie MBE, Dr Paul Kelly and Dr Graham Baker were all based within the Physical Activity for Health Research Centre, University of Edinburgh throughout the duration of my PhD.

A PhD advisory group was convened soon after commencement of my PhD to facilitate interactions with academics from other disciplines and non-academic stakeholders whose insights would be valuable for the development of my PhD, such as government officials/policymakers and professionals in the PA for health field. This group included:

Professor Mary Brennan: Chair of Food Marketing and Society and Director of UG Programmes, Business School, University of Edinburgh. Professor Mary Brennan's expertise in social marketing was drawn on throughout the PhD. She attended an advisory group meeting in June 2019, acted as a 'critical friend' and provided feedback from a social marketing point of view on the manuscript of my scoping review study, and met

informally with me in October 2019 to discuss the role of social marketing in physical activity for health promotion.

Flora Jackson: Health Improvement Manager (Physical Activity), Public Health NHS Scotland. Flora Jackson attended an advisory group meeting in June 2019 to provide feedback on PhD plans and insights from a practitioner point of view.

Jocelyn Moar: Active Lives programme officer at Sport & Exercise, University of Edinburgh. Jocelyn Moar attended an advisory group meeting in June 2019 and provided feedback on PhD plans.

Mary Allison: PhD student researching realist evaluation of Paths for All's workplace step count challenge. Mary Allison attended an advisory group meeting in June 2019 and acted as a peer mentor throughout the duration of my PhD.

Professor Adrian Davis: Professor of Transport and Health, Edinburgh Napier University. Adrian was invited to become a member of the advisory group due to his expertise in translational research. Professor Adrian Davis is also a member of PAHRC and offered informal feedback on elements of my PhD on several occasions (e.g., at weekly PAHRC seminars) throughout my PhD process.

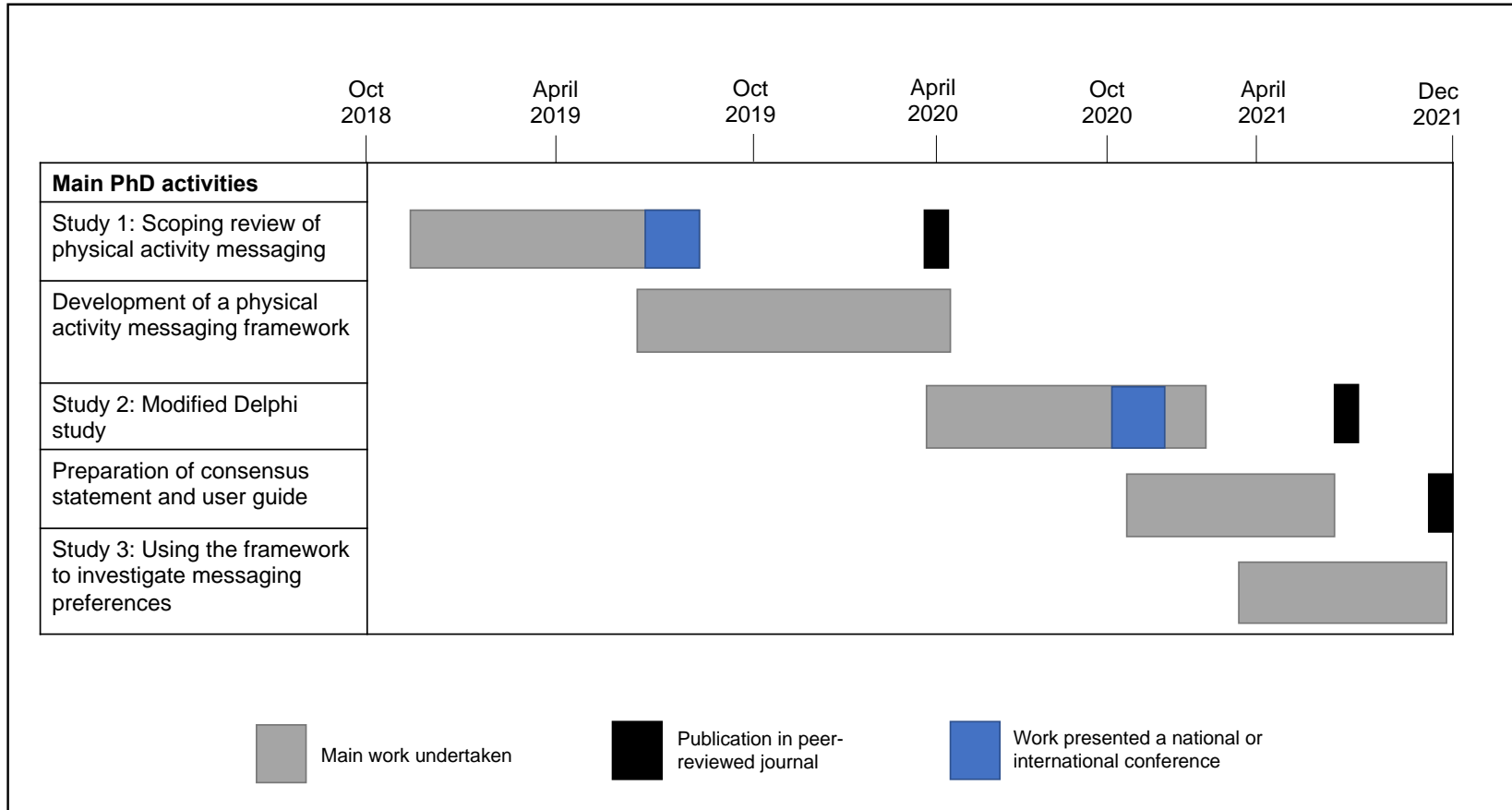
Colleagues from the PA for health field beyond my advisory group also provided valuable contributions to this PhD. Namely, Dr Ailsa Niven, Dr Justin Richards, Dr Jennifer Tomasone and Professor Adrian Bauman were

all invited to be involved in study 2 given their expertise in PA messaging. This group also contributed as co-authors to the two peer-reviewed publications that resulted from study 2 (see Chapters 7 and 8 for published articles).

Timeline

Figure 1-1 provides an overview of the timeline relating to the main work carried out during this PhD.

FIGURE 1-1: TIMELINE OF MAIN WORK UNDERTAKEN THROUGHOUT THESIS



Thesis aims

At a broad level, this thesis aims to:

1. Further our understanding of PA messaging and its role in improving population PA levels.
2. Contribute towards improving the PA messaging evidence base and practice.

To achieve these overarching aims, specific aims and objectives will be addressed (and stated) in each chapter of this thesis.

Chapter 2 The need for physical activity promotion

Chapter outline

This chapter provides relevant background knowledge to PA and health evidence and policy before PA messaging is introduced and described in detail in Chapter 3. Specifically, this chapter aims to define PA, summarise the evidence for the relationships between PA and various health outcomes, describe the role of PA guidelines and the importance of PA policy, present the argument for a systems approach to tackling population level PA, and introduce the role of health communication in PA promotion.

Physical activity definition

PA is traditionally defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” (Caspersen et al., 1985). More specifically, behaviours that result in an energy expenditure of above 1.5 metabolic equivalents tasks (METs) are considered as PA (Ainsworth et al., 2011). PA can be categorised into 3 broad intensity levels: light PA (1.6 - 2.9 METs), moderate PA (3.0 – 5.9 METs) and vigorous PA (≥ 6 METs) (Ainsworth et al., 2011). PA can be carried out in a range of contexts, settings, or domains. These include at work (occupational), around the home and garden (domestic), during free time (leisure) or specifically for getting from A to B (active transportation or travel) (Strath et al., 2013). PA therefore encompasses some other commonly used terms, such as ‘exercise’ and ‘sport’.

The relationships between physical activity and health

Alongside other significant public health issues such as smoking and alcohol use, physical inactivity is now widely accepted as a major contributor to the growing global burden of non-communicable diseases (NCDs) (Kohl et al., 2012; Lee et al., 2012). The importance of PA on health and wellbeing was highlighted again in The Lancet's third series on PA published in 2021 (Martin Ginis et al., 2021; van Sluijs et al., 2021).

Low PA was ranked as the 10th leading risk factor in terms of disability-adjusted life years in the Global Burden of Disease Study 2010 (Lim et al., 2012). The Global Burden of Disease Study 2019 provided an updated ranking of over 80 risk factors, both behavioural and metabolic (Abbasi-Kangevari et al., 2020). This updated ranking demoted low PA to 19th out of 20 risk factors regarding disability-adjusted life years. However, authors in the field have criticised this updated publication for oversimplifying the complex and multidimensional behaviour that is PA, and highlighted the danger that this demotion may result in weakening of the well-established role that PA plays in disease prevention (Stamatakis et al., 2021). Insufficient PA should therefore remain a leading risk factor.

Specifically, inactivity-related diseases are estimated to cause more than 41 million deaths each year, a third of which are in individuals younger than 70 years old (Forouzanfar et al., 2015). It is estimated that physical inactivity causes 65% of the burden of NCDs, and that if inactivity were reduced by 25%, 1.3 million deaths could be averted each year (Lee et al.,

2012). The global cost of physical inactivity is estimated to be \$54 billion annually in direct healthcare, with an additional \$14 billion relating to loss of productivity (World Health Organization, 2019).

Observational studies consistently demonstrate an inverse association between PA and risk of mortality (Gill, 2022), and the evidence base demonstrating relationships between PA and leading NCDs and mortality in all populations is growing, with ever more robust methods allowing us to have greater confidence in findings. For example, with focus on a range of outcomes, a recent systematic review of reviews combined evidence from twenty-four reviews and meta-analyses and found that physically active older adults (aged 60+) are at a reduced risk of all-cause mortality, cancer mortality, breast and prostate cancer, fractures, recurrent falls, disability in activities of daily living and functional limitation, cognitive decline, dementia, Alzheimer's disease and depression (Cunningham et al., 2020). Another recent systematic review including 136 studies and focusing specifically on cancer found that higher pre- and post- cancer diagnosis levels of PA are associated with improved cancer survival outcomes for at least 11 different cancer types in adults (Friedenreich et al., 2020).

There is also strong evidence for the inverse association between PA and Type 2 Diabetes (T2D) in adults, and it is believed that all types of PA carried out in all domains are beneficial in reducing risk of T2D (Aune et al., 2015). Also in adults and considering cardiovascular disease (CVD) in addition to T2D, moving from being inactive to achieving the recommended

PA levels (150 minutes of moderate-intensity PA per week) was found to be associated with lower risk of CVD mortality by 23%, CVD incidence by 17%, and T2D incidence by 26% in a systematic review of 36 studies (Wahid et al., 2016).

Though the evidence for relationships between PA and health in younger generations is more difficult to obtain due to many outcomes (e.g., NCDs) not presenting themselves until later life, there is a growing body of evidence to support positive relationships between PA and health in children and young people. A systematic review of 96 studies found PA to be associated with favourable motor development, fitness, bone, and skeletal health in children aged 0-4 years (Carson et al., 2017). Another systematic review of 31 studies involving children and adolescents aged 3-18 years found higher levels of PA to be associated with better health-related quality of life (Wu et al., 2017).

In addition to reducing risk of physical ill-health (Lee et al., 2012), increased PA also brings important mental, social and economic benefits. Existing evidence supports a positive association between PA and health related quality of life in the general adult population (Bize et al., 2007) as well the role of even small amounts of PA in reducing risk of mental ill-health. Existing reviews and meta-analytical evidence show reduced risk of depression and anxiety in adults as a result of PA including walking (Kelly et al., 2018; Schuch et al., 2019; Schuch et al., 2018), benefits of leisure-time PA and active travel on positive mental health, a negative association

between leisure-time PA and mental ill-health (White et al., 2017), and beneficial effects of PA on improving cognitive abilities and enhancing mood (Mandolesi et al., 2018). Furthermore, evidence supports the role of increased active travel (such as cycling and walking) in reducing carbon dioxide emissions (Woodcock et al., 2009).

Social benefits have been reported from various types of PA and in various populations. For example, evidence from systematic reviews demonstrates that there is consistent evidence for associations between sport and social health in adults, independent of type of sport, age, somatic or mental health status (Andersen et al., 2019), as well as social benefits (e.g. generating friendships and social belonging) resulting from sport participation in older adults (Kim et al., 2020). In more specific population subgroups, group exercise classes have been found to have a large potential to improve psychosocial aspects of quality of life in women with breast cancer (Mutrie et al., 2007), and research involving participants with Dementia found that walking groups facilitate a sense of community or belonging (Robertson et al., 2020).

The social and mental health benefits of PA are also evident in younger populations. For example, a 2013 systematic review found that team sport was associated with greater improved health outcomes when compared with individual activities due to the social nature of team sport in children and adolescents (Eime et al., 2013). Relating to mental health outcomes in children and adolescents, a review of 42 reviews found that

higher levels of PA or fitness levels are associated with better cognitive health and performance (Biddle et al., 2019). This same review also found partial evidence for a causal relationship between PA and reduced risk of depression. Supporting this, a systematic review and meta-analysis from 2019 including 114 studies (12 included in meta-analysis) found a small but significant overall effect of PA on mental health in children and young people aged 6-18 years (effect size 0.173) (Rodriguez-Ayllon et al., 2019). A further systematic review of 31 studies involving children and adolescents aged 3-18 years found higher levels of PA to be associated with better health-related quality of life (Wu et al., 2017).

Overall, the evidence to support the physical, mental, and social benefits of PA in several populations is compelling, and the importance of encouraging PA behaviour in almost all populations is clear.

Physical activity guidelines, policy, and prevalence trends

In 1953, a seminal study concluded that movement is good for health (Morris et al., 1953). This study was followed by growing interest and research into PA epidemiology. This growing body of research later allowed for the development of PA guidelines. PA guidelines are evidence-based statements on epidemiological thresholds of PA required to reap a variety of health benefits (Oja & Titze, 2011). In other words, PA guidelines summarise the evidence on how much and what type of PA is beneficial for health (Milton et al., 2020).

In 1978, the American College of Sports Medicine (ACSM) issued a position statement in which they recommended 15-60 minutes of exercise at 50-85% VO₂ max (60-90% maximum heart rate) on three to five days per week to develop and maintain fitness in healthy adults (American College of Sports Medicine, 1978). Reflecting the field's developing understanding of the benefits of less vigorous exercise and a shift in focus from exercise for fitness to PA for health, the first official evidence-based guidelines or recommendations for PA and health were published in 1995 by the U.S. Centres for Disease Control and Prevention (CDC) and the ACSM (Oja & Titze, 2011; Pate et al., 1995). These 1995 guidelines recommended that adults in the USA should undertake 30 minutes of (at least) moderate PA on most (but preferably all) days of the week (Pate et al., 1995). Although developed for Americans, these guidelines were adopted by many other countries across the globe (Oja & Titze, 2011). For example, the UK CMO published the report "At Least Five a Week" in 2004, supporting the 1995 recommendation (Department of Health, 2004).

These guidelines were updated to reflect new evidence in 2007, at which time the American Heart Association (AHA) and the ACSM recommended all healthy adults need moderate-intensity aerobic activity for a minimum of 30 minutes on 5 days a week, or vigorous intensity aerobic activity for a minimum of 20 minutes on 3 days a week (Haskell et al., 2007). The U.S. Department of Health and Human Services presented further updated guidelines for Americans in 2008 (US Department of Health and Human Services, 2008). These guidelines were in principle similar to the

2007 guidelines, but they differed in that they recommended a total weekly time of 150 minutes of aerobic PA rather than a certain number of sessions per week (Oja & Titze, 2011).

The U.S. 2008 recommendations were largely adopted globally, with the first official global guidelines published in 2010 by the WHO (World Health Organization, 2010). The first UK-specific PA guidelines for health were published in 2011 'Start Active, Stay Active' (Department of Health, 2011). The UK and global guidelines were updated in 2019 and 2020, respectively (Department of Health & Social Care, 2019; World Health Organization, 2020). These more recent recommendations do not contradict the 1995 recommendation, but they include further detail and new components compared to earlier guidelines, such as more specific guidance for different population groups and on different types of PA. Both the Global and UK guidelines recommend that adults should aim to accumulate at least 150 minutes of moderate to vigorous aerobic PA each week as well as muscle-strengthening exercises twice a week for adults. The guidelines also recommend minimising time spent sedentary and breaking up sedentary time with light PA. The UK CMO PA guidelines for health for various population subgroups are presented in Table 2-1.

TABLE 2-1: SUMMARY OF UK CMO PHYSICAL ACTIVITY GUIDELINES FOR HEALTH

Group	Summary of guideline
Under 5s	<ul style="list-style-type: none"> • Infants (less than 1 year): <ul style="list-style-type: none"> ○ Should be physically active several times every day in a variety of ways ○ For infants not yet mobile, this includes at least 30 minutes of tummy time • Toddlers (1-2 years): <ul style="list-style-type: none"> ○ At least 180 minutes per day in a variety of physical activities • Pre-schoolers (3-4 years): <ul style="list-style-type: none"> ○ At least 180 minutes per day active, with 60 of these minutes being MVPA
Children and young people (5-18 years)	<ul style="list-style-type: none"> • Should engage in MVPA for an average of at least 60 minutes per day across the week • Should engage in a variety of types and intensities • Should minimise time spent being sedentary and break up long periods of not moving with at least light PA
Adults (18-65 years)	<ul style="list-style-type: none"> • Should aim to be active every day • Any activity is good, more is better • Should do muscle strengthening activities on at least 2 days of the week (but any is better than none) • Should accumulate at least 150 minutes of moderate intensity activity, or 75 minutes of vigorous, or even shorter durations of very vigorous, or a combination • Should minimise time spent being sedentary and break up long periods of not moving with at least light PA
Older adults (65+ years)	<ul style="list-style-type: none"> • Should aim to be active every day • Some PA is better than none, and even LPA brings benefits • Should do muscle strengthening activities on at least 2 days of the week • Should accumulate at least 150 minutes of moderate intensity activity, or 75 minutes of vigorous or a combination • Should minimise time spent being sedentary and break up long periods of not moving
Adults with disabilities	<ul style="list-style-type: none"> • As per adult guidelines • No evidence to suggest appropriate PA is a risk for disabled benefits and health benefits are analogous for disabled adults as for the rest of the adult population
Physical activity during pregnancy & during postpartum	<ul style="list-style-type: none"> • As per adult guidelines • PA choices should reflect activity levels pre-pregnancy and should include strength training • Vigorous PA is not recommended for previously inactive women • Depending on how woman feels after 6-8 week postnatal check, moderate PA can be built up to more intense PA

Source: UK CMOs Physical Activity Guidelines for Health (Department of Health & Social Care, 2019). Note MVPA = moderate-to-vigorous physical activity, PA = physical activity.

In 2010, WHO identified several purposes of PA guidelines, including: providing consensus on the scientific evidence, raising awareness of health benefits of PA, guiding future research, and underpinning monitoring and surveillance of PA (World Health Organization, 2010). PA guidelines alone are not sufficient to increase population level PA, rather, PA promotion for public health should be informed by PA guidelines (Oja & Titze, 2011). Thus a final key purpose of PA guidelines is to inform national policy to support implementation actions (World Health Organization, 2010). Specifically, PA guidelines can provide a solid foundation for PA promotional policies and strategies (Oja & Titze, 2011).

Policy can be defined as “a guide to action to change what would otherwise occur... it sets priorities and guides resource allocation” (Milio, 2001, p. 622), and may include global, national or sub-national targets, strategies, legislation, guidelines and implementation plans (Bull et al., 2015). The need for PA policy is clear as the highest achievable standard of health is a basic human right of every individual (United Nations General Assembly, 1948; World Health Organization, 2010). The unnecessary physical and mental ill-health caused by physical inactivity denies this basic human right and burdens society.

Numerous PA policies have been developed over time to help address the physical inactivity pandemic at global, national, and local levels. The WHO’s Global Strategy on Diet Physical Activity and Health is a seminal document that recognised physical inactivity as a key risk factor in the

prevention and control of NCDs (World Health Organization, 2004). In 2007, the WHO published a guide with the aim of assisting member states and other relevant stakeholders in developing and implementing national PA action plans and providing guidance on policy options for effectively promoting PA at national and sub-national levels (Oja & Titze, 2011; World Health Organization, 2007). In 2009, a content analysis in the European region identified 49 national PA policy documents; 29 in health promotion, 12 in transport, seven in sport and one in environment (Daugbjerg et al., 2009). Analysis of 27 of these policy documents showed that policies generally addressed multiple important elements such as goals, implementation, timeframes and appropriate evaluation, but that there was a lack of focus on groups most needing intervention and limited consideration for cross-sectoral collaborations (Daugbjerg et al., 2009).

Since then, the International Society for Physical Activity and Health (ISPAH) published the Toronto Charter for Physical Activity: A Global Call for Action (ISPAH, 2010). Alongside the Toronto Charter, “NCD Prevention: Investments that Work for Physical Activity” was released as a guide to help nations prioritise resources in PA promotion efforts (ISPAH, 2011). The Toronto charter aimed to address pitfalls of previous policy efforts by promoting cross-sectoral and whole-of-community approaches. Following this, in 2013 the WHO published a global target including priority actions to reduce premature mortality from the four leading NCDs (CVDs, cancer, diabetes and chronic respiratory disease) by 25% by 2025 (WHO, 2013).

Recently, the WHO developed and published the GAPPa 2018-2030: More Active People for a Healthier World (World Health Organization, 2018). This action plan sets out four strategic objectives that can be achieved through 20 policy actions that are applicable globally. Aligning with GAPPa, in 2020 ISPAH published the Eight Best Investments that Work for Physical Activity; a call to action for everyone to embed PA in national and subnational policies (ISPAH, 2020). The GAPPa and Eight Best Investments and their relevance for this thesis will be discussed in more detail later in this chapter.

Despite the existence of such policies and extensive international research efforts and the identification of various effective interventions (Heath et al., 2012; Varela et al., 2017), as a world we are failing to change PA behaviour (Abbasi-Kangevari et al., 2020). Available data show that physical inactivity prevalence has remained mostly stable over the past 15 years globally (Guthold et al., 2018; Tracy et al., 2019). In 2018, the global (data from 168 countries) age-standardised prevalence of insufficient PA for adults aged 18 and over was 27.5% (Guthold et al., 2018). Even more concerning is that 81% of adolescents (aged 11-17) were insufficiently active worldwide in 2016 (Guthold et al., 2020).

Exacerbating these prevalence figures, recent research suggests that the global pandemic caused by the Covid-19 virus has had a negative impact on PA behaviour in both adults (Lesser & Nienhuis, 2020), and in children and adolescents (Bates et al., 2020). As a whole, these data indicate that, so far, global and national governing bodies' strategies to improve PA levels

have not been able to increase the proportion of the population meeting PA recommendations (Hallal et al., 2012; Rutter et al., 2019), and further illuminate the urgent need for improved PA promotion.

A systems approach to improving population physical activity

According to ecological models, the existence of policies can affect a person's behaviour by interacting with individual determinants as well as their social, cultural, natural, and built environment (Pratt et al., 2014). Thus, PA promotion in recent years has increasingly focused on an ecological approach whereby PA interventions are designed to address the problem at a personal, social, policy or environmental level (Mehtala et al., 2014). However, it has been argued that this approach does not necessarily consider how problems on each of these levels interact and influence one another (Rutter et al., 2019).

This same argument suggests that the lack of improvement in PA levels is at least partially due to PA promotion efforts being isolated, inadequate and inequitable (Rutter et al., 2019). It is believed that by thinking of the system as an interactive whole, better solutions will be found (Piggin et al., 2017, p. 10). Thus, building on an ecological approach, it has been suggested that systems theory and tools such as systems mapping may play an important role in responding to complex public health challenges such as physical inactivity (Friel et al., 2017; Hawe et al., 2009; Peters, 2014; Rutter et al., 2017).

Within public health, systems thinking has been utilised most extensively in the field of obesity (Bagnall et al., 2019; Swinburn et al., 2019), in which recently an Action Scales Model has been developed to help policymakers and practitioners work within complex systems to address obesity, and to help evaluators theorise, identify and appraise actions within a complex system (Nobles et al., 2021). The field of PA for health is now progressing towards systems thinking, with a systems map having been recently developed specifically to help achieve global PA plans (Rutter et al., 2019).

Physical inactivity is a complex issue, and therefore a systems model for PA is a complex one. A complex systems model of public health theorises poor health and inequalities as consequences of a host of interdependent elements within a connected whole (Rutter et al., 2019). The elements within a complex systems model affect one another in sometimes subtle ways, and changes in one element may echo throughout the system (Rutter et al., 2017).

Both ecological and systems approaches for PA promotion include not only environmental and socio-political factors, but also societal and individual factors, and a systems approach considers how each of these factors may influence one another. Both approaches acknowledge that alongside efforts to modify policy and the physical environment to promote PA (Sallis et al., 1998), there is an important role for approaches that attempt to change individual and societal beliefs and attitudes about PA, and which therefore

promote PA through changes to individual factors such as motivation and self-efficacy, and to consider how these factors may interact with other elements of the whole system.

In line with the systems approach to target physical inactivity, GAPPA 2018-2030 calls for establishments globally to utilise a coordinated, whole-of-system approach to ensure effective implementation of its recommended policy actions at national and subnational levels (Tracy et al., 2019). In short, GAPPA's strategic aims include creating "active societies" through policy actions such as implementing mass media campaigns, creating "active environments" through policy actions such as improving walking and cycling infrastructure, creating "active people" through policy actions such as improving quality of physical education, and creating "active systems" through policy actions such as enhancing PA policy research, implementation, evaluation, and surveillance. It can be said that these four strategic aims broadly align with the areas of an ecological approach: personal (active people), social (active societies), policy (active systems) and environmental (active environments) levels.

In line with the various strategic aims of GAPPA, ISPAH's Eight Best Investments that work for PA highlight the importance of eight different investment areas, from active travel and active urban design to healthcare and workplaces. Of the recommended policy actions and best investments, several demonstrate an important role for communication approaches. For example, the GAPPA strategic aim 'create active societies' recommends

implementing best practice communication campaigns to heighten awareness, knowledge and understanding of, and appreciation for, the numerous health benefits of taking part in more PA. Similarly, the best investment of 'public education, including mass media' from ISPAH promotes the use of various forms of media to facilitate mass-distribution of information and enhance awareness and understanding of PA. Evidently, the importance of communication approaches in improving population level PA have been acknowledged. Yet, there is evidence to suggest that such approaches may be undervalued.

A systems approach encompassing a broad range of areas for policy development offers opportunity for improving PA through a comprehensive approach. However, it has been argued that this approach also opens up the risk of "uncoordinated policy actions, piecemeal planning and patchy implementation" (Nau et al., 2019). In GAPP 2018-2030, creating "active societies", "active people" and "active systems" are strategic objectives that are held in equal weight by the WHO as "creating active environments", yet this equal weighting is not necessarily reflected in policy and promotion to date. A cross-sectoral analysis of PA policy in Australia published in 2019 found substantial evidence of policies that align with the strategic objective of creating "active environments", but fewer examples of policy addressing "active people" and "active societies" (Nau et al., 2019). Specifically, this audit found that urban design and infrastructure, and transport and environment were addressed in 61% and 53% of policies reviewed, respectively. Conversely, mass media and public education were only

addressed in 31% of policies reviewed. Thus, there is a need for further research into communication approaches and greater efforts to promote PA at a societal and individual level to complement efforts at other levels, such as environmental. If an individual has a negative perception of cycling, will adding in a new cycle lane be impactful? It will likely take a combination of individual-level and environmental and policy-level interventions to achieve and maintain substantial positive change in PA behaviour (Sallis & Owen, 2015).

Health communication in physical activity promotion

As advocated by ISPAH Eight Best Investments and GAPPA, one way of promoting PA at an individual and societal level is through health communication approaches. Health communication encompasses the study and use of communication strategies to inform, influence and motivate individual, institutional and public audiences about important health issues (US Department of Health and Human Services, 2010). Health communication has been argued as being more akin to health education than health promotion (Cross et al., 2017, pp. 5-6). Health education's attendant focus is on behavioural determinants of health and aiming to address these through educational efforts aimed largely at the individual (Green, 2015). Although health education is considered key component of health promotion, health promotion goes beyond the definition of health education as it also addresses structural, social, and environmental determinants of health (Dixey et al., 2013).

Since the beginning of the mass communication period, health communication approaches have been utilised with varying levels of success across a range of disciplines within the public health field, such as in alcohol consumption (Young et al., 2018), smoking cessation (Borland & Balmford, 2003), seatbelt use (Akbari et al., 2021), cancer screening (Stratigos et al., 2007), and promoting healthy diet (Herbert et al., 2010).

Health communication approaches have also been used in the field of PA for health. There are various outcomes that may be targeted by PA communication approaches. Almost 20 years ago, Cavill & Bauman (2004) proposed seven potential levels of impact of PA communication: (1) awareness, (2) knowledge, (3) saliency, (4) attitudes/beliefs, (5) self-efficacy, (6) intention, and finally (7) behaviour itself. Importantly, these levels or stages are not necessarily sequential, but rather demonstrate a probably pattern of change. The authors also note that attrition between each of these seven stages or levels of impact means that the final proportion of a given population exposed to a PA message who actually change behaviour may be small (Cavill & Bauman, 2004). This notion is reflected in PA communication literature to date. While some large-scale PA communication efforts have positively affected awareness (Barnes et al., 2013; Booth et al., 1992; Leavy et al., 2013; Owen et al., 1995) attitudes (Beaudoin et al., 2007; Leavy, 2014; Leavy, 2011) and PA behaviour (Barnes et al., 2013; Booth et al., 1992; Leavy et al., 2013; Owen et al., 1995), generally, health communication interventions to date have shown limited effects on PA behaviour and mixed findings on more immediate outcomes. Therefore, there is a need to further

understand how to most effectively use PA communication approaches to target individual and social factors as part of a systems approach to improving population level PA. The potential role of communication approaches in promoting population level physical inactivity is described in more detail in the next chapter (Chapter 3).

Chapter summary

Physical inactivity is a significant contributor to the growing global burden of NCDs and premature mortality. Despite the existence of PA guidelines and PA policy, levels of inactivity across the globe have remained relatively stable over the past 15 years. The public health field now acknowledges the importance of using a systems approach to target population PA; one that recognises the importance of environmental, societal, social, and individual factors, as well as how these various factors may interact with one another to impact PA behaviour. There is evidence to suggest that policy and PA promotion efforts to date have focused more on changing the physical environment, with less attempts made to target social and individual factors. Further research to better understand how we can most effectively utilise health communication to promote PA is essential. The next chapter will look at PA messaging as a subtype of health communication in greater detail and consider its role in PA promotion.

Chapter 3 Physical activity messaging: its role in physical activity promotion and key concepts

Chapter outline

This chapter describes the overarching concept of PA communication before discussing the specific role of PA messaging in promoting PA at a population level. Specifically, this chapter aims to describe the topic of health communication and its importance to public health, justify the decisions to focus on PA messaging as a subtype of health communication, and outline key messaging sub-concepts and highlight research gaps.

The overarching concept of physical activity communication

An editorial by Bernhardt (2004) provides a useful overview to the background and importance of broad public health communication. Almost 20 years ago definitions for 'health communication' and 'public health' were combined to give the following definition for 'public health communication': "the scientific development, strategic dissemination, and critical evaluation of relevant, accurate, accessible and understandable health information communication to and from intended audiences to advance the health of the public" (Bernhardt, 2004, p. 2051). At this time, public health communication was associated only with dissemination of scientific findings by various public health professionals who assumed that public health information could "speak for itself" (Bernhardt, 2004, p. 2051). It was also argued that communication operated at the "periphery of public health" (Bernhardt, 2004, p. 2051). As outlined in the previous chapter, there is evidence to suggest that communication techniques are still less frequently researched and

utilised (and arguably less valued) in PA promotion than other approaches such as changes to the physical environment. However, there has been an increase in PA communication research in recent years.

Adapting the above definition of public health communication, I have defined *PA communication* as “scientific development, strategic dissemination, and critical evaluation of relevant, accurate, accessible and understandable PA related information communication to and from intended audiences to advance the health of the public through improving PA levels” for the purpose of this thesis. As discussed in the previous chapter and as reflected in GAPP 2018-2030 (World Health Organization, 2018), the importance of utilising a systems approach to target population level physical inactivity is now widely recognised.

Public health communication embraces this approach as its many subtypes have potential to influence change at individual (creating “active people”), social (creating “active societies”), environmental (creating “active environments”) and policy levels (creating “active systems”) (Bernhardt, 2004). For example, to create “active systems” we may utilise media advocacy. Media advocacy has a goal of changing public policy rather than individual health behaviour, and focuses primarily on reaching opinion leaders and policymakers rather than the traditional audience of public health communication (Institute of Medicine, 2003). To create “active environments”, we can combine communication with the physical environment to create ‘point of decisions prompts’, such as posters that

encourage stair use over elevator use (Nocon et al., 2010). To create “active societies”, we may utilise mass media campaigns and social marketing to promote socially beneficial behaviour change (Grier & Bryant, 2005). To create “active people”, targeted messaging may be used to define a population subgroup based on common characteristics and then provide relevant information to this subgroup (Schmid et al., 2008). Alternatively we may provide one to one PA counselling (Elley et al., 2003) or tailored messaging which fits messages to individual level characteristics and preferences (Schmid et al., 2008).

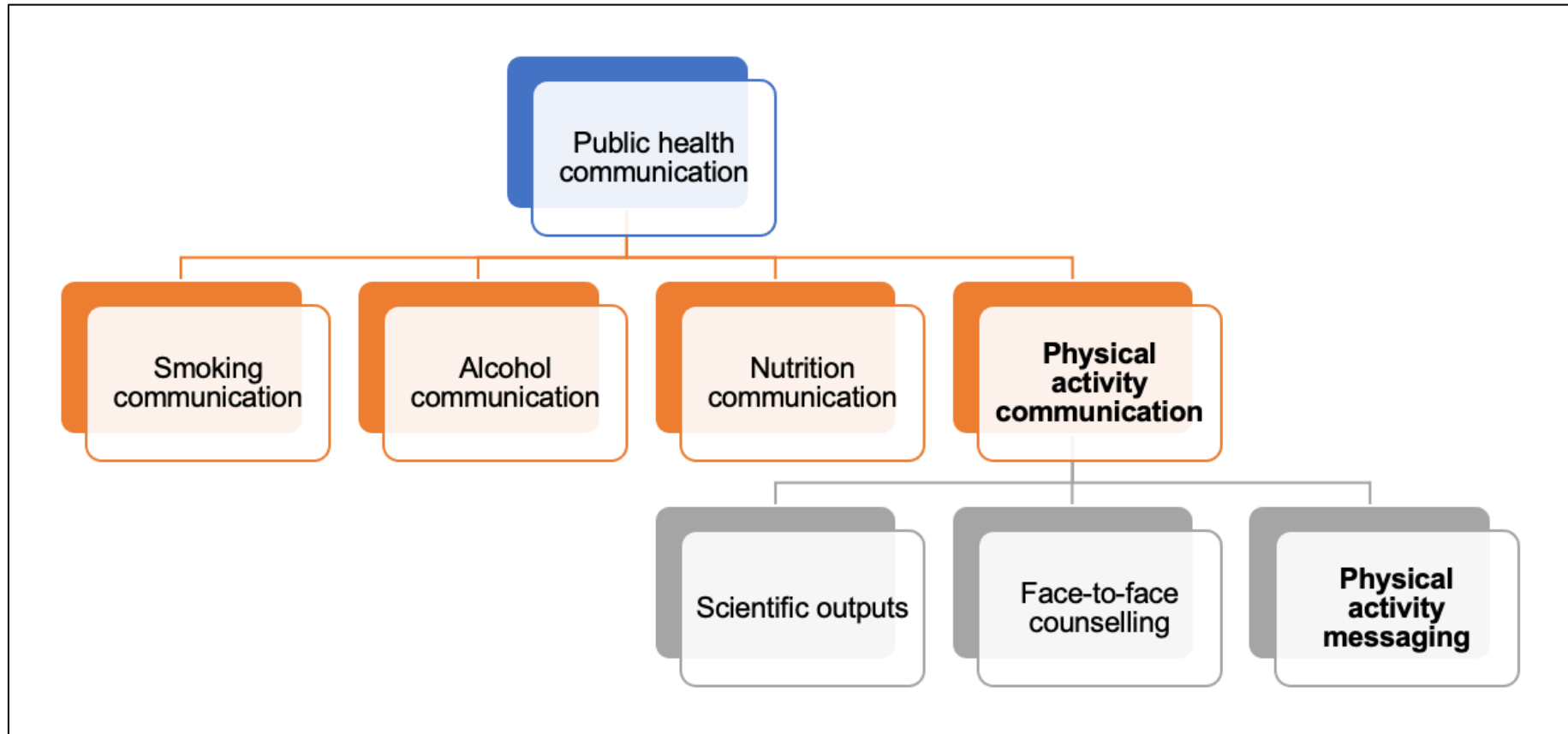
Although the extent to which public health communication may play a role at each of these levels varies, the potential role of communication strategies in improving public health is increasingly clear. As described in Chapter 2, there is an argument that communication approaches have been overlooked or are an undervalued element of the systems approach. As this thesis is unable to address an entire systems approach, it will focus on communication approaches, appreciating how such approaches may interact with approaches from other systems.

The potential role of physical activity messaging in PA promotion

This thesis focuses specifically on PA messaging as a sub-type of PA communication and even wider public health communication (see Figure 3-1), although it will consider and discuss the implications within the wider contexts of PA and even health communication, as well as to the broader system. Although no universally agreed definition of PA messaging exists,

interventions utilising this technique tend to feature the delivery of PA related information to members of the population with the aim of either directly (change behaviour immediately) or indirectly (change behaviour through a pathway) improving PA levels. To guide study 1 (and subsequent studies in this thesis), the following working definition of PA messaging was developed: PA messaging can be defined as the overall process of designing, creating, and delivering PA messages. Further definitions for more specific elements of PA messaging will be presented in Chapter 5 (see page 107).

FIGURE 3-1: PHYSICAL ACTIVITY MESSAGING AS A SUBTYPE OF WIDER HEALTH COMMUNICATION



Note: the above figure is not comprehensive. Communication subtypes displayed in this figure are examples only.

The rationale to focus on PA messaging in this thesis has four key interlinked components. First, messaging interventions can be used to reach large numbers of people at relatively low cost compared to other PA communication approaches, meaning it has potential to influence population-level thinking around PA (Cavill & Bauman, 2004). Public health campaigns involving messaging have played key roles in changing social climates around other public health concerns such as smoking (Almestahiri et al., 2017), vaccinations (Nowak et al., 2015), and seat-belt use (Zambon et al., 2012). PA messaging is therefore important as a potentially scalable and cost-effective method of improving PA levels compared to more intensive communication approaches e.g., one-to-one counselling.

Second, messaging is important in the dissemination of PA research findings. Obtaining meaningful research findings alone will not change behaviour, and most research information needs translation into messages that can aid dissemination of findings to relevant audiences. A key example of this can be found in the dissemination PA guidelines. PA guidelines (as described in the previous chapter) and the evidence reviews that guide them are not generally created with the notion that they will be public facing, nor with the notion that they will motivate people to become or remain physically active simply through existing (Latimer et al., 2010). Therefore, the use of messaging is encouraged to inform the public about how and why they should be physically active in a way that is meaningful and digestible to them (Brawley & Latimer, 2007). Furthermore, as mentioned in Chapter 1, during the design of this PhD, the UK CMO PA Guidelines were being updated, and

there was a policy and scientific motivation to improve the messaging approach compared to the 2011 guidelines. How to effectively message the new guidelines was an evidence gap that I wished to try and address. It should be noted that PA is not only important for disease prevention later in life but should play a fundamental role in our daily lives. Therefore, it is argued that a broader understanding of PA as part of daily living should influence PA guidelines, research and PA promotion (Silva et al., 2017). For this reason, this thesis will consider and include broader PA messages as well as guideline-specific messages.

Third, we do not yet understand how to effectively develop and deliver PA messages. Although a number of reviews focusing on PA messaging exist (Berry & Latimer-Cheung, 2013; Brawley & Latimer, 2007; Brown et al., 2012; Cavill & Bauman, 2004; Finlay & Faulkner, 2005; Latimer et al., 2010; Latimer-Cheung et al., 2013; J. Leavy et al., 2011), this existing evidence shows PA messaging interventions to date have had limited effects on PA behaviour itself and mixed findings on less distal outcomes such as awareness and motivation. Further research on how to conduct PA messaging most effectively is therefore warranted.

Fourth, and relating to the third point, although some understanding of aspects of message content (Latimer et al., 2010) and delivery (Leavy et al., 2011) exists, many important messaging concepts are not well understood. Gaining greater clarity on what the various PA messaging sub-concepts are and what we know about them may facilitate improved research and practice

in this area. These PA messaging concepts are discussed in greater detail later in this chapter.

Taking these four arguments together, understanding how to create and deliver effective PA messages for and to various population subgroups to reframe societal norms around PA and to re-establish the salience and awareness of PA may play a crucial role in the systems approach of increasing population PA levels. This was a key motivation for, and guided the design and implementation of, this body of research.

Subconcepts of physical activity messaging

It is important to identify key practical PA messaging concepts or components to begin to understand how to create and delivery effective PA messages. When reviewing the literature, I found that PA messaging concepts can be broadly categorised to either relate to message content (what is in the message) and message delivery (how it is delivered to the intended recipient). In the following section I describe five key messaging concepts identified when initially reviewing the messaging literature, organised by prominence and whether they relate to message content or message delivery.

Message content

Relating to message content, an important publication for this thesis is a 2010 systematic review of three messaging approaches for constructing PA messages (Latimer et al., 2010). A key concept of PA messaging considered by this review is message framing whereby health messages are

framed to either highlight a benefit of behaviour engagement (gain-framed) or consequences of failing to engage in a certain behaviour (loss-framed) (Rothman & Salovey, 1997). It is believed that framing messages can enhance message persuasiveness (Salovey & Williams-Piehota, 2004), and that the same information may have differential effects on health behaviour simply by being framed differently.

Latimer et al. found a slight advantage for gain-framed messages over loss-framed messages (Latimer et al., 2010). However, the recommendation for gain-framed messages was made cautiously. This systematic review only included six studies examining the effects of gain- and loss-framing on PA behaviour and/or intentions due to strict inclusion criteria, and the message content and delivery decisions varied greatly across these studies. The studies included only populations which would fit into the “adult” category of PA guidelines (young adult university studies and community dwelling adults). Additional studies that were not included in this review due to inclusion and exclusion criteria do exist and may offer further insights into message framing. Supporting the cautious recommendation for gain-framed messages in PA, a meta-analytic review conducted in 2012 found that in promoting illness prevention behaviours (including PA), gain-framed messaging was more effective in enhancing behaviour (Gallagher & Updegraff, 2012). There have also been several studies relating to PA message framing in various population groups published since this key systematic review was published in 2010 (Bassett-Gunter et al., 2013; Gilbert et al., 2021; Jarvis et al., 2014; Kozak et al., 2013; Lithopoulos et al., 2017),

and it is possible that framing preferences could vary between population subgroups. Thus, further research into the role of PA message framing on various outcomes across each PA guideline group is warranted.

A further PA messaging concept that was investigated in the Latimer et al., 2010 systematic review is message tailoring. Latimer et al. describe message tailoring as presenting information in a manner that suits the individual characteristics of the message recipient (Latimer et al., 2010). It is believed that messaging can improve message salience (Noar et al., 2007), that is, it can make messages more personally relevant to that specific individual (Cavill & Bauman, 2004). Latimer et al. (2010) identified 12 studies examining the effects of message tailoring on PA behaviour and found that overall tailored messages resulted in significantly greater PA compared to control group in over half of the included studies. However, all studies included adult populations and all messages investigated were tailored specifically to individual Stage of Change, as described by the Transtheoretical Model (note that the Stages of Change and their relevance to PA messaging are discussed in greater detail in Chapter 4). There are various other factors to which message content may be tailored, for example based on an individual's goals or PA levels. Therefore, further research into the role of tailoring in PA messaging for various population subgroups is required.

Closely related to and potentially overlapping with message tailoring is the concept of message targeting. Message targeting was not included in the

Latimer et al. systematic review. I found from my initial literature review that the terms tailoring and targeting are not used consistently and are often used interchangeably, despite being distinct concepts. Although both tailoring and targeting approaches involve customisation of message content, message targeting involves designing messages for a *group* that shares distinct features (as opposed to tailoring to an individual) (Kreuter & Wray, 2003). Like tailoring, targeting is believed to improve personal relevance or salience of the message (Cacioppo & Petty, 1982), with the idea that a targeted message is less likely to be overlooked than a generic 'one size fits all' message. Messaging targeting can be applied to broad groups (such as women) or more specific population subgroups (such as women with Type 2 Diabetes).

In 2017, Bassett-Gunter et al. collated three key factors considered important in successful development of targeted messages (Bassett-Gunter et al., 2017). First, messages should meet the informational needs and preferences of the target audience (Lavis et al., 2003, pp. 221-248; Letts et al., 2011). Second, messages should draw on theoretical predictors or determinants of behaviour change, such as self-efficacy (Latimer et al., 2010). Finally, messaging strategies that enhance determinants of message effectiveness (e.g., message salience and credibility) should be used (Rothman & Updegraff, 2010). Although individual studies and reviews have investigated the effects of message targeting in populations including parents of children with disabilities (Bassett-Gunter et al., 2017; Larocca et al., 2021) and for obese women (Leone et al., 2012), prior to this PhD, no review

existed that provided an overview of what is known about targeting PA messages for and to different population subgroups. Such a resource would be useful for construction of PA messages for different PA guideline groups and to advance the area of PA messaging.

Message delivery

The concepts described above (framing, tailoring, and targeting) relate largely to message content that is, what is *in* the message. However, there are also concepts to consider that relate more to what can be termed “message delivery”, that is how the message content is transmitted to the intended recipient(s). Unlike for message content, there is no dedicated systematic review for PA message delivery approaches. However, some message delivery concepts have been explored to an extent in the PA messaging literature.

The aforementioned systematic review of PA messaging approaches found that credibility of source or message provider warrants mention and further investigation (Latimer et al., 2010). Although not in their aims, they found a consistent advantage for message delivered from a highly credible source regardless of whether the message was gain- or loss-framed (Latimer et al., 2010). Further research with a clearer focus on understanding the preferred PA message source or provider for various populations is required.

A further message delivery concept identified in the initial literature review was message media or mode. Various potential modes for message delivery exist, including both digital (SMS, emails, TV advertisements, social

media posts) and non-digital (posters, billboards, leaflets). Existing evidence from previous mass media campaigns indicates using multiple modes of delivery (such as TV advertisements and billboards) may result in more favourable outcomes (Peterson et al., 2008). Some themes can be observed in the existing literature. For example, individual studies have found a dislike to PA guideline documents as a delivery mode in older African American women (SebastiAo et al., 2015) and in the general adult population (Berry et al., 2010), and digital modes of delivery (including SMS and smartphone apps) are indicated as promising modes in adults (Kinnafick et al., 2016) and children and young people (Latimer-Cheung et al., 2013). However, further investigation into the preferences for message mode or media in various groups is warranted.

In addition to PA message source or provider and delivery modes, there are likely further message delivery concepts that exist than were identified in this initial literature review, and which warrant further exploration. Therefore, a formal review is required to map out the various PA delivery concepts that do exist and summarise what we know about each concept for various population subgroups.

Chapter summary

PA communication has potential to influence each level of a systems approach to targeting population level physical inactivity. PA messaging as a specific of subtype of PA communication is of particular interest in this thesis as it is cost effective, has potential to aid dissemination of PA research and

guidelines, and best practice is not known. Within PA messaging there are several sub-concepts relating to content and delivery that warrant further investigation to improve PA messaging practice, and a formal review to explore what is known about the various messaging concepts is required. Prior to embarking on this formal review, the next chapter will consider various models and psychological theories and their potential implications for PA messaging to further our understanding of the theoretical underpinnings of PA messaging.

Chapter 4 Theoretical underpinnings of physical activity messaging

Chapter outline

Models and theories provide plausible explanations for how interventions, such as PA messaging interventions, may bring about change in behaviour or related outcomes. There is recognition in the disciplines of psychology and public health that the development and implementation of behaviour change interventions are enhanced by applying theory (Craig et al., 2008). Therefore, guided by principles of good research practice (Michie & Prestwich, 2010) and discussions with my advisory group, it was decided early on in that this PhD research would aim to acknowledge and align with existing theory with relevance for PA communication, and more specifically PA messaging. This chapter aims to describe the theoretical underpinnings of PA messaging to help guide the theoretical position of this research. Specifically, this chapter provides an overview of existing communication models, as well as various psychological theories and approaches, and considers their implications for PA messaging.

A brief history of communication models

Models that help us understand how communication works have been around for over 70 years. Three key communication models and their potential implications for PA messaging are described in the following section (summarised below in Table 4-1).

TABLE 4-1: KEY COMMUNICATION MODELS AND THEIR IMPLICATIONS FOR PHYSICAL ACTIVITY MESSAGING

Model or theory	Key principles	Potential implications for PA messaging
Linear, one-way communication models	Information (or a message) is transferred from a source to a recipient in a linear fashion.	PA messages may consider who says what, to whom, in which channel, and to what effect.
Cyclical or circular communication models	Information (or a message) is passed between senders and receivers with no endpoint.	Where possible, PA may include feedback from the recipient to improve future messages.
Communication (input-output) persuasion model	There are five key steps in successful persuasion (i.e., persuasion that results in change): exposure and attention to the message, comprehension of the message, yielding to the message, retaining the message, and acting on the message.	PA messaging is unlikely to immediately result in PA behaviour change. There are likely several more proximal PA-related outcomes that may first be affected by messaging.

Linear, one-way communication models

In 1948, Laswell developed the Formula of One-Way Communication; a classic model of how communication involves the transfer of information from source to recipient (Laswell, 1948). This early model of communication described the process as “who says what, to whom, in which channel, with what effect?” (Cross et al., 2017, p. 20) and reflects an early understanding of communication; that it is a persuasive process serving the purpose of influencing the recipient. In this model, the primary purpose is to transmit a message and for the message to have an effect; the purpose of creating behaviour change within the recipient is implicit (McQuail & Windahl, 1993). Another one-way, linear model is Shannon-Weaver’s 1949 model, which

builds on Laswell's model by including metaphorical 'noise', or factors that influence the communication process (Shannon & Weaver, 1963). This may refer to external 'noise' in the environment and social context or, internal 'noise' from the life experiences of the individual recipient (Hargie, 2016). Crucially, both of these early models of communication do not feature any feedback loop (Hartley, 1999). This is an important critique of linear models, as feedback is required to improve and assess if the communication has been effective (Cross et al., 2017, p. 20).

Cyclical or circular communication models

To better reflect the rich, complex, and cyclical nature of human communication, further models of communication were developed. In the Circular Model of Communication (Schramm, 1949), messages are passed between senders and receivers with no endpoint; the sender and receiver exchange information forwards and backwards, both interpreting messages from and giving feedback to the other (Cross et al., 2017, p. 21). In the Simple Model of Interpersonal Communication (Hartley, 1999) there is a focus on social identity and perceptions of both the sender and receiver with the assumption that mental and cognitive processes shape behaviours and how we communicate (Cross et al., 2017, p. 21). Greene et al. present a more comprehensive communication model demonstrating the communication process and the reciprocal nature of the relationship between sender and receiver (Green, 2015, p. 313).

Although linear models of communication are heavily criticised, it can be argued that both linear and circular models of communication serve a

purpose depending on the type of communication in question. For example, circular models may be useful in communication types where direct interaction between senders and recipients occurs such as in one-to-one counselling. Similarly, linear models may be useful in mass communication efforts where messages are sent to recipients through various media channels and direct interaction between sender and recipient is not possible or appropriate. Therefore, despite their limitations, linear models may have relevance for PA messaging, the specific focus of this thesis.

Communication (input-output) persuasion model

One concept that features throughout communication models and theories is persuasion. In 1969, McGuire formulated the Communication/Persuasion or Input-Output Persuasion Model (McGuire, 1969). McGuire's model identifies five critical steps in successful persuasion (i.e., persuasion that results in change). These steps are: (1) exposure and attention to the message, (2) comprehension of the message, (3) yielding to the message (personalising the behaviour to fit one's life and accepting the change), (4) retaining the message, (5) acting to make the change and accepting the behaviour in one's life. Demonstrating clear parallels with Laswell's (1948) model (who, says what, through which channel, to whom, with what effects), McGuire's model also considers how various aspects of the messaging process, including message design, source, channel and receiver characteristics will affect the message outcome (Institute of Medicine, 2003, p. 343).

Overall, various communication models that have been developed and adapted over time exist to help us to understand how communication may 'work', that is, change behaviour. These models outline the overall process of communication and highlight some key concepts for consideration in PA messaging. However, to fully understand how and why communications such as messages may bring about a change in PA behaviour, we should consider these models alongside psychological theory.

Theories and approaches in physical activity messaging

Behaviour change interventions can be defined as “coordinated sets of activities designed to change specified behaviour patterns” (Michie et al., 2011, p. 1). Theory, which has been defined as “a set of concepts and/or statements with specification of a system that accounts for what is known and explains and predicts phenomena” (Davis et al., 2015, p. 327), can improve efficacy of behaviour change interventions. Specifically, behavioural change theories focus on understanding and attempting to explain behaviour change, such as PA. To maximise potential effectiveness of interventions aiming to change PA behaviour it is necessary to have a theoretical understanding of behaviour change (Davis et al., 2015). Indeed, evidence suggests that theory-based PA interventions have greater chance of success than approaches that do not draw on theory (Michie & Abraham, 2004; Rhodes et al., 2019), and therefore theoretical frameworks are generally considered to be an essential element in PA research (Rhodes & Nigg, 2011).

There are multiple theories and theoretical frameworks that may help us to understand the potential role of PA communication in promoting PA behaviour change at a population level. To begin exploring the potential theoretical underpinnings of PA messaging, I refer here to a recent publication providing a narrative historical overview of four key theoretical frameworks that have been applied to aid understanding of PA over the past three decades (Rhodes et al., 2019).

Rhodes et al., 2019 describe that early PA psychology research was largely atheoretical, with researchers using available measures in secondary data analysis to predict and explain PA participation and maintenance (Dishman, 1988). Although this early research expanded the use of potential determinants of PA, it has been argued that it created a list of variables that lacked coherence, and which were not explored in depth (Courneya, 2004). It also became apparent that using elements of PA guidelines themselves as messages, e.g., telling people to do a certain amount of activity, was not sufficient to produce behaviour change, and that a range of behavioural influences (both internal and external) are required to enhance PA (Rhodes et al., 2019). Subsequently, the application of theoretical frameworks in the late 1980s and early 90s can be considered as a crucial transitional point in PA research (Rhodes et al., 2019). Theoretical frameworks provide opportunities to understand, explain and intervene upon PA behaviour (Rothman, 2004).

Rhodes et al., 2019 outline four main theoretical frameworks that have become dominant in the psychology of PA discipline: (1) social cognitive approaches, (2) humanistic/organismic approaches, (3) socio-ecological approaches, and (4) dual-process approaches. In the following section, ten key theories with potentially important implications for PA messaging are described and, where appropriate, organised by these four main theoretical frameworks as outlined by Rhodes et al., 2019. These theories, their key principles and potential implications for PA messaging are summarised in Table 4-2.

TABLE 4-2: KEY MODELS AND THEORIES WITH IMPLICATIONS FOR PHYSICAL ACTIVITY MESSAGING

Theories	Key principles	Implications for PA messaging
1. The social cognitive framework		
Social cognitive theory (self-efficacy)	<p>1. Self-efficacy (an individual's belief that they are capable of successfully carrying out a task) is a strong influence of behaviour.</p> <p>2. Individuals will act in ways they believe will lead to favourable outcomes and avoid behaviours which may lead to unfavourable outcomes.</p>	PA messages may aim to improve PA through improving self-efficacy or by encouraging positive outcome expectations through highlighting benefits of being active or consequences of being inactive.
Health belief model	Individuals are more or less likely to take up a behaviour depending on their beliefs around susceptibility to the outcomes and pros/cons of taking up behaviour.	PA messages may seek to change beliefs around the benefits and barriers of PA and susceptibility to inactivity-related consequences (e.g., non-communicable disease).
Diffusion of innovation theory	New ideas, notions, opinions, attitudes, and behaviours are communicated through various channels over time and disseminated among individuals within a system. Perceived characteristics of an innovation influence its adoption	PA messages should be easy to understand, should be in line with the target population's values and needs, and may seek to demonstrate that engaging in PA as a 'better' option than the alternative of not being active.
Stages of Change (Trans-theoretical model)	Five psychological 'stages' can be observed in people making a behavioural change. Individuals may fall into one of these five categories based on their capabilities, motivation, or intent.	Optimal PA messages for individuals in one stage of change may differ from optimal PA messages for individuals in another stage of change.
Theories of Reasoned Action and Planned Behaviour	Behaviour adoption is a result of a person's intention to perform that behaviour. In turn, intention to perform a given behaviour is a result of a person's attitude towards that behaviour and of perceived social norms, motivation to comply, and the extent to which an individual believes they are capable of taking up that behaviour.	Correlates and determinants of PA such as attitudes, social norms and motivation may be important targets of PA messages.

2. Humanistic/organismic framework		
Self-determination theory	Humans have an innate drive to fulfil three basic needs: relatedness, autonomy, and competence. Motivation can be considered as a continuum of self-determination from amotivation to intrinsic motivation.	PA messages should aim to target relatedness, autonomy and competence, and should focus more on benefits or consequences of PA that relate to more intrinsic forms of motivation than those relating to extrinsic forms.
3. Dual process framework		
Theories of emotional response and dual processes	Affect and cognition are under control of distinct and somewhat independent systems. Thoughts and behaviours can arise through two distinct routes or processes: implicit/impulsive (automatic, unconscious) and explicit/reflective (controlled, conscious).	PA messages should consider how messages may function through one of two potential pathways to create behaviour change.
4. Socioecological framework		
Socioecological model	Behaviour is a result of direct, indirect, and interactive influences from factors that exist on interpersonal, intrapersonal, community and policy levels.	PA messaging has potential to contribute to socioecological framework approaches by targeting individual factors.
Other		
Social marketing theory	Behaviour change can occur by offering benefits in exchange for adopting the desired behaviour. Insight-driven segmentation is important to develop interventions based on audience needs, values and circumstances.	PA messaging may utilise social marketing principles such as audience segmentation to create more targeted and effective messages that meet the needs of the target audience.
Behaviour Change Wheel (BCW) and COM-B Model	There are several potential intervention and policy actions that could be used to target specific mechanisms required to create behaviour change. An individual's capability, opportunity and motivation interact to generate behaviour.	PA messages may wish to utilise intervention functions such as education and persuasion to target opportunity, capability and/or motivation as mechanisms of behaviour change.

The social cognitive framework

Understanding different correlates and determinants of PA is a crucial step in developing effective PA interventions. There is a vast number of such variables (Troost et al., 2002), however, cognition-related variables are often at the forefront of health promotion research as they are thought to be the most proximal factors to the health behaviour itself (e.g., PA), and more susceptible to change compared with other variables (e.g., socio-demographic factors) (Luszczynska & Schwarzer, 2005). To try and provide overarching explanations for human behaviour, theorists have structured these cognitive variables into explanatory frameworks or social cognitive theories. Below, five theories that fit within the social cognitive framework and their relevance for PA messaging are described.

Social Cognitive Theory (including self-efficacy)

One social cognition model that has been used widely in PA promotion literature is Bandura's Social Cognitive Theory (SCT) (Bandura, 2001). The two main constructs within SCT are self-efficacy and outcome expectations. Self-efficacy describes a state-like and task-specific form of self-confidence, defined as an individual's belief that they are capable of successfully carrying out a potentially difficult task (Bandura, 1997). Self-efficacy is widely regarded as the most significant contribution of SCT to the evidence base (Rhodes & Nigg, 2011), and literature demonstrates it is strongly and consistently associated with PA (Bauman et al., 2012). The second key construct, outcome expectations, represent an individual's

judgements of the likely consequences that will occur as a result of (or not) performing a certain task or behaviour (Bandura, 2004).

This construct relates to the key assumption of SCT, that individuals will act in ways they believe will lead to favourable outcomes and avoid behaviours which may lead to unfavourable outcomes (Williams et al., 2005). These outcomes may be physical, social or self-evaluative (Bandura, 1997). Relatedly, it has been suggested that individuals may be sensitive to the manner in which these outcomes are framed in terms of gains (benefits) or losses (negative consequences), and depending on how 'risky' the behaviour is (Rothman & Salovey, 1997; Tversky & Kahneman, 1981), relating to message framing (described in Chapter 3). A third and final construct within Social Cognitive Theory is 'goals' which mediate the influence of the other constructs on behaviour (Bandura, 2004). In line with SCT, therefore, PA messages may aim to improve PA through improving self-efficacy or by encouraging positive outcome expectations through highlighting benefits of being active or consequences of being inactive.

Health Belief Model

One of the earliest psychological theories devised to help us understand health-related behavioural change is the health belief model (Becker, 1974). This model was developed in an attempt to explain why individuals do or do not engage in preventative and/or protective health behaviours (Salazar et al., 2013) and reflects a conscious decision-making process. The health belief model proposes that individuals are more or less likely to take up certain behaviours based on a range of beliefs, such as how

susceptible they believe they are to a condition, and the perceived pros and cons of making a change (Cross et al., 2017, p. 61). In other words, the health belief model proposes that for an individual to adopt a recommended health-protective behaviour they must (a) feel adequately susceptible or threatened by the disease or condition, and (b) believe that the benefits of taking action outweigh the perceived costs (Institute of Medicine, 2003).

Despite the popularity of the health belief model in explaining adherence to various behaviours, there is a comparative lack of systematic meta-analytic research (Cross et al., 2017, p. 61), perhaps due to the inconsistent application of health belief model across interventions (Rodham, 2010). Meta-analytic evidence that does exist suggests that perceiving the benefits of the behaviour to be high and the barriers to the behaviour as low are the strongest predictors of behaviour (Carpenter, 2010). To this end, PA messages that successfully target perceived benefits of and barriers to PA may have a higher chance of success.

Diffusion Theory

Also relevant to PA messaging and arguably falling within the social cognitive framework is Everett Roger's Diffusion Theory (Rogers, 2003). This theory describes the process by which innovations, ideas, notions, opinions, attitudes and behaviours are communicated through various channels over time and disseminated among individuals within a social system or community (Institute of Medicine, 2003). This theory has been used for over six decades to examine the spread of various innovations, such as new technology and educational curricula (Institute of Medicine, 2003), as well as

to analyse how the transfer of effective programs occurs (Owen et al., 2006). Diffusion theory involves five major assumptions: (1) adoption of an innovation takes time, (2) people pass through various stages in the adoption process, (3) people can modify the innovation and sometimes continue its use, (4) the perceived characteristics of the innovation influence its adoption, and (5) individual characteristics influence its adoption (Institute of Medicine, 2003).

Relating to the fourth assumption of Diffusion Theory, there are several perceived characteristics of innovation that may affect how readily it will be adopted. Some of the characteristics that may have particular relevance in PA messaging include “relative advantage”, or the degree to which the innovation is perceived as better than what was previously available, “compatibility”; the degree to which the innovation is consistent with values, experience and needs of the individual, and “complexity”; how difficult the innovation is to understand or use (Owen et al., 2006). In line with Diffusion Theory, PA messages should align with the target population’s values and needs, should be easy to understand, and may seek to demonstrate engaging in PA as a ‘better’ option than what was previously available (e.g., being inactive). In addition to considering different characteristics of the innovation itself, Diffusion Theory also categorises individuals based on their respective rates of adopting innovative ideas (innovators, early adopters, early majority, late majority, and laggards). Having awareness of these different groups in PA promotion efforts is important as one approach to sharing a PA message may not suit all. For

example, where 'early adopters' may already be aware of the need for change and feel comfortable trying something new, 'laggards' may be more sceptical and require greater persuasion.

Stages of Change (Transtheoretical Model)

A further theory that recognises different groups of readiness to change or adopt new behaviours is the Stages of Change Theory. Part of the wider Transtheoretical Model (Prochaska & Velicer, 1997), Stages of Change theory posits that numerous psychological 'stages' can be observed in people making a behavioural change: (1) pre-contemplation (not really considering making the change), (2) contemplation, (3) preparation (intention to make the change), (4) action (making the change), and (5) maintenance. These five stages exist in a 'spiral' formation, meaning an individual may progress forwards through the stages as well as relapse backwards. Different strategies are theorised to be needed at different stages of change, as there are several reasons why an individual may be classed as being in one stage over another, for example based on their capabilities, their motivation, or their intent to be active. Therefore, PA messages that 'work' for those in the preparation stage may be different to those that are effective for pre-contemplators.

Theories of Reasoned and Planned Behaviour

Theory of Reasoned Action (Fishbein & Ajzen, 1975) also has relevance for PA messaging. This theory postulates that behaviour adoption is a result of a person's intention to perform that behaviour. In turn, the intention to perform a given behaviour is a result of a person's attitude

towards performing that behaviour and of perceived social norms and motivations to comply (Institute of Medicine, 2003). In addition to attitude and perceived social norms, the Theory of Planned Behaviour (Ajzen, 1991) builds on the Theory of Reasoned Action by adding a third construct; perceived behavioural control. This construct refers to the extent to which an individual believes they are capable of taking up a particular behaviour (Crosby et al., 2013) and is considered similar to the concept of self-efficacy (as described earlier in this chapter). Importantly, in line with Theories of Reasoned Action and Planned Behaviour, correlates, and determinants of PA such as attitudes, social norms, and motivation may therefore be important targets of PA messages.

Summary of the social cognitive framework

To summarise, the social cognitive framework is based on the basis that people form, and consequently act on, expectancies of behavioural events and outcomes (Rhodes et al., 2019). Particularly, valued outcomes and expectancies that are most important are considered critical to subsequent behaviour (Rhodes et al., 2019). Although these outcomes and expectancies are labelled differently across several social cognitive theories, they generally involve a focus on expectancies related to behaviour outcomes (such as weighing up pros and cons, considering barriers and facilitators, attitudes, and outcome expectations) or on one's ability (or belief in their ability) to perform a behaviour that will result in a certain outcome (self-efficacy, competence, and perceived behavioural control). These elements are subsequently believed to create an intention to act that then

determines behaviour change (Rhodes, 2017). In simple terms, theories within the social cognitive framework posit that individuals will intend to be active if they believe that PA is important, and they believe they are capable of being active.

Humanistic/organismic framework and physical activity

Considering human behaviour from a slightly different point of view, humanistic or organismic perspectives theorise that humans have innate needs and that behaviour is not simply a response to reinforcement or punishment. That is, whether someone will behave in a certain way is not only a result of what they believe the outcome will be. Rather, behaviour is thought to be motivated by an inherent drive to grow, develop and realize one's potential (Rhodes et al., 2019). This concept is often referred to as self-actualization (Maslow, 1943).

Self-determination theory

Self-determination theory (SDT) is the most common theory to come from these humanistic or organismic perspectives (Deci, 1985). SDT is comprised of five smaller theories. These theories and how they inform our understanding of motivation are outlined in Table 4-3.

TABLE 4-3: MINI THEORIES WITHIN SELF-DETERMINATION THEORY

Mini theory	How this mini theory informs our understanding of motivation
Causality orientations theory	Helps us to understand individual differences in one's tendencies towards motivation
Goal contents theory	Helps us to understand the types of goals that people strive to achieve
Cognitive evaluation theory	Helps us to understand the conditions in one's environment that can impact their motivation
Basic psychological needs theory	Helps us to understand the psychological needs that each person has in relation to motivation
Organismic integration theory	Helps us to understand individual innate tendencies to partake in activities and refine their inner representation of themselves

Source of information: (Deci & Ryan, 2000).

Two of the five mini theories within SDT are widely used to examine PA behaviour; basic psychological needs theory (BPNT) and organismic integration theory (OIT) (Rhodes et al., 2019). BPNT posits that humans have an inherent drive to fulfil three basic needs: (1) experiencing meaningful connections with other people (relatedness), (2) having control or sense of choice over their own behaviour (autonomy) and (3) feeling capable and effective when carrying out a task (competence) (Ryan et al., 2009). OIT suggests that motivation is considered as a continuum of self-determination, with amotivation (or having no motivation to be physically active) on one side of a spectrum, and intrinsic motivation (engaging in physical activity for its own sake, for example because it is enjoyable) on the other side of the spectrum (Ryan et al., 2009).

Extrinsic motivation falls somewhere between amotivation and intrinsic motivation, and relates to engaging in an activity in order to obtain an outcome that is separate from the activity itself (Ryan et al., 2009). Extrinsic motivation can be divided into four types. Firstly, and the least self-determined form, is external regulation, wherein behaviour is controlled by some external contingency, such as engaging in PA because it would please or impress somebody else. Second, introjected regulation includes behaviour that is partially internalised and based on emotions or self-perceptions, for example, being active for ego enhancement or to avoid guilt. Third, is identified regulation wherein a behaviour is valued and deemed as important, for example, being active because it is good for your heart health. Fourth and the most self-determined is integrated regulation, in which a behaviour is part of a person's sense of self, for example, a person being active because they believe that is who they are as a person (Ryan et al., 2009).

Importantly, it is hypothesised that individuals can achieve higher levels of self-determination by fulfilling their needs of relatedness, autonomy and competence, as previously described (Deci & Ryan, 2000). Consequently, those with higher levels of self-determined motivation (i.e., more intrinsically motivated) are more likely to be more active compared with those whose motivation is extrinsically controlled (Rhodes et al., 2019). Approaching PA messaging from a SDT lens may therefore see PA messages targeting relatedness, autonomy, and competence, and focusing on benefits or consequences of PA that relate to more intrinsic forms of motivation than those relating to extrinsic forms.

Dual process framework and physical activity

Dual process theories

In short, dual process frameworks involve mapping individual level behavioural determinants onto one of two different types of influence: reflective processes (deliberate and effortful) and non-conscious or automatic (more spontaneous) (Metcalf & Mischel, 1999; Sloman, 1996; Smith & de Coster, 2000; Strack & Deutsch, 2004; Wiers et al., 2007). Dominant theories of health behaviour discussed in this chapter so far largely focus on reflective precursors of action and assume that changing a person's conscious cognitions will create changes in behaviour (Sheeran et al., 2013). Conversely, dual-process theories describe how human behaviour is controlled by two separate information-processing systems that can be distinguished based on the levels of automaticity or reflectiveness of actions. In other words, thoughts can arise through two distinct routes or processes: explicit/reflective (controlled, conscious) and implicit/impulsive (automatic, unconscious).

The reflective system creates behaviour change decisions based on knowledge about facts and values, whereas the impulsive system creates behaviour change through associations and motivation (Strack & Deutsch, 2004). From the perspective of dual-process theories, it has been argued that dominant theories have overstated the role of reflective, explicit processes and neglected the role of more automatic, implicit processes (Brand & Ekkekakis, 2018). Meta-analytical evidence demonstrates that medium-to-large changes in intention produce only small-to-medium changes

in behaviour (Webb & Sheeran, 2006), suggesting that changing conscious thought may not guarantee behaviour change. Therefore, it may be important in PA messaging to consider how messages may function through one of two, or both, potential pathways to behaviour change.

Theories of emotional or affective response

With strong links to dual process frameworks are theories of emotional or affective response. In the context of health communication (and more specifically PA messaging), the assumption that individuals will use cognition and engage in behaviours that they know are 'good' for them and avoid behaviours that are 'bad' for them in certain theories is open to critique. People engage in behaviours regularly despite having the knowledge that they may lead to unfavourable outcomes. For example, an individual may eat a large amount of cake despite having the knowledge that this may lead to poorer physical health long term. Why, therefore, do they continue to eat cake? We must consider that, in addition to this long-term unfavourable outcome of poorer physical health, there are more immediate favourable outcomes such as enjoyment and satisfaction. Such emotional or affective responses may overpower longer term outcomes when an individual makes a decision on whether or not to engage in a certain behaviour.

Relevant to this consideration are views or theories of emotional response, such as proposed by Zajonc in 1980. Zajonc argued that affect and cognition are under the control of distinct and somewhat independent systems that can impact each other in several ways (Zajonc, 1980). This view suggests that emotional or affective response precedes and conditions

cognitive and attitudinal effects. Thus, PA messages may aim to target not only cognitive and attitudinal effects such as those focused on in theories discussed earlier in this chapter, but also emotional or affective responses in efforts to bring about behaviour change.

Socioecological framework and physical activity

The socioecological framework is based on the premise that behaviours result from a combination of direct, indirect, and interactive influences from factors of multiple levels ranging from the individual to environment and social policy. This premise holds true for a systems approach that was discussed in detail in Chapter 2. A seminal publication in this field was by Bronfenbrenner, whose ecological systems model proposed that there are numerous levels of influence from the environment that affect a person's behaviour (Bronfenbrenner, 1996). Bronfenbrenner's model was later adapted slightly for health behaviour (such as PA) to include five layers forming concentric rings: intrapersonal factors, interpersonal factors, an organizational level, a community level and a policy level (McLeroy et al., 1988).

Where the socioecological model has been applied to PA, focus has largely been on the environmental and settings level, with less focus on the social and individual rings of the model (Rhodes et al., 2019), potentially due to the fact that the individual and social level rings have been such a key focus of other approaches, including social cognitive and humanistic frameworks (Biddle & Nigg, 2000). Although the relative sizes of associations

between the different levels of influence in a socioecological model on PA has not been systematically reviewed, effect sizes from individual studies suggest that individual-level factors provide the greatest contribution compared with social and environmental factors (Giles-Corti & Donovan, 2002; Haughton McNeill et al., 2006; McCormack et al., 2013; Rhodes et al., 2006).

Approaches within the socioecological framework, arguably including systems approaches, highlight the importance of considering individual and social factors in addition to environmental factors when aiming to improve population PA. Therefore, approaches that have potential to target these individual factors (such as PA messaging) should not be overlooked. For further information on the role of PA messaging in a systems approach to improving PA levels please refer to Chapter 2.

Social Marketing Theory

Although not a psychological theory as such, a further model or framework that has potential relevance for understanding and influencing PA messaging is social marketing. Social marketing as a discipline has focused more on impulsive, automatic processes than wider health promotion. The global definition of social marketing endorsed by the Boards of the International Social Marketing Association states that social marketing “seeks to develop and integrate marketing concepts with other approaches to influence behaviour that benefits individuals and communities for the greater good” (French, 2017, p. 1).

Where messaging has traditionally included attempts to change behaviour indirectly through changing knowledge or attitudes about PA by disseminating information, social marketing approaches aim to change behaviour directly by offering benefits in exchange for adopting the desired behaviour (Xia & Deshpande, 2016). Social marketing seeks to incorporate research, best practice, theory, and target audience insights to inform delivery of competition sensitive and segmented (or sub-population specific) social change programmes that are effective, efficient, fair and maintainable (French, 2017, p. 1). The insight-driven segmentation element of social marketing is a particularly relevant consideration for PA messaging. This feature aims to understand what is important to members of the target audience to develop targeted interventions based on audience needs, values and circumstances (French, 2017, p. 23).

Although attempts to utilise social marketing principles in public health communication approaches have been limited to date, its use has now been advocated by WHO in GAPP 2018-2030 (World Health Organization, 2018, p. 45) and in a recent publication accompanying the updated global PA guidelines (Milton et al., 2020). It is therefore anticipated that social marketing could become part of standard practice for governments, public health organisations, and for-profit and non-for-profit organisations aiming to promote health (French, 2017, pp. 13-14). A better understanding of the potential role of social marketing approaches and practice in PA promotion is therefore warranted.

The Behaviour Change Wheel and COM-B Model

Theories and frameworks, such as those described in this chapter, help us to maximise potential effectiveness of interventions aiming to change behaviour such as PA. Improving the design and implementation of theory and evidence-based practice relies on effective behaviour change interventions (Michie et al., 2011). As evidenced in this chapter so far, there is a plethora of ways in theory can be used to inform PA messaging interventions, and there is no evidence that one of the theories discussed so far is more applicable or relevant for PA messaging than the others. In an attempt to provide an appropriate method for characterising behaviour change interventions, Michie et al developed the Behaviour Change Wheel (BCW) (Michie et al., 2011) (see Figure 4-1). The BCW has been included here as it provides a useful tool for organising, incorporating, and applying the various theories that may have relevance for PA messaging.

The BCW organises interacting concepts within a behaviour system (relating to sources of behaviour, intervention functions and policy categories) in a three-layered 'wheel' structure. This theory- and evidence-based tool allows users to design and select interventions and policies based on the nature of the behaviour, the mechanisms that need to be changed in order to bring about behaviour change, and the interventions and policies required to change said mechanisms (Michie et al., 2011). It should be noted here that the BCW is all encompassing, and therefore complementary and inclusive of the various individual theories considered in this chapter, as these can simply be incorporated into the BCW where appropriate.

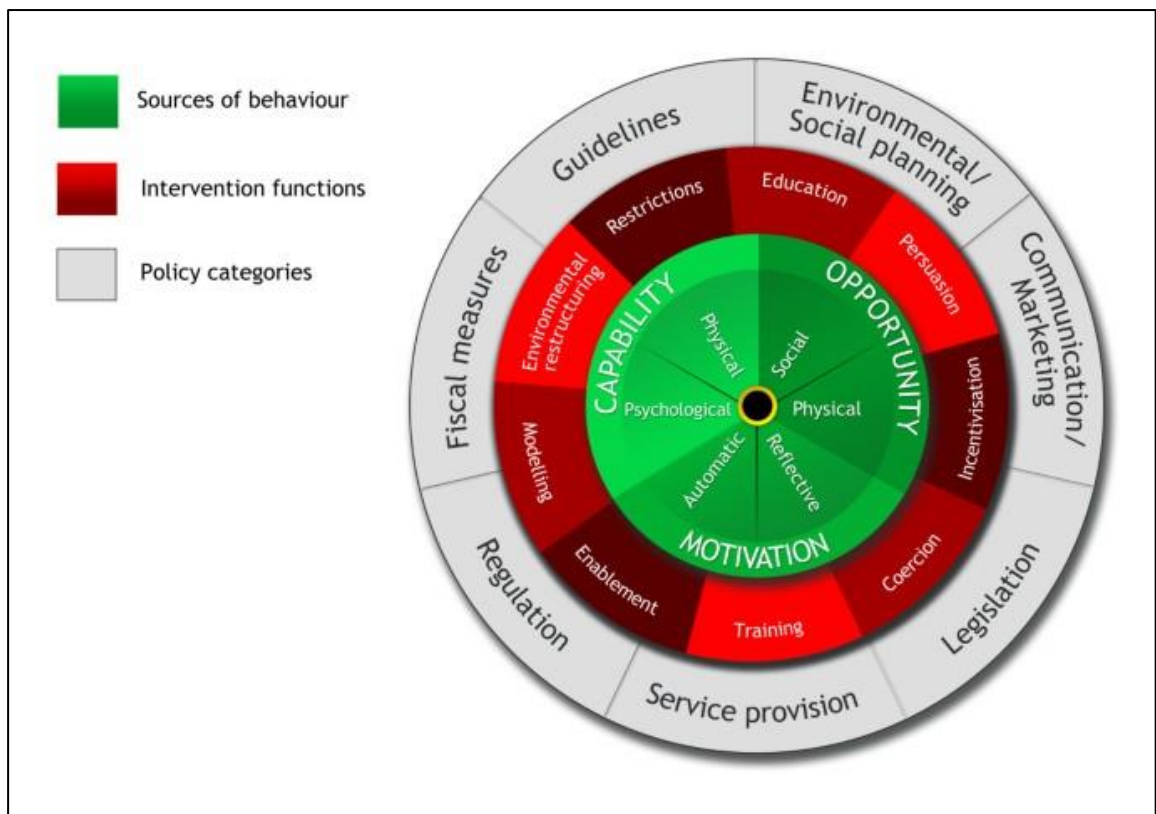
The BCW encompasses nine intervention functions. Michie et al. propose that five of these nine can contribute to the policy area relevant to this thesis (communication/marketing): education, persuasion, incentivisation, coercion, and modelling. Modelling is defined as “providing an example for people to aspire to or imitate” (Michie et al., 2011, p. 7), and may therefore include messages that show others being physical activity. Incentivisation and coercion are described as techniques that create expectation of reward or punishment, respectively (Michie et al., 2011, p. 7). Where incentivisation in a PA message may involve offering a free or discounted gym membership in an advertisement, coercion may involve informing employees about a fee for using a workplace car park where walking and cycling are free alternatives via email or poster.

Based on the context of this thesis so far, the two intervention functions with the clearest links to PA messaging specifically are education (defined as “increasing knowledge or understanding”) and persuasion (defined as “using communication to induce positive or negative feelings or stimulate action”) (Michie et al., 2011, p. 7). A message utilising education may provide information on how much PA is recommended for health. A message utilising persuasion may use music and imagery to promote positive feelings towards PA.

These definitions also indicate links between these two intervention functions and the two routes or processes through which thoughts and behaviours may arise as outlined in dual process theories (described earlier

in this chapter). Specifically, education seems to parallel with the more reflective, explicit processes and persuasion seems to parallel with the more automatic, implicit processes, highlighting the potential role of both routes of information processing. The intervention functions of education and persuasion may be useful in understanding how PA messages may work and in developing interventions that aim to use PA messaging to change behaviour, alongside other theoretical constructs.

FIGURE 4-1: THE BEHAVIOUR CHANGE WHEEL (MICHIE ET AL., 2011)



Central to the BCW is the Capability, Opportunity, and Motivation Behaviour (COM-B) model. This model demonstrates how capability, opportunity and motivation interact to generate behaviour, and how behaviour in turn impacts these components (Michie et al., 2011). Capability,

defined as “an individual’s psychological and physical capacity to engage in the activity concerned” (Michie et al., 2011, p. 4) may refer to an individual having the necessary knowledge, skills and physical capabilities to act on a PA message. Motivation, defined as “brain processes that energize and direct behaviour, not just goals and conscious decision making” (Michie et al., 2011, p. 4) may refer to an individual’s PA habits, their perceptions and emotional responses towards PA, and their conscious decision making on PA behaviour. Motivation, in this context, would therefore encompass both automatic and reflective thought processes (relating to the dual process framework described earlier), and can be further subdivided into ‘reflective motivation’ and ‘automatic motivation’. Finally, opportunity, defined as “all the factors that lie outside the individual that make the behaviour possible or prompt it” (Michie et al., 2011, p. 4) is subdivided into both physical and social opportunity. Where physical opportunity may refer to an individual’s access to green space in which they can be active, or whether or not they own a bike, social opportunity may refer to cultural milieu and social norms around PA.

The COM-B model considers how each of these three constructs may influence behaviour and vice versa. PA messages may wish to utilise intervention functions such as education and persuasion to target opportunity, capability, or motivation as mechanisms of behaviour change. Of these constructs, it could be said that PA messaging is more relevant to psychological capability, motivation (both reflective and automatic), and social opportunity, as it is clear to see how PA messaging may influence

these constructs. For example, considering principles from other theories reviewed in this chapter, PA messaging has the potential to improve necessary knowledge and skills to be active (psychological capability), as well as to target individual PA habits, perceptions, and emotional responses towards PA, as well as their conscious decision making on PA behaviour (reflective and automatic motivation). Messaging may also help change social norms around PA in a community, enabling social opportunity.

Where the role of PA messaging may be less clear is in improving physical opportunity. Having said this, despite PA messaging being unable to improve an individual's physical opportunity to be active by improving their access to green space or giving them a bike, it does have potential to signpost opportunities (such as providing information on local walking routes or where to rent a bike), and therefore may still have a role in facilitating this construct of physical opportunity.

Taking all of this into consideration, the BCW and COM-B model may be useful tools for understanding how PA messaging may bring about behaviour change and may also therefore be useful in the development of PA messages, whilst still allowing consideration of various other individual theories.

Theoretical approach of this thesis

As evident from this chapter, there is an array of individual theories that can help to understand PA messaging, and these theories can be largely categorised into four overarching approaches. In reviewing these theories

from a PA messaging perspective, I found that there are various overlapping and agreeing elements between the individual theories and even the overarching approaches or frameworks. Importantly, I identified no clear indication that one theory or approach is more relevant for PA messaging than others. In fact, I believe that, based on the information in this chapter, there may be value in trying to understand PA messaging using numerous theories. Furthermore, the extent to which each individual theory or theoretical framework has been used to understand and inform PA messaging is not known.

For these reasons, exploring PA messaging through the lens of one theory would not be a logical decision and indeed is not required for the studies included in this body of research. Given the nature of PA messaging and the lack of exploration into the use of theory in this field to date, it seems more appropriate here to acknowledge the overall importance of drawing on theory to understand messaging than it does to pick one and carry out this research from that specific perspective. Therefore, this thesis will not take a single theoretical approach from the outset. Rather, this thesis acknowledges the importance of theory in general in understanding PA messaging and will aim to relate findings back to the key theories outlined in this chapter. Having said this, the BCW provides a useful tool for understanding PA messaging and drawing on the BCW does not rule out the consideration of individual relevant theories. Therefore, the BCW will be utilised to help guide elements of this thesis and will be considered carefully when analysing and discussing findings throughout this thesis.

Chapter summary

There are a multitude of models and theories that can be drawn on to help us to understand how PA messaging may contribute towards improving population PA levels. In this chapter, I have discussed those which could be deemed most prominent and important to PA messaging. Upon review, it is evident that there are several overlapping or agreeing constructs throughout the various theories and models with relevance to PA messaging, and that more than one theory may be required to fully understand how PA messages may bring about behaviour change. Study 1 (presented in the next chapter) will address research gaps identified in Chapter 3, as well as the extent to which various theories have been used in PA messaging research to date.

Chapter 5 Physical activity messaging: a scoping review

Chapter outline

This chapter presents work relating to Study 1: a scoping review of PA messaging. Study 1 was published in the International Journal of Behavioural Nutrition and Physical Activity (IJBNPA) in April 2020 and is included as part of this chapter. The published article presented here is preceded and followed by additional commentary expanding on the paper and providing further discussion. My contributions to the published article can be found in the declaration section on pages 2-4. Contributing to the overall thesis aim of furthering our understanding of PA messaging and its role in improving population PA levels, this chapter aims to investigate what is known about PA messaging, identify key research gaps, and provide PA messaging recommendations for various subgroups of the public.

Preamble

As described in Chapter 2, a systems approach including communication approaches (such as PA messaging) that target individual and social factors has been advocated for the promotion of population level PA. However, there is evidence to suggest that such approaches have been utilised less in PA promotion, and best practice in PA messaging is not clear. In Chapter 3, several potentially important PA messaging concepts relating to both content and delivery were identified and described, namely the use of message framing, tailoring, targeting, the PA messenger or provider, and the mode of delivery. However, each of these concepts are mentioned sporadically in the literature, and there are likely further studies relating to

these concepts that were not identified in the initial informal literature review. Moreover, Chapter 4 identified that although several theories exist with potentially important implications for PA messaging, the extent to which each of these theories have been used to inform PA messaging was not clear. Overall, as made evident in Chapters 2, 3 and 4, there is a need for a formal review to map out the various PA messaging concepts and systematically take stock of what we already know about PA messaging and what the research priorities should be going forward.

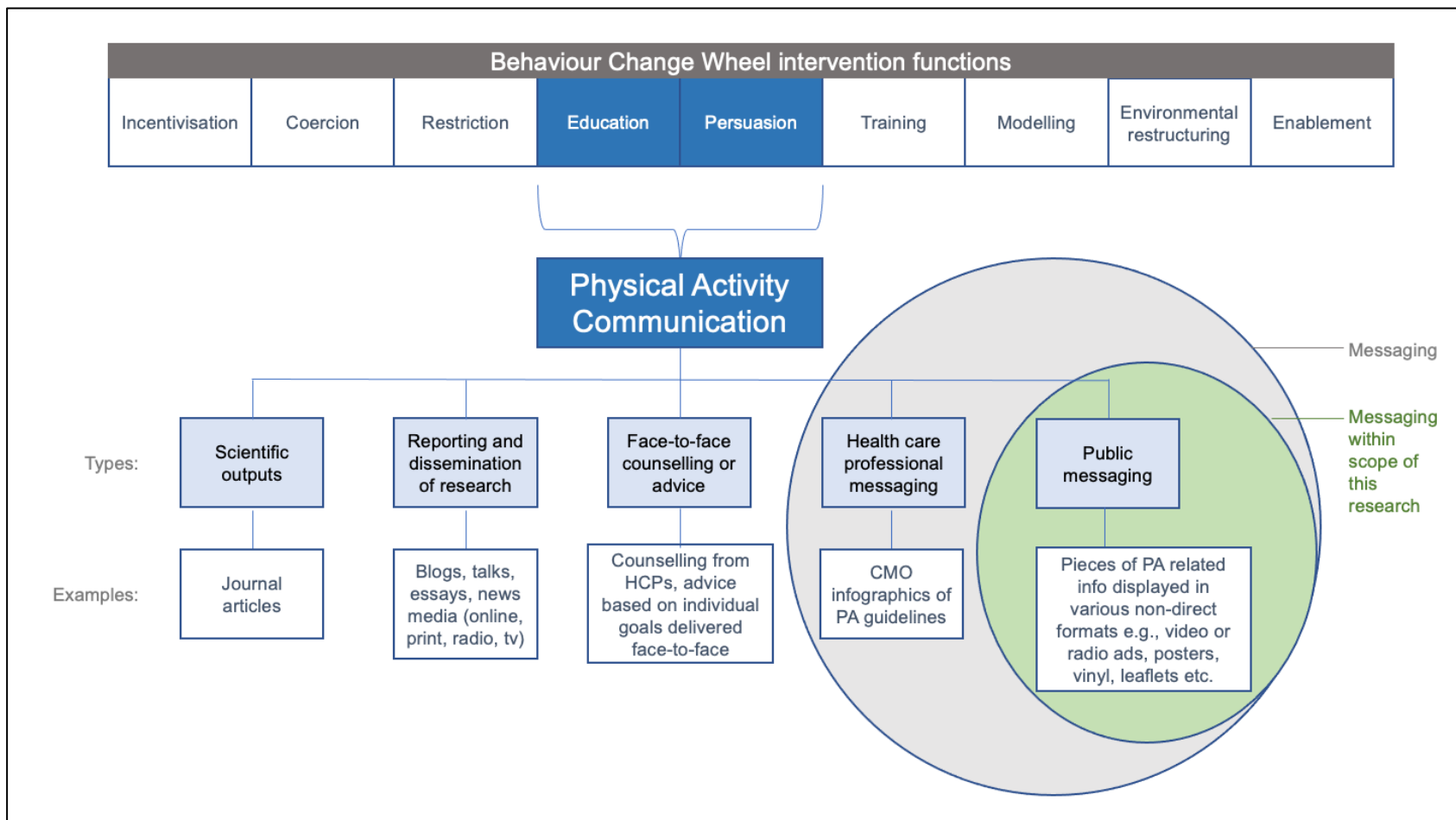
As described in previous chapters, a systematic review of PA messaging approaches has already been published (Latimer et al., 2010). Although robust and suitable for its own aims, this existing review included strict inclusion criteria. For example, only studies focusing on distal and intermediate outcomes of messaging, and had a narrow focus on studies testing messages using minimal contact direct delivery methods were included (Latimer et al., 2010). Furthermore, this existing review only investigated three PA messaging concepts, limiting its breadth. Finally, this review only included studies involving healthy adults, limiting generalisability to other population groups, such as the other PA guideline groups.

In this complex area of study, a more broad and inclusive review approach may be useful in mapping out what is already known and where the gaps lie. Therefore, a traditional systematic review with meta-analysis was not a suitable method for the following study. Rather, a scoping review was chosen as the most suitable approach to address the broad aims.

Further description of the scoping review approach, and justification for using this method, is provided in the published article later in this chapter.

As demonstrated in Chapter 3, PA communication is a broad overarching concept, and so defining PA messaging specifically and setting boundaries for this scoping review was a key step. To help with this, a practical tool for setting boundaries and guiding inclusion/exclusion of studies was developed (see Figure 5-1). This tool was developed by drawing on definitions of Education and Persuasion from the BCW and distinguishes between PA messaging and other types of PA communication. Specifically, this research focuses on PA messaging aimed directly at members of the public as opposed to, for example, healthcare practitioners. Drawing on both this developed tool and existing definitions from previous literature, definitions for PA messaging, PA message, PA message content and PA message delivery for the purpose of this thesis were developed. These definitions are presented in the published article that follows this preamble (Table 5-1).

FIGURE 5-1: A PRACTICAL TOOL TO DEFINE BOUNDARIES OF THIS RESEARCH



Note that the figure above is not comprehensive. Physical activity communication subtypes shown are examples only.

Published article

Abstract

Background: Understanding how to create and deliver effective physical activity (PA) messages for and to various population subgroups may play a role in increasing population PA levels. This scoping review aimed to provide an overview of what is known about PA messaging and highlight key research gaps.

Methods: We followed a 5-stage protocol proposed by Arksey & O'Malley and the Preferred Reporting Items For Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping reviews checklist. *Stage 1:* research questions were identified. *Stage 2:* we identified relevant studies by searching electronic databases, contacting existing networks and hand searching reference lists. *Stage 3:* studies were screened in Covidence™ software. *Stage 4:* study data were extracted and charted. *Stage 5:* findings from included studies were collated, summarised and reported in two ways: (1) a descriptive numerical analysis providing insight into extent, nature and distribution of the included studies, and (2) a narrative summary summarizing the evidence reviewed organised by messaging concepts and by population subgroup.

Results: A total of 9525 references were imported into Covidence™ for screening. Of these, 123 studies were included in final analysis. We found that PA messaging evidence is complex and multidimensional in nature, with numerous concepts to consider when creating or evaluating messages. The

extent to which these different PA messaging concepts have been researched is variable. Where research has accumulated and evidence is consistent, it supports the following: (1) PA messages should be framed positively and highlight short-term outcomes specifically relating to social and mental health, (2) message content should be tailored or targeted to intended recipient(s), and (3) when developing messages, formative research, psychological theory and/or social marketing principles should be used.

Conclusion: While it is unlikely to address global inactivity on its own, PA messaging may play a valuable role improving population PA levels. However, it is a complex and multidimensional concept and greater understanding is still needed. We present a synthesis of the existing evidence, highlighting key areas where evidence has accumulated and where gaps lie, as well as recommendations for PA messaging to different population subgroups.

Introduction

Physical inactivity is a major contributor to the growing global burden of non-communicable diseases including cancer, cardiovascular disease, depression and diabetes (Lee et al., 2012). Recent research shows that overall, global trends are worsening with physical inactivity levels rising in many high-income Western countries and with the steady prevalence of inactivity in low income countries making a substantial contribution to the burden of disease (Guthold et al., 2018). It has been suggested that a systems approach may play an important role in responding to complex

public health challenges, such as efforts to increase PA at population level (Friel et al., 2017; Hawe et al., 2009; Peters, 2014; Rutter et al., 2019; Rutter et al., 2017). A systems approach acknowledges that alongside efforts to modify policy and the physical environment to promote PA (Sallis et al., 1998) there is an important role for interventions which aim to address individual factors. One such approach is PA messaging.

Interventions utilising a PA messaging approach tend to feature the delivery of information to members of a target group within the public with the aim of either directly or indirectly improving PA levels. Understanding how to utilise PA messaging effectively is important for three reasons. Firstly, messaging is a scalable approach that can be used to reach large numbers of people at relatively low cost (Cavill & Bauman, 2004). Secondly, effective messaging can augment the dissemination of PA guidelines and related information such as benefits of PA to various population subgroups, as this information is generally not created to be public facing or to motivate people to become or remain physically active (Latimer et al., 2010). Indeed, evidence suggests that the general public have limited knowledge of the current PA recommendations for health (Scottish Government, 2012). Thirdly, existing evidence shows PA messaging interventions to date have had limited effects on PA behaviour itself and mixed findings on outcomes such as awareness and motivation (Bergeron et al., 2019; Berry & Latimer-Cheung, 2013; Brawley & Latimer, 2007; Brown et al., 2012; Cavill & Bauman, 2004; Finlay & Faulkner, 2005; Latimer et al., 2010; Latimer-Cheung et al., 2013; Leavy et al., 2011). Further research to understand how to effectively develop and

deliver PA messages for and to different population subgroups is therefore warranted.

In terms of previous research into PA messaging, a number of reviews exist. While these reviews have focused on specific aspects of messaging such as guideline dissemination (Brawley & Latimer, 2007; Latimer-Cheung et al., 2013), solely on message content (Latimer et al., 2010), specifically on mass media campaigns (Brown et al., 2012; Cavill & Bauman, 2004; Finlay & Faulkner, 2005; Leavy et al., 2011), or only included research from the USA (Bergeron et al., 2019), no review that provides a broad overview of the evidence on PA message content and delivery from multiple countries across the globe has been conducted. A summary paper which maps and synthesises what is currently known across the various PA messaging concepts may be an important step in understanding how to optimally create and deliver effective PA messages for various population subgroups. Therefore, the aim of this study was to provide the first such broad scoping of the evidence on PA messaging. Specifically, we sought to answer the following research questions:

1. What is known about (a) PA message content and (b) PA message delivery?
2. What is known about PA message content and delivery for specific population groups?
3. What are the research gaps?

Methods

Study design and protocol

Based on the study aim, a scoping review was determined to be the most appropriate method. The aim was too broad to address via a traditional systematic review (and meta-analysis), and could be more appropriately answered through examining the extent, range and nature of research in this area, summarising and disseminating research findings to date, and identifying research gaps in this area; all of which are common scoping review purposes (Arksey & Malley, 2005). The process of conducting a scoping review is often iterative, allowing for changes to inclusion and exclusion criteria, research questions and analytical approaches as more is learned about the evidence base. Furthermore, a scoping review allows for inclusion of a broad range of study designs, providing a more comprehensive picture of the research area. To ensure robustness, this study adopted an established five-stage scoping review protocol proposed by Arksey & O'Malley (Arksey & Malley, 2005) and built upon by Levac, Colquhoun & O'Brien (Levac et al., 2010), and followed the Preferred Reporting Items For Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping reviews checklist (Additional File 1) (Tricco et al., 2018).

Key definitions and position of messaging

Health communication encompasses the study and use of communication strategies to inform, influence and motivate individual, institutional and public audiences about important health issues (Services, 2010). At the outset of this review, we sought to define and position PA

messaging within the wider context of health communication to inform searches and inclusion criteria. We present PA messaging as a subtype of health communication and as an overall concept that encompasses both content and delivery aspects of a PA message. As no universally used definition of PA messaging exists, working definitions were developed by the study authors for the purpose of this study (Table 5-1).

TABLE 5-1: WORKING DEFINITIONS FOR THE PURPOSE OF THIS RESEARCH

Term	Working definition
Physical activity messaging	The overall process of designing, creating and delivering physical activity messages
Physical activity message	Educational or persuasive material to be relayed to a specific individual or group within the public with the aim of ultimately increasing physical activity levels
Physical activity message content	The specific aspects which comprise a PA message, such as the type, amount and presentation of information
Physical activity message delivery	The process by which a physical activity message is delivered to the target individual or group of the public

Definitions adapted from Latimer et al (Latimer et al., 2010) and drawing on Michie et al., intervention functions (Michie et al., 2011).

Initial literature searching to establish an understanding of key PA message and messaging terms revealed multiple sub-concepts and inconsistencies in the use of terminologies surrounding these. Indeed, these inconsistencies and the need to take caution when comparing studies have been previously noted (Yap & Davis, 2008). One example of this are the terms *tailoring* and *targeting*. Although some authors clearly distinguish between tailoring as an exclusively individual level approach and targeting as

an exclusively group level approach (Brawley & Latimer, 2007), the term tailoring has also been used to describe customisation of message content at an individual level (Martinez et al., 2013), and at a group level (Yan, 2015). Similarly, the term targeting has been used to describe a group-level approach (Marmo, 2013) as well as to describe individually-customised messages (Berry, 2016). Thus, a glossary of PA messaging sub-concepts and their working definitions for the purpose of this scoping review was created and is presented in Table 5-2. Establishing these working definitions was a fundamental step as it allowed us to standardise information from various studies despite inconsistencies in terminologies used and thus reliably extract data in Stage 4.

TABLE 5-2: WORKING DEFINITIONS OF KEY PHYSICAL ACTIVITY MESSAGE CONTENT AND DELIVERY CONCEPTS

Concept	Working definition
Message Content	
Type of information	The nature or purpose of information included in the message. Messages identified in the literature can generally be grouped into three broad categories: ‘how much and what type’ information (such as physical activity guidelines), ‘why’ information (such as benefits of physical activity), and ‘how to’ information (practical and supportive information).
Use of gain- or loss-framing (Latimer et al., 2010)	The use of framing a message to highlight either the benefits of taking part in physical activity or the consequences of not taking part.
Tailoring (Conroy et al., 2019)	Information based on individual user data (e.g. specific feedback on pre-established goals such as step counts)
Targeting (Conroy et al., 2019)	Information designed to be relevant to a specific group (e.g. inactive individuals or diabetics)
Personalisation (Conroy et al., 2019)	The use of static, user-specific information in a message (e.g. name or home address).
Message Delivery	
Media or mode of delivery	The type of media through which the message is being relayed, for example, emails, posters or radio adverts.
Provider or source	The provider or source of the message, for example, GP, the media, or friends and family.
Frequency and dose	How often the message is delivered and for how long, for example, emails sent 3 times a week for 4 weeks.

Stage 1: Identifying the research question

Our research aim was to provide a broad overview of what is known about PA messaging. To address this aim, three specific research questions were identified.

- (1) What is known about (a) PA message content and (b) PA message delivery?
- (2) What is known about PA message content and delivery for specific population groups?
- (3) What are the research gaps?

Stage 2: Identifying relevant studies

We identified relevant studies by:

1. Searching the following electronic databases: Ovid (MEDLINE), ProQuest, SPORTDiscus (Ebscohost), and Web of Science
2. Contacting existing academic, policy and practice networks requesting relevant studies
3. Hand searching reference lists of key studies and checking recent publications by key authors

The database search strategy was designed to be as comprehensive as possible with the available resources. Databases were searched for titles that contained at least one “PA” term as well as at least one “messaging” term (full list of search terms can be found in Supplementary Table 1, Additional File 2¹). Appropriate truncation symbols and wild cards were used to account for search term variations and maximise searches. No limits on journals searched were used. As an example, the full electronic search strategy for

¹ This file is available online as part of the published article.

MEDLINE can be found in Supplementary Table 2, Additional File 2².

Searches were conducted up to August 30th, 2019. Inclusion and exclusion criteria (see Table 5-3) were designed to be highly inclusive.

TABLE 5-3: INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> • Research articles or reports in any geographical location or setting • Research conducted in healthy or clinical populations • Articles published in peer-reviewed journals and grey literature • Articles reporting on development of or effects of PA messages • Articles published in English • Research designs including: empirical research studies (qualitative, cross-sectional or longitudinal designs, interventions or natural experiments with pre-post measures or comparison) and non-empirical research (systematic and non-systematic reviews, and methods or theory papers) 	<ul style="list-style-type: none"> • Articles focusing on wider PA communication not within the scope of this review, for example messages not directed to public or studies using other communication techniques such as one-to-one counselling • Abstracts without full text

Stage 3: Study selection

All identified studies were uploaded to Covidence™ software where duplicates were automatically removed at time of upload. Titles and abstracts were screened by CW with 15% double screened by either GB or PK. Full

² This file is available online as part of the published article.

text level reviewing was carried out by two independent researchers (CW, PK, GB or AN) with conflicts resolved by a third researcher.

Stage 4: Charting the data

Data were extracted and entered into a data charting form using Excel.

Where available, the data charted included all of the following:

- General study information including author, title, study location, study design and participant information
- Description of study and message used
- Primary focus of study (message content, delivery or both)
- The use or absence of psychological theory
- The use or absence of social marketing principles
- Key findings
- Implications

Stage 5: Collating, summarising and reporting

In a scoping review, there are numerous ways in which data from identified studies can be organised, synthesised and reported. Findings of this scoping review were reported in two ways: (1) through a descriptive numerical analysis providing insight into extent, nature and distribution of the included studies, and (2) through a narrative summary of the evidence base. To address our research questions and maximise relevance for researchers,

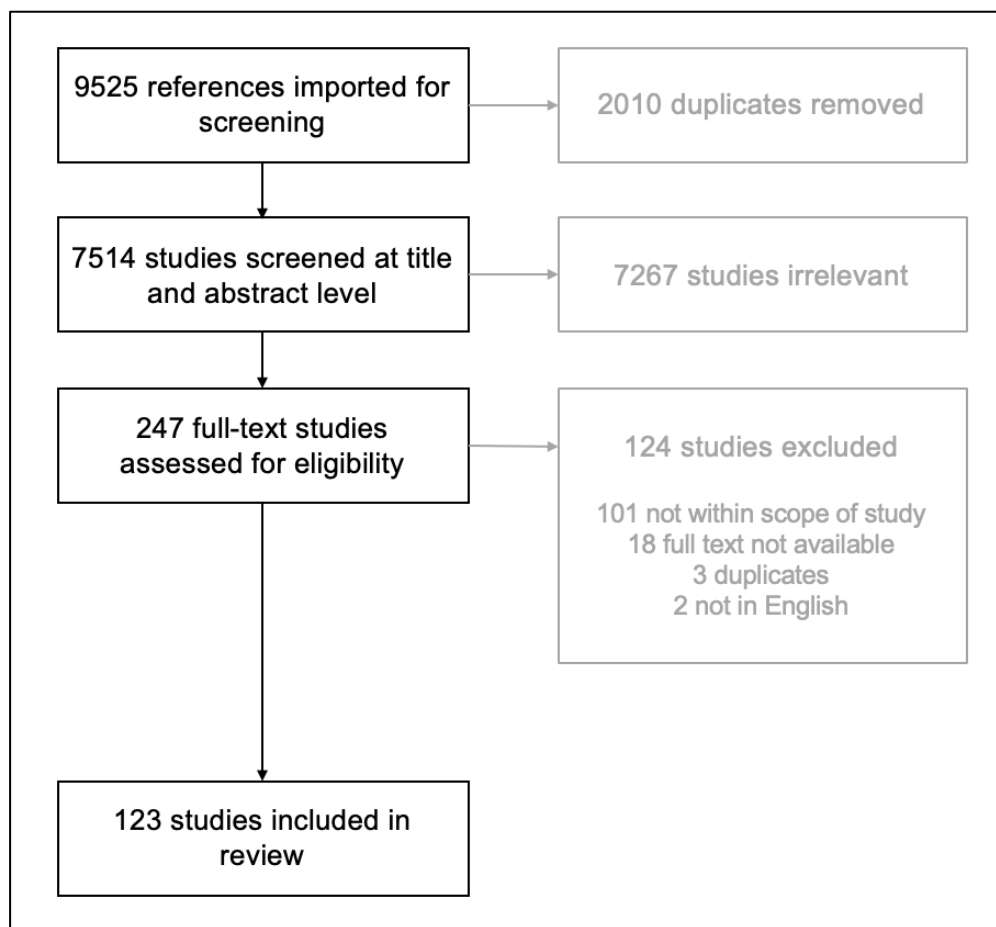
policymakers, practitioners and other relevant stakeholders, we made the decision to organise the narrative summary by the pre-identified messaging constructs of content and delivery as well as by UK Chief Medical Officer's guideline groups (Children and Young People, Adults, Older Adults, Pregnant Women and Disabled People) (Department of Health & Social Care, 2019). Finally, a matrix displaying where consistent research had accumulated and where gaps lay, organised by messaging concept and population group was created. This matrix displays research areas across 5 levels of evidence from strong (e.g. systematic review level evidence) to non-existent (i.e. no research identified in this review) based on the number, type and agreement of findings across studies relating to each research area.

Results

Descriptive numerical analysis

A total of 9525 references were identified for screening (n=9514 from database searches, n=6 from existing networks, and n=5 from hand searching). Following removal of duplicates and screening, 123 studies were included in final analysis. A study selection flowchart is presented in Figure 5-2.

FIGURE 5-2: STUDY SELECTION FLOWCHART



Of these 123 studies, 99 were empirical (original research) and 24 were non-empirical (reviews, commentary, methods, etc). Of the 99 empirical studies, there were 78 experimental studies (34 between-groups studies, 16 pre-post, 13 randomised controlled trials, 6 cross-sectional, 4 within-subjects, 3 quasi-experimental, 1 longitudinal, 1 post-test only, 1 single-group experiment, and 1 uncontrolled trial) and 21 non-experimental (18 qualitative and 3 cross-sectional) studies. Of the non-empirical studies, there were 13 non-systematic reviews, 6 systematic reviews, 3 commentaries, 1 conference foreword, and 1 methods paper.

The 99 empirical studies took place in the following locations: Canada (n=34), USA (n=32), Australia (n=12), UK (n=8), China (n=2), France (n=2), Germany (n=2), Japan (n=2), Belgium (n=1), Brazil (n=1), Ireland (n=1), Netherlands (n=1) and 1 took place in multiple countries (Bulgaria, Croatia and Romania). Almost half of the included studies (n=58, 47.2%) were published in the past 5 years (2014-2019). The relevant guideline groups of the 123 studies were as follows: Adults (n=61), Adults and Older Adults (n=17), Children and Young People (n=16), Children and Young People & Adults (n=9), Pregnant Women (n=4), Older Adults (n=3), Disabled People (n=3), and All (n=10).

Of the 99 empirical studies, 62 (62.6%) stated use of psychological theory. The most commonly identified psychological theories were Theory of Planned Behaviour (n=11), Social Cognitive Theory (n=9), Self-Determination Theory (n=5) and Elaboration Likelihood Model (n=4). Authors in 8 of the 99 empirical studies (18.2%) reported use of social marketing principles, although no universally referred to set of principles was apparent. Study descriptions, participant information, key findings and implications of these 123 studies are presented in Additional File 3³. Of the 123 studies, 60 primarily focused on message content, 6 primarily focused on delivery, and 57 focused on both.

³ This file is available online as part of the published article.

Narrative summary of findings

The main findings around concepts relating to message content (type of information, use of framing and use of tailoring or targeting), and message delivery (media or mode, provider/source and frequency & dose) (see Table 5-4 for definitions) are summarised below. This scoping review identified studies reporting on the following 11 outcomes: message recall, messages awareness, message appeal, message preference, affect, beliefs about PA, attitudes towards PA, PA intentions, self-efficacy, motivation, and PA behaviour. These outcomes can be broadly classified as proximal, intermediate, or distal (see Table 5-4).

TABLE 5-4: WORKING DEFINITIONS OF IDENTIFIED OUTCOMES

Outcomes	The effects/impacts of the message
<i>Proximal (Bauman & Chau, 2009)</i>	Immediate impacts e.g. awareness and recall of the message.
<i>Intermediate (Bauman & Chau, 2009)</i>	Short term impacts e.g. intent, motivation, self-efficacy and knowledge.
<i>Distal (Bauman & Chau, 2009)</i>	Medium- and long-term impacts/outcomes e.g. physical activity behaviour(s).

Children and young people

Message content

Evidence from qualitative research (Bellows et al., 2013; Nicholson, 2012b), existing reviews (Alberga et al., 2019; Latimer-Cheung et al., 2013) and experimental research (Sirriyeh et al., 2010) supports the use of messages targeting affective outcomes and highlighting the social and mental health benefits of being physically active (e.g. PA is fun and cool) in this population. Although one experimental study found no advantage for gain-framed messages over loss-framed in encouraging parent's support for

child PA (Bassett-Gunter et al., 2017), evidence from existing reviews and qualitative research generally supports the use of gain-framed messages when focusing on children or their parents (Jarvis et al., 2014; Latimer-Cheung et al., 2013; Nicholson, 2012b). Messages targeting cognitive antecedents of PA specified by Theory of Planned Behaviour (e.g. attitude) also had positive effects on intentions to exercise (Hill et al., 2007).

Mass media campaigns targeting children and young people (namely the VERB (Wong et al., 2004) and WIXX (Bélanger-Gravel et al., 2014) campaigns) have had promising effects on PA (Huhman et al., 2005) and on campaign recall and awareness (Bélanger-Gravel, Cutumisu, Gauvin, et al., 2017; Bélanger-Gravel, Cutumisu, Lagarde, et al., 2017; Bélanger-Gravel et al., 2014). Following the success of the social marketing-based VERB campaign, a 10-year review was published on how the campaign had informed other campaigns (Huhman et al., 2017). They found evidence of numerous program planners having aspired to follow the VERB approach, but few had taken advantage of the full capabilities of social marketing principles to bring about changes in PA behaviour.

Message delivery

Qualitative research suggests young people would prefer to hear messages from adults other than general practitioners (GPs) or teachers whom they felt “lectured” by (Nicholson, 2012b). Rather, formative evidence supports delivering PA messages to young people through mass media, websites and smartphone apps (Latimer-Cheung et al., 2013). Experimental and survey evidence also exists to support the use of video messages over

static images when targeting motivation and message recall (Deshpande et al., 2015; Peterson et al., 2008).

Adults

Message content

Experimental evidence focusing on “how much” information (e.g. 150 minutes each week, 30 minutes x 5 days a week, or 10,000 steps each day) does not clearly support one ‘amount’ or dose as the most effective message (Murtagh et al., 2014; Pal et al., 2011). However, evidence does exist to suggest presenting 150 minutes each week as a minimum threshold may be damaging to perceived benefits of shorter bouts of PA (Knox et al., 2014), and that adult populations (in a national survey) show high willingness to increase PA by short bouts (i.e. 10 minutes per day) (Miyachi et al., 2015).

Overall, existing evidence from formative research and existing reviews supports the use of gain-framed messages when targeting various outcomes for adults (Adams, 2000; Black et al., 2000; Latimer et al., 2010; Latimer-Cheung et al., 2013; Mendez et al., 2012). Some experimental evidence from studies comparing gain- and loss- framed message content in trial designs have found no significant difference in effectiveness on proximal or distal outcomes in young adults (Bassett-Gunter et al., 2014; Berry & Carson, 2010; Kin-Kit et al., 2014; Notthoff & Carstensen, 2014), adults over 55 years (Berry & Carson, 2010), inactive colorectal cancer survivors (Hirschey et al., 2016), or in community dwelling individuals with multiple sclerosis (Lithopoulos et al., 2017). However, an advantage for gain-framed messages over loss-framed messages has been found in general adult

populations (Latimer et al., 2010; Sweet et al., 2014; van 't Riet et al., 2010), university students (Jones et al., 2003), overweight females (Kozak et al., 2013), sedentary adults (Latimer, Rench, et al., 2008), and cardiac rehabilitation patients (McCall & Ginis, 2004) on outcomes including attitude, exercise intentions and PA behaviour. It also appears the effect of framing may depend on the type of outcome emphasised and on the individual's need for cognition (i.e. an individual's tendency to enjoy activities that require thinking) (Gallagher & Updegraff, 2011), or on an individual's emotional risk perception (Michalovic et al., 2018). Messages involving threat-based information or forceful language appear to be ineffective or may even have detrimental effects on PA and PA-related outcomes such as intentions, motivation and affect (Brenngman et al., 2010; Hatchell et al., 2013; Kang et al., 2017; Quick & Considine, 2008).

Evidence from an existing scoping review suggests mental health benefits are less frequently focused on than physical health benefits in PA messages (Bergeron et al., 2019). Despite a lack of focus, evidence from existing reviews, qualitative research and experimental research supports the use of messages highlighting short-term social (e.g. PA an opportunity to connect with others) and mental (e.g. improved mood and energy levels) health benefits in university students (Reese et al., 2017), adults (Berry, 2017; Groshong et al., 2017; Howle et al., 2017; Nicholson, 2012a) and specifically in active adults (Hevel et al., 2019) when targeting various outcomes including motivation and self-efficacy. Experimental evidence identified does not support the use of appearance-based messages to

improve PA intentions or attitudes in young adults (Berry, Jones, et al., 2011; Rhodes & Courneya, 2000).

This scoping review identified more evidence from experimental studies demonstrating a benefit of messaging tailoring (see Table 5-2) in improving PA behaviour, self-efficacy and feelings towards PA (Bull et al., 1999; Latimer et al., 2010; Latimer, Rivers, et al., 2008; Quintiliani et al., 2010) than no benefit (Martinez et al., 2013). Experimental evidence also supports the use of tailoring over simple personalisation of a generic message when targeting PA behaviour (Bull et al., 1999), and no evidence was found to support the use of non-tailored messages over tailored messages. Qualitative research and existing reviews support the use of psychological theory to help identify behavioural determinants that messages can be tailored to (Berry & Latimer-Cheung, 2013; Latimer et al., 2010). This scoping review identified a number of determinants by which messages could be tailored to, namely: Stage of Change (as described in Transtheoretical Model) (Latimer et al., 2010; Yan et al., 2015), social support needs (Bailis et al., 2005; Kinnafick et al., 2016; Yan et al., 2015) and self-efficacy (Latimer et al., 2010; Marmo, 2013). The increasing potential for intervention designers to create individually tailored messages due to advancements in technology is also apparent in the evidence base (Conroy et al., 2019; Op Den Akker et al., 2015).

The evidence supports the use of messages targeted to specific demographics, such as women (Leone et al., 2012; Thai et al., 2019) or

young healthy adults (Berry & Carson, 2010) to improve outcomes such as attitudes and intentions. Further, the importance of identifying and targeting to more specific population subgroups (such as education level, physical activity level, intention to be active, attitudes towards PA and perceived benefits of PA) beyond traditional demographics (such as age and gender) was evident across multiple studies and study types identified in this scoping review (Berry, 2006; Berry, 2016; Berry, Jones, et al., 2011; Black et al., 2000; Cheval et al., 2015; Latimer, Rivers, et al., 2008; Leahy et al., 2009; Yap & Davis, 2008).

Previous reviews support the use of practical advice and “how to” information in PA messages (Brawley & Latimer, 2007; Latimer et al., 2010; Nicholson, 2012a). Existing evidence also highlights the importance of including information that is relevant to the target audience and using formative research to highlight what the specific focus of messages should be. For example, qualitative research suggests messages for women may address identified barriers to women such as poor body image (Reese et al., 2017; Segar et al., 2017). Mixed findings were found on the use of descriptive norm information (e.g. information about prevalence of PA amongst peers) on intentions and PA behaviour in adults (Crozier & Taylor, 2019; Priebe & Spink, 2012; Priebe & Spink, 2015; van Bavel et al., 2014).

One study found the use of spouse’s health risk information to be promising in promoting PA in middle-aged adults (Skapinsky et al., 2018), and another found active women had higher confidence in response to

reading information that PA was preventive of heart disease compared to breast cancer (Berry et al., 2018). Potentially adverse effects of PA messages were identified in only one study, where recipients who viewed exercise-related messages consumed more calories post-message than those in control group (Albarracin et al., 2009).

Numerous existing reviews focusing on mass media campaigns targeting mixed adult populations were found in this scoping review (Bauman & Chau, 2009; Brown et al., 2012; Cavill & Bauman, 2004; Finlay & Faulkner, 2005; Leavy et al., 2011; Marcus et al., 1998; Marshall et al., 2004; Yun et al., 2017) as well as numerous evaluations of single mass media campaigns (Bauman et al., 2001; Peterson et al., 2005; Peterson et al., 2008; Saito et al., 2018; Smith & Bonfiglioli, 2015). Mixed findings were found for effects of campaigns on proximal outcomes (e.g. awareness and campaign recall) and intermediate outcomes (e.g. intention to be active), but generally campaigns had less of an effect on intermediate outcomes than on proximal. Campaign effects on distal outcomes such as PA behaviour itself were modest and inconsistent, with few campaigns reporting increases. However, mass media campaigns specifically targeting walking have had positive effects on awareness (Barnes et al., 2013; Booth et al., 1992; Leavy et al., 2013; Leavy et al., 2014; Owen et al., 1995), attitudes (Beaudoin et al., 2007; Leavy et al., 2014; Leavy et al., 2013) and levels of walking (Barnes et al., 2013; Booth et al., 1992; Leavy et al., 2013; Owen et al., 1995).

The evidence supports the use of social marketing principles (e.g. branding and promotional strategies) in the development of mass media campaigns (Buller, 2006; Huhman et al., 2017; Wong et al., 2004), and suggests that interventions which use campaign building principles or social marketing benchmarks (e.g. formative research, audience segmentation and channel placement) are more successful in bringing about behaviour change than those which do not use these principles (Lankford et al., 2014; Xia et al., 2016).

Message delivery

The internet was found to be a common source of PA information in a general adult population (Berry, Spence, et al., 2011), and interventions using the internet as a method of message delivery (e.g. email) have had promising results (Rhee et al., 2009). In terms of provider or messenger, the evidence from formative research supports the delivery of PA messages through peers (Black et al., 2000; Marmo, 2013; Nicholson, 2012a) in a general adult population. In terms of media or mode of message, the general public find guideline documents unappealing (Berry et al., 2010), and the evidence from existing reviews and qualitative research supports the use of commercial style messages (Berry, 2017; Berry et al., 2010). Mobile phone text messages have also been successfully used in PA messaging interventions identified in this review (Filion et al., 2015; Kinnafick et al., 2016).

In terms of frequency and dose, when staff and students in UK universities received text messages on top of regular PA promotion emails,

PA levels decreased significantly more than in the group that received emails only (Suggs et al., 2013). In young adults, evidence supports sending short messages (Reese et al., 2017) at times where there is opportunity to act on them (e.g. near morning or afternoon work break) (McCoy et al., 2017), and a maximum of 2 messages per day (Yan et al., 2015). Lastly, relating to media or mode of delivery, some experimental evidence exists to support the use of images in social media posts promoting PA (Johnston & Davis, 2019).

In terms of mass media campaigns, qualitative research, experimental research and existing reviews identified in this scoping review support the use of multiple modalities (e.g. TV and billboard) of message delivery (Peterson et al., 2008), the use of messages focusing on mental and social health benefits (Scarapicchia et al., 2015), and working with local partnerships to provide opportunities for the behaviours promoted in the campaign (Graham & Graham, 2008). Longitudinal evidence following campaign effects has shown disparities between high and low socio-economic status and between majority and minority ethnic groups, highlighting the importance of considering social inequalities when designing, implementing and evaluating mass media campaigns (Pena-Y-Lillo & Lee, 2019).

Older adults

Message content

Experimental research in older adults supports the use of gain-framed messages over loss-framed messages in bringing about improvements in motivation and PA levels (Li et al., 2017; Notthoff & Carstensen, 2014;

Notthoff et al., 2016). Qualitative evidence exists to suggest messages to older adults should highlight the short term social and mental health benefits of PA (e.g. feeling relaxed and connecting with others) (Nicholson, 2012a; Sebastiao et al., 2015). Messages promoting mental imagery (e.g. encouraging older adults to imagine themselves walking) may also be a promising approach to improve PA behaviour (Robin et al., 2018).

Message delivery

Qualitative research in older adults has found that this population have difficulty digesting technical language (e.g. 'cardiovascular' rather than 'heart') (Nicholson, 2012a), and dislike the format of existing PA guideline documents (Sebastiao et al., 2015). Qualitative evidence also suggests older adults value messages from health care professionals (HCPs) and peers (Letts et al., 2011; Nicholson, 2012a).

Pregnant women

Message content

Qualitative research found that pregnant women with Gestational Diabetes want to feel confident about being physically active during pregnancy, and that they would like practical information on safe physical activities they can take part in (Harrison et al., 2019). Empirical research suggests that appearance and health based messages were equally ineffective at improving intentions to exercise post-partum (Gaston & Gammage, 2010), but that persuasive messages grounded in Theory of Planned Behaviour resulted in significantly greater improvements in PA related outcomes than control (Gaston & Gammage, 2011).

Message delivery

Qualitative research supports message delivery through credible sources such as HCPs in pregnant women (Harrison et al., 2019). A randomised controlled trial found that pregnant women who received six PA messages/week had greater decreases in PA and increases in sedentary time than those who received fewer messages (Huberty et al., 2017).

Disabled people

Message content

A commentary on research conducted in disabled people supports messages promoting short term affective outcomes of PA (e.g. PA makes you feel good, do what you enjoy) (Smith & Wightman, 2019). Qualitative research with disabled people and their carers has highlighted the importance of acknowledging the heterogeneity of disabilities and conducting formative research to determine appropriate message content and delivery methods (Jaarsma et al., 2019). Qualitative research with parents of disabled children supports the use of messages including targeted information, inclusive images that promote belongingness, and messages providing self-regulatory tools (Bassett-Gunter et al., 2017). One study conducted with community dwelling men and women with spinal cord injury found greater effects on proximal and intermediate outcomes following loss-framed messages targeting psychological health than gain-framed messages (Bassett-Gunter et al., 2013).

Message delivery

In parents of disabled children, qualitative research has revealed that preferred PA message providers are reliable and credible organisations, other parents (Bassett-Gunter et al., 2017), and the school (Jaarsma et al., 2019). Role models (e.g. coaches or mentors), doctors, psychologists, physiotherapists, social workers and peers have also been highlighted as important messengers for disabled people (Jaarsma et al., 2019; Smith & Wightman, 2019). Community dwelling people with spinal cord injury stated preference messages delivered via the internet and via HCPs (Letts et al., 2011).

Gaps in the literature

With the findings from studies summarised above, it is also helpful to consider an overview of where evidence has and has not accumulated on the topic of PA messaging. Overall, studies more frequently focused on aspects of message content than on aspects of message delivery, and on adults more than other populations. A matrix displaying where evidence has accumulated and where evidence is lacking (based on the studies reviewed) is displayed in Figure 5-3.

FIGURE 5-3: GAPS MATRIX DISPLAYING WHERE EVIDENCE HAS ACCUMULATED AND WHERE GAPS LIE RELATING TO PHYSICAL ACTIVITY MESSAGING

	Children and young people	Adults	Older adults	Pregnant women	Disabled people
Message content					
Type of information	Consistent evidence from formative primary research and non-systematic reviews. Little evidence from experimental research.	Consistent evidence from formative primary research, non-systematic reviews and experimental research.	Some evidence from formative primary research and non-systematic reviews. No evidence from experimental research identified in this review.	Little evidence from formative and experimental research.	Some evidence from non-systematic reviews and formative research.
Use of framing	Some evidence from formative primary research and non-systematic reviews. Little evidence from experimental research.	Systematic review level evidence.	Little evidence from formative research and non-systematic reviews. Consistent evidence from experimental studies.	No evidence identified in this review.	No evidence identified in this review.
Use of tailoring and targeting	Little evidence from formative research and non-systematic reviews. No evidence from experimental research identified in this review.	Systematic review level evidence.	Little evidence from formative research and non-systematic reviews. No evidence from experimental research identified in this review.	No evidence identified in this review.	Little evidence from formative research. No evidence from experimental research identified in this review.
Message delivery					
Media or mode of delivery	Some evidence from formative primary research and non-systematic reviews. Little evidence from experimental studies.	Some evidence from formative primary research and non-systematic reviews. Little evidence from experimental studies.	Some evidence from formative primary research and non-systematic reviews. No evidence from experimental research identified in this review.	No evidence identified in this review.	No evidence identified in this review.
Provider or source	Some evidence from formative primary research and non-systematic reviews. No evidence from experimental research identified in this review.	Some evidence from formative primary research and non-systematic reviews. No evidence from experimental research identified in this review.	Some evidence from formative primary research and non-systematic reviews. No evidence from experimental research identified in this review.	Little evidence from formative research. No evidence from experimental research identified in this review.	Some evidence from formative research and non-systematic reviews. No evidence from experimental research identified in this review.
Frequency and dose	No evidence identified in this review.	Some evidence from experimental research.	No evidence identified in this review.	Little evidence from experimental research.	No evidence identified in this review.

Colour coded based on level of existing evidence in each population from **strong** (dark green) to **non-existent** (orange).

Discussion

Summary of principal findings

This scoping review aimed to map the literature on PA messaging and identify key research gaps. We found that PA messaging is complex and multidimensional in nature, with numerous concepts to consider when creating or evaluating messages. The extent to which each individual concept has been researched across different populations is variable and for many concepts there is no clear consensus on how to optimally design or deliver PA messages. However, the review has successfully mapped where evidence has accumulated and where clear gaps exist. Where consistent evidence does exist, it suggests that PA messages should be gain-framed, should highlight short-term outcomes (specifically relating to social and mental health), message content should be tailored or targeted, and formative research, psychological theory and/or social marketing principles should be used in message development.

Comparison with literature and plausible explanations for findings

Our principal findings agree with those from another recent scoping review (Bergeron et al., 2019) that reviewed PA communication efforts solely in the USA from 1995-2015. The authors of that review found that 68% of messages were grounded in theory with the majority of communication research being conducted in adult populations (Bergeron et al., 2019). They also recommended that PA campaigns should use visual content such as videos, content targeted to specific populations, and multiple modalities to deliver messages (Bergeron et al., 2019). Our scoping review builds on these

findings by providing an up-to-date overview of PA messaging research evidence from multiple countries across the globe and making recommendations for population groups aligning with PA for health guidelines (see Table 5-5 below). Our review also supports findings from a systematic review of different approaches to PA message construction (Latimer et al., 2010). In line with our findings, Latimer et al., found a benefit for gain-framed messages over loss-framed messages, found that message tailoring is important for success, and found messages targeting the psychological determinant of self-efficacy to be beneficial but concluded that overall understanding of PA messaging was lacking (Latimer et al., 2010).

Evidence from this scoping review supports the use of gain-framed messages. Message framing originates from Prospect Theory, which suggests individuals will respond differently to factually equivalent messages depending on whether they are worded to highlight benefits or consequences (Tversky & Kahneman, 1981). The benefit of gain-framing over loss-framing in promoting PA may be partially due to the greater ability or likelihood of a gain-framed messages to include information targeting psychological determinants of PA. For example, it would be difficult to construct a loss-framed message that aimed to improve an individual's self-efficacy. This links with the finding that messages are more promising when grounded in psychological theory. This is not surprising, as the importance of using theory in the development of public health interventions is widely recognised (Green, 1999) although we acknowledge this is a currently debated topic in the literature (Hagger & Weed, 2019). The evidence supporting the use of

tailoring or targeting in PA messaging is also intuitive. It is believed that customising a message increases message salience (Kreuter et al., 1999), which leads to greater information processing and behaviour change (Marcus, 2010; Napolitano & Marcus, 2002).

In a field where the physical long-term health benefits of taking part in PA are often at the forefront of epidemiology and subsequent communications, an important finding of this scoping review is that evidence supports the use of messages highlighting short-term outcomes, particularly those relating to mental and social health. This finding may relate to social marketing, which involves applying marketing techniques to influence human behaviour for social good and to improve health outcomes (Hastings, 2018). Social marketing involves presenting a product (in this case PA) in exchange for a cost (in this case somebody's time, energy, or other potential resources). To market such a product effectively to an individual, it is important we make it as appealing as possible. It seems logical then that an individual may respond better to what they can get out of 'buying into' this product immediately (e.g. feel good, have more energy, spend time with others) than what they may get out of it later (e.g. reduced risk of cardiovascular disease later in life). An individual may know that eating cake regularly could increase their risk of weight gain and negatively affect their health, but they may continue to do so for the immediate enjoyment of eating cake. Social marketing therefore highlights the importance of utilising affective and emotional responses to make a 'product' more appealing

(Hastings, 2018), and this aligns with creating messages that depict PA as, for example, fun, enjoyable, or an opportunity to spend time with loved ones.

Future research and implications

Our findings show an increasing interest in the area of PA messaging, with almost half of the studies identified published in the past 5 years. In terms of future research, there is a need for instructive studies with appropriate evaluative designs to systematically isolate and test individual components of message content and delivery for effectiveness, and thus develop our understanding of optimal PA content and delivery in different population subgroups. Such research efforts should prioritise the PA messaging concepts identified in this review as having little or no evidence focusing on them (e.g. message dose and frequency in all populations). In areas where evidence has accumulated but has not yet been synthesised (e.g. type of information in adults), systematic reviews with meta-analyses are also warranted. Qualitative research and mediator analysis to help gain a greater understanding of the specific mechanisms by which existing PA messages work (i.e. which psychological determinants are affected by PA messages), or which outcomes future PA messages should target is also required to enhance our understanding of PA messaging. Also, although we attempted to identify commonly used theories from included studies, numerous potentially important theories were not discussed in this review (e.g. Knowledge Gap Hypothesis and Elaboration Likelihood Model). Therefore, to further enhance our understanding of PA messaging, a specific review of the role of theories and the extent to which they have been used in

PA messaging using existing guidance (Michie & Prestwich, 2010) may also be warranted. Lastly, due to the complex and multidimensional nature of PA messaging highlighted in this review, there is a need to organise and conceptualise the area of PA messaging to encourage further understanding of, and application in, this area.

The findings of this research are timely as they could inform the dissemination of newly developed, or updated guidelines to various populations (Brown et al., 2012; Department of Health & Social Care, 2019; US Department of Health and Human Services., 2018; World Health Organization, 2020). At current, the World Health Organisation (WHO) are updating global PA guidelines, and these findings may aid their communication and dissemination plans. In the UK specifically, the Updated Chief Medical Officers' (CMO) guidelines (released on September 9th 2019) state that a Communications Working Group is being established to advise approaches to communicating PA recommendations and related messages to the wider public (Department of Health & Social Care, 2019). Based on key findings, recommendations which could be used by such working groups to aid development of PA messages to each guideline group are presented below (Table 5-5)⁴.

⁴ These recommendations are presented in an infographic in Apendix 2.

TABLE 5-5: PHYSICAL ACTIVITY MESSAGE RECOMMENDATIONS BASED ON SUMMARY OF FINDINGS

Guideline group	Physical activity message recommendations
Children and young people	<ul style="list-style-type: none"> • Messages to this population should be framed positively, highlighting the benefits of physical activity. Specifically, messages should highlight the social and acute affective benefits of physical activity, for example, “physical activity is fun”. • Messages to this population should be delivered via engaging modes such as videos and should be delivered through informal sources such as smartphone apps or the media.
Adults	<ul style="list-style-type: none"> • Messages to this population should be framed positively, with specific focus on social and mental health benefits of physical activity, for example, “physical activity makes you feel good”. • Messages should be brief and should avoid threat-based language. To the general adult population, informal modes of delivery are encouraged such as through the media. • In clinical populations, messages should be delivered through health care professionals.
Older adults	<ul style="list-style-type: none"> • Messages to this population should be framed positively, with specific focus on social and mental health benefits of physical activity, for example, “physical activity is an opportunity to connect with others”. • Messages delivered through health care professionals are likely to be well-received
Pregnant women	<ul style="list-style-type: none"> • Messages to this population should include clear and practical information on physical activity during pregnancy, for example, messages could include examples of safe exercises. • Messages should be delivered through credible sources such as health care professionals.
Disabled people	<ul style="list-style-type: none"> • Messages to this population should highlight short-term affective benefits of physical activity and should use inclusive images. • Messages should be delivered through credible organisations, health care professionals and social workers.

Strengths and limitations

This scoping review is the first to attempt to provide an overview of available evidence on PA messaging from across multiple countries. A key strength of this scoping review is its inclusivity of a range of study designs, allowing us to provide a more comprehensive overview of the evidence base. Further strengths of this scoping review include the use of established protocol (Arksey & Malley, 2005; Levac et al., 2010; Tricco et al., 2018), and presentation of findings by key concepts and population groups. This review has produced meaningful findings which may aid dissemination of PA guidelines (such as the under-development new WHO Global PA guidelines or the newly released UK PA guidelines for health (Department of Health & Social Care, 2019) and related information to various population subgroups.

Due to the nature of scoping reviews, we did not appraise the quality of evidence included. We are also unable to comment on the effectiveness of different messaging techniques as the heterogeneous nature of included studies do not allow for meta-analysis, and indeed that is not the aim of a scoping review (Arksey & Malley, 2005). Rather, we have presented a descriptive account of available research. Another limitation of this scoping review is that only titles were searched due to the time and resource constraints. This limitation means that some relevant studies were missed. For example, although our review identified the Canadian campaign ParticipACTION (Deshpande et al., 2015), not all publications on this campaign were identified due to the limitations of our search terms (Spence et al., 2009). Indeed, given the nature of PA messaging, it could be argued

that it is impossible for one review to completely capture all of the available evidence in this area. However, a substantial body of literature was generated (123 studies); almost double the number identified in a previous scoping review of PA communication in the USA alone (Bergeron et al., 2019). We are confident we have included a range of studies that adequately provide an overview of the PA messaging evidence base, and which is sufficient in addressing our aims. Finally, there are likely lessons to be learned from other forms of PA communication (e.g. one-to-one counselling) however, these were deemed to be outside the scope of this study and therefore not included. Isolating PA messaging to the public from other forms of communication was necessary to focus our study and develop our understanding of PA messaging and its application in this area.

Conclusion

While it is unlikely to address global inactivity on its own, PA messaging may play a significant role in targeting individual factors in a systems approach to improve PA population levels, but is a complex and multidimensional concept. We present a synthesis of the PA messaging evidence from across the globe, highlighting key areas where evidence has accumulated and where gaps exist. We provide recommendations for PA messaging to different population groups. Headline findings include support for the use of gain-framed messages highlight short-term mental and social health outcomes, tailored or targeted messages, and messages grounded in psychological theory or social marketing principles. Further instructive

research is required to understand how to optimally message PA information to different populations.

Postamble

The scoping review described in this chapter helped broaden our understanding of PA messaging by highlighting key areas where evidence had accumulated and others where evidence was lacking. This scoping review helped advance our field by providing clear working definitions for PA messaging, PA message, PA message content, and PA message delivery. On reflection, the definition of PA messaging presented in this chapter may be more accurately described as a description than as a definition, as it includes the term PA message. Regardless, the terms presented in this chapter provide a useful reference point for future PA messaging research.

This scoping review collated and summarised further evidence than was previously discussed for each of the five messaging concepts identified in the initial literature review (Chapter 3), including identifying evidence within each of the PA guideline population groups. Furthermore, an additional three concepts were identified and defined in this formal scoping review than were identified in the initial literature review, providing a clear set of defined PA messaging concepts relating to both either message content and delivery (defined in Table 5-2). This is a key step in harmonising the PA messaging research area. In addition to organisation of key concepts and provision of PA messaging recommendations for various groups, a further key output from this scoping review was the gaps matrix that summarises where

research relating to each of these concepts for each population subgroup has accumulated and where research gaps lie (Figure 5-3).

Given the number of PA messaging concepts identified, and the number of concept- and population subgroup- specific gaps, there were several potentially relevant paths that this PhD could have taken following this first study. For example, any of the yellow or orange areas in the gaps matrix (Figure 5-3) could have been further explored in detail. Focusing in one messaging concept or one target population following the scoping review would have allowed me to begin to address some of the gaps identified. However, it was not clear from the scoping review that one specific gap was more in need of addressing than others. Furthermore, as the scoping review was so broad and revealed the complex and multidimensional nature of PA, I saw value in conducting further work at this broader level for the next stage of the PhD. Following sharing of findings and research plans with my advisory group, it was found that improving overall understanding of PA messaging (as opposed to focusing on a more specific gap) and would allow more useful findings for important groups including the CMO communication working group and Public Health Scotland. Furthermore, addressing this broader gap would benefit subsequent more specific PA messaging work.

Improving overall understanding of PA messaging was therefore viewed as the priority gap to fill over one of the several more niche gaps identified in study 1. This will be further discussed and justified in the following chapter.

Chapter 6 Rationale for and development of a framework for physical activity messaging

Chapter outline

Considering findings from Chapter 5 and existing frameworks and guidance, this chapter aims to provide the rationale for and outline the development of a PA messaging framework and checklist that have potential to enhance and harmonise the PA messaging research area.

Rationale for developing a physical activity messaging framework

During the process of the scoping review of PA messaging (detailed in Chapter 5), four key considerations became evident from the identified evidence base that formed a rationale for developing a conceptual framework for PA messaging. Firstly, PA messaging is a complex and multidimensional area of growing interest, and, as evidenced in Chapter 5, best practice is not yet well understood (Williamson et al., 2020). Within PA messaging, there are several potentially important concepts to consider, identified and described in previous chapters. To the best of my knowledge, there have been no attempts to date to organise or categorise the different concepts that may or may not be considered in PA messaging. This makes it challenging to understand and compare the various PA messaging sub-concepts (and their effectiveness) and makes mapping out or categorising existing PA messaging approaches more difficult. An agreed framework that organises these concepts will help future synthesis and understanding of existing messages approaches.

Second, terminologies used for, and understandings of, the various PA messaging concepts are inconsistent across the literature. A key example of this are the terms tailoring and targeting. As described in Chapter 3, these are two distinct terms both relating to message customisation. Although some authors clearly distinguish between tailoring as an exclusively individual level approach and targeting as an exclusively group level approach (Brawley & Latimer, 2007), the term tailoring has also been used to describe customisation of message content at a group level (Yan et al., 2015). Similarly, the term targeting has been used to describe individually-customised messages (Berry, 2016). These inconsistencies also make it difficult to collate and summarise what is known about different PA messaging concepts. An agreed framework that harmonises these concepts will help future evidence generation and synthesis.

Third, it is often unclear what are the proposed mechanism(s) (Connell et al., 2019) by which PA messaging interventions aim to bring about changes in PA. In other words, *how* they are expected to work. For example, do they aim to increase knowledge, motivation, or awareness? Are they designed to elicit fear, or offer a reward? Which psychological antecedents are being targeted by the message? Not considering potential mechanisms and having unclear message aims may hinder appropriate evaluation of PA messages, as understanding which outcome(s) to measure will be less clear.

Fourth, and relating to message mechanism(s) and aim(s), the scoping review presented in Chapter 5 also showed that many studies did

not draw on, or failed to adequately report, how formative research, psychological theory, or social marketing principles had been used to guide message creation. In addition to the concepts identified in the scoping review relating to message content and delivery, a third potential set of PA messaging concepts has therefore arisen; those relating to the message mechanism or aim, and how decisions on message content and delivery are made. A framework that encourages design of messaging based on theory, formative work, and existing evidence, with emphasis on understanding plausible mechanisms of action would, we believe, be an important contribution to the field.

I therefore aimed to develop a framework for PA messaging that could address the above points to improve future PA messaging research and practice through aiding message creation and evaluation. Specifically, such a framework could facilitate synthesis of existing evidence, harmonise understanding and use of key concepts and terminologies, and encourage consideration of aims and pathways as well as use of theory, formative evaluation, and existing evidence in PA message development. To aid development of such a framework, existing frameworks and guidance within health communication were considered.

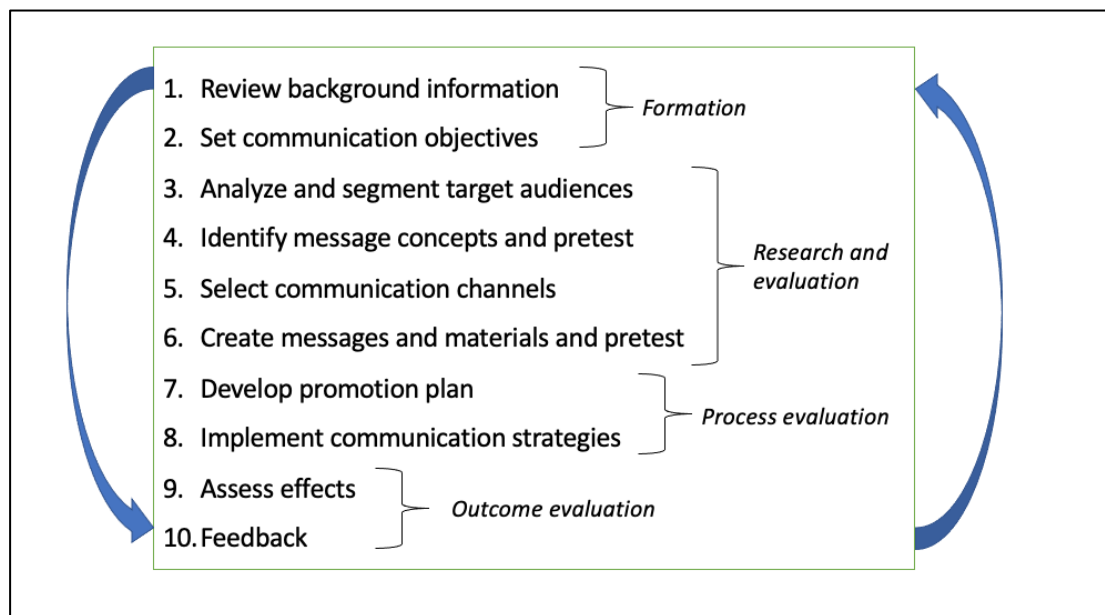
Existing frameworks and guidance

Health communication encompasses the study and use of communication strategies to inform, influence and motivate individual, institutional and public audiences about important health issues (U. S.

Department of Health and Human Services, 2010). As demonstrated in Figure 5-1 (see page 101), I consider PA messaging to be a subtype of health communication and as an overall concept that encompasses both content and delivery aspects of a PA message. Although to the best of my knowledge no framework specifically for creating and evaluating PA messages currently exists, there are existing frameworks, guidance, and principles for wider health communication that we can draw from and build upon. In this section, four existing frameworks for communication with potential relevance to PA messaging are discussed.

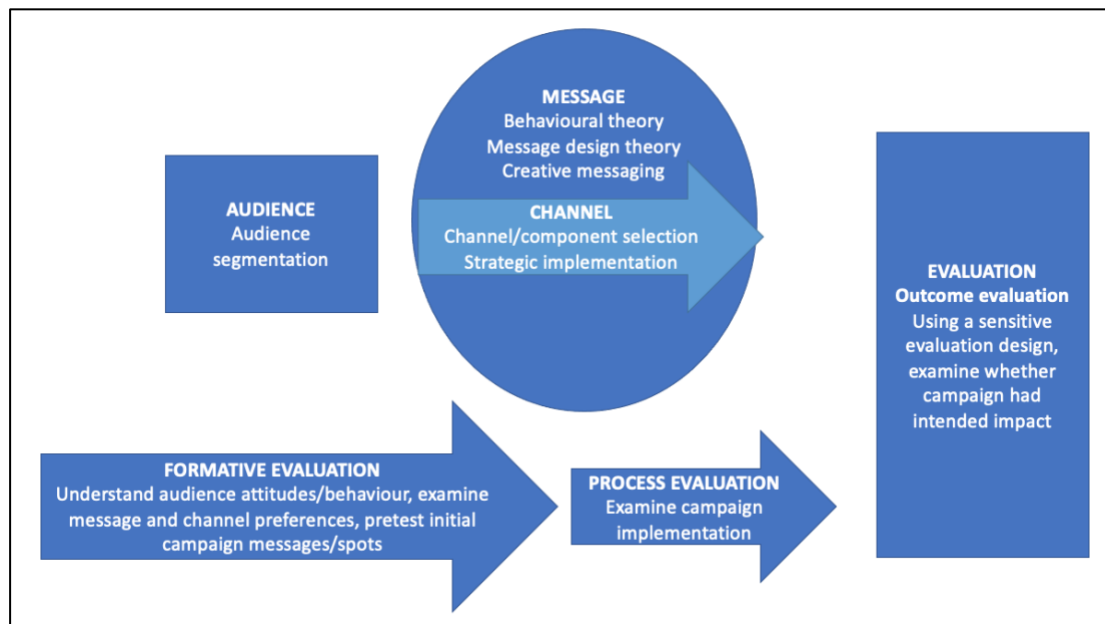
First, in 1995 the CDC published a Framework for Health Communication; a 10-step model for the development, pre-testing, refinement, delivery, and evaluation of health messages (Robert, 1995; William, 1993) (see Figure 6-1). This model is similar to others used by commercial marketers and health educators for campaigns advertising health behaviours. While this framework has some key strengths and similarities with the conceptual framework that is being developed as part of this PhD, such as setting clear objectives prior to deciding on message content and delivery channels, the framework was not designed specifically for PA, does not comprehensively illustrate the various concepts to be considered within establishing PA message aims, message content and message delivery (as identified in previous chapters), and is not being used in the field of PA messaging (identified in the scoping review outlined in Chapter 5).

FIGURE 6-1: CDC FRAMEWORK FOR HEALTH COMMUNICATION (ADAPTED FROM ROBERT, 1995; WILLIAM, 1993)



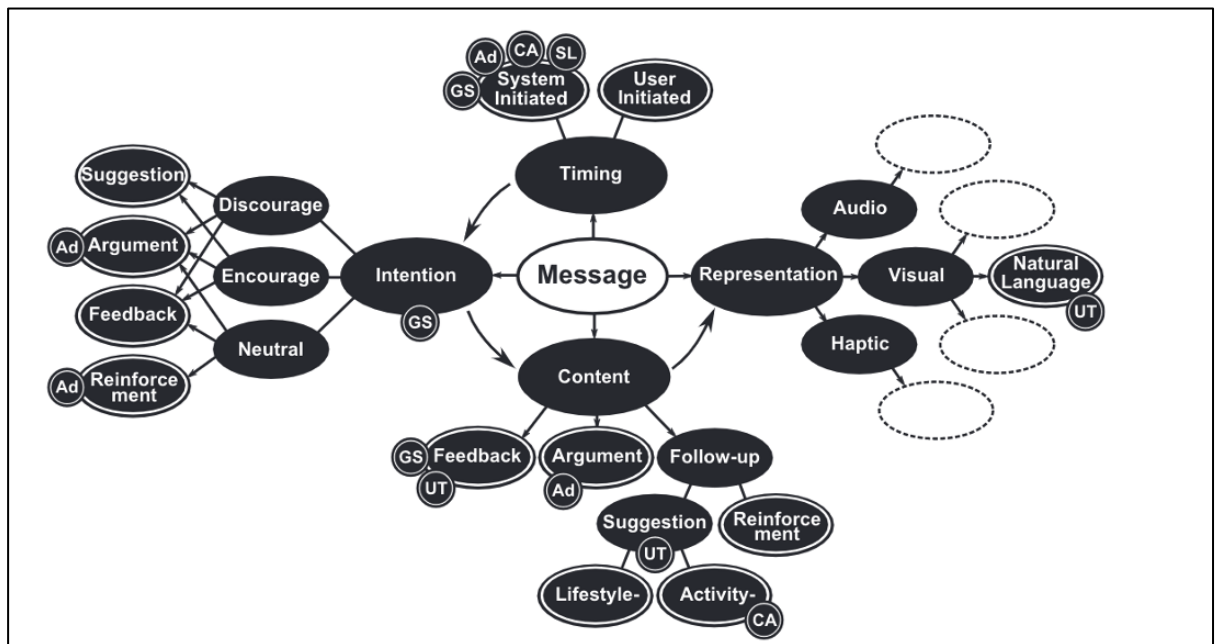
Second, and also for general health communication, the Audience-Channel-Message-Evaluation (ACME) Framework for Health Communication was published in 2012 (Seth, 2012) (Figure 6-2). This presents an integrated organising framework with the aim of helping design, implement and evaluate health communication campaigns. The ACME framework has some key elements that are important and transferable to the developing framework; it includes a focus on the target population and careful consideration of evaluation. However, the ACME Framework is specifically designed for health communication campaigns and not individual messages. Furthermore, like the CDC Framework for Health Communication, the ACME Framework is not specific to PA communication. Therefore, a framework based on PA messaging evidence and offering detailed guidance and considerations for individual PA message content and delivery (as well as multiple messages within a campaign) would be helpful.

FIGURE 6-2: THE AUDIENCE-CHANNEL-MESSAGE-EVALUATION (ACME) FRAMEWORK FOR HEALTH COMMUNICATION CAMPAIGNS (ADAPTED FROM SETH, 2012)



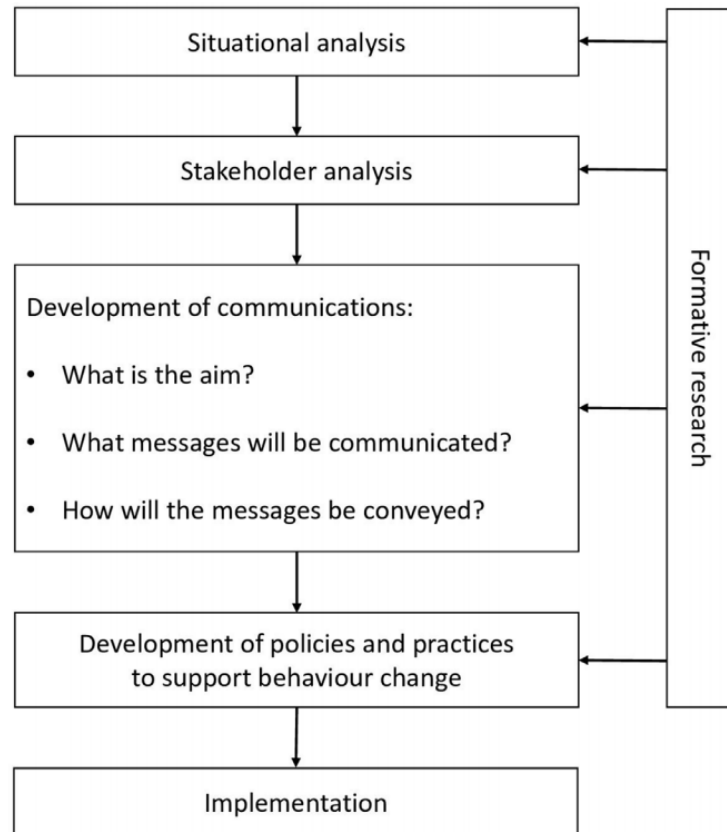
Third, in 2015, a Model of Motivational Messages specific to PA messaging was published (Op Den Akker et al., 2015) (Figure 6-3). This model presents a linear modular system for generating tailored PA messages to individual users in real time. Whilst this model has value in our technologically advancing world, it is only useful for a specific area of messaging (real-time tailored messages). As identified in this thesis so far, PA messaging encompasses many more concepts than those included in the Model of Motivational Messages, and therefore a more comprehensive framework for PA messaging is warranted.

FIGURE 6-3: MODEL OF MOTIVATIONAL MESSAGES (OP DEN AKKER ET AL., 2015)



Finally, as outlined in Chapter 4, the value of learning from social marketing in the field of PA for health promotion is becoming more widely recognised. A planning framework for communication of PA guidelines adapted from social marketing (Hastings, 2007) has recently been developed and published (Milton et al., 2020) (Figure 6-4). This framework encourages situational and stakeholder analysis before development of communication, therefore highlighting the critical role of formative evaluation in effective communication of the WHO PA guidelines (World Health Organization, 2020). This planning framework therefore has some key parallels with the developing framework presented later in this chapter and is useful for constructing an overall strategy for communicating PA guidelines. However, it does not include all concepts to consider when specifically developing PA messages for the general public.

FIGURE 6-4: PLANNING FRAMEWORK FOR PHYSICAL ACTIVITY COMMUNICATION (MILTON ET AL., 2020)



Overall, some frameworks and guidance do exist for wider health communication as well as for specific areas of PA communication. However, no framework or guidance exists that provides a comprehensive overview of the various concepts within PA messaging and that has the specific aims of aiding creation and evaluation of evidence based physical activity messages to the public. Therefore, using concepts identified in the scoping review (Chapter 5) and drawing on existing frameworks and psychological theory (Connell et al., 2019; Michie et al., 2011) a conceptual framework specifically for PA messaging was developed.

The Physical Activity Messaging Framework (PAMF) was developed over the course of a year (Spring 2019 – Spring 2020), undergoing numerous rounds of informal feedback and amendments through meetings, conference presentations and via an online pre-print. At time of writing, Version 2 of the Physical Activity Messaging Framework and an accompanying checklist (The Physical Activity Checklist) has been developed. The following section outlines the development of this framework.

Preliminary work and framework development

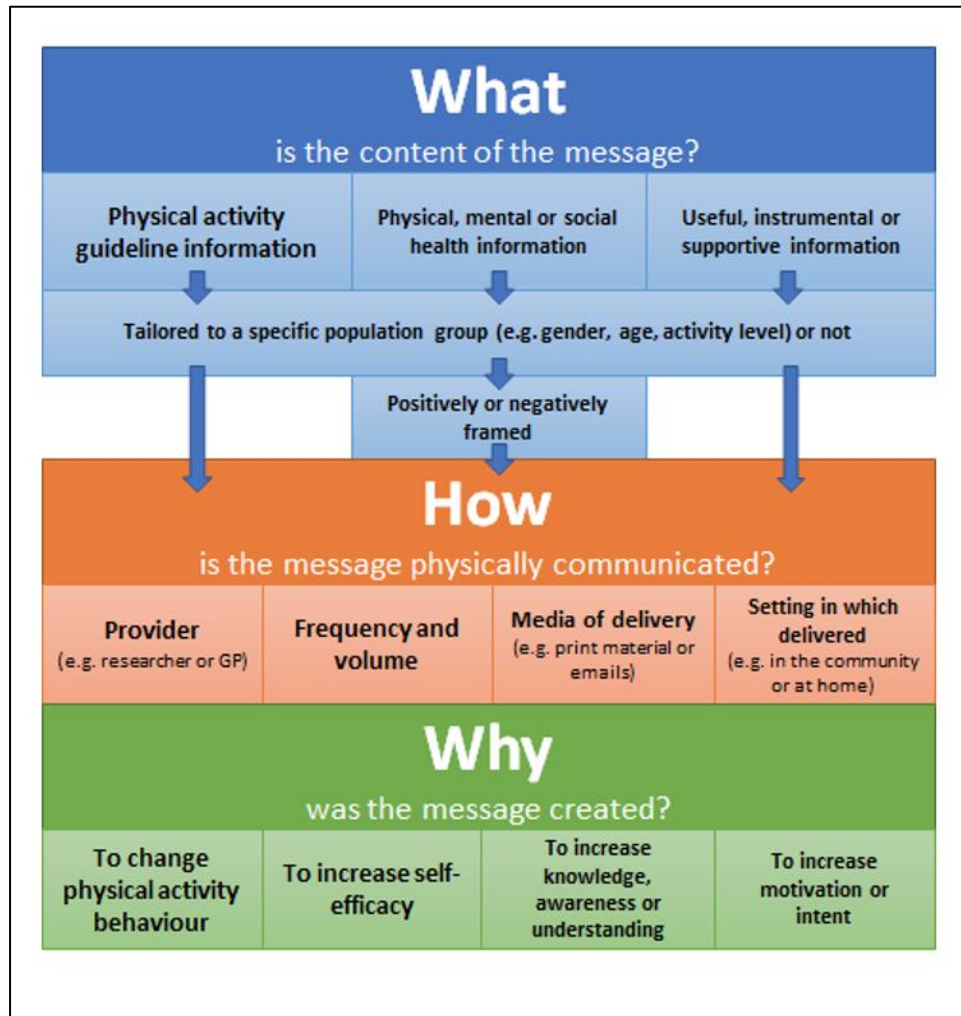
As the scoping review was progressing (Chapter 5), an initial list of key messaging concepts from the literature that was included in the scoping review was devised. These concepts could be broadly categorised into three areas: message content, message delivery and message mechanism/aim. Several of these concepts were identified prior to (and expanded on in) the scoping review in an initial literature review (Chapter 3), including use of framing, use of tailoring or targeting, media or mode of message, and message provider or messenger. Following the scoping review, further concepts were identified, including message mechanism/aim, the use of personalisation, and frequency and dose of delivery. Moreover, further concepts emerged from already identified concepts, e.g., from media/mode of delivery came delivery setting and volume or length of message. This initial list of PA messaging concepts (N=10) can be found in Table 6-1.

TABLE 6-1: LIST OF INITIAL PHYSICAL ACTIVITY MESSAGING CONCEPTS IDENTIFIED IN SCOPING REVIEW

List of initial identified physical activity messaging concepts (n=10)
<ol style="list-style-type: none">1. Message mechanism/aim– how it is intended to work2. Type of information in message3. Use of framing4. Use of tailoring or targeting5. Use of personalisation6. Media or mode of message7. Message volume or length8. Message provider or “messenger”9. Setting(s) in which message is delivered10. Frequency and dose of delivery

Discussions with the wider author group (CW, PK, GB, NM and AN) led to these concepts being clustered into three higher level categories (What, How and Why) to form Version 0 of the framework (Summer 2019) (Figure 6-5). ‘What’ related to the content of the message, ‘How’ related to the delivery of the message, and ‘Why’ related to the aim and rationale of the message. As described earlier in this chapter, it was difficult to organise, compare and synthesise existing evidence relating to various PA messaging concepts without a framework in which these concepts were organised. This initial grouping of messaging concepts therefore was a tool developed to facilitate synthesis of evidence in the scoping review by helping me to organise the large volume of evidence identified in the scoping review.

FIGURE 6-5: VERSION 0 OF THE PHYSICAL ACTIVITY MESSAGING FRAMEWORK

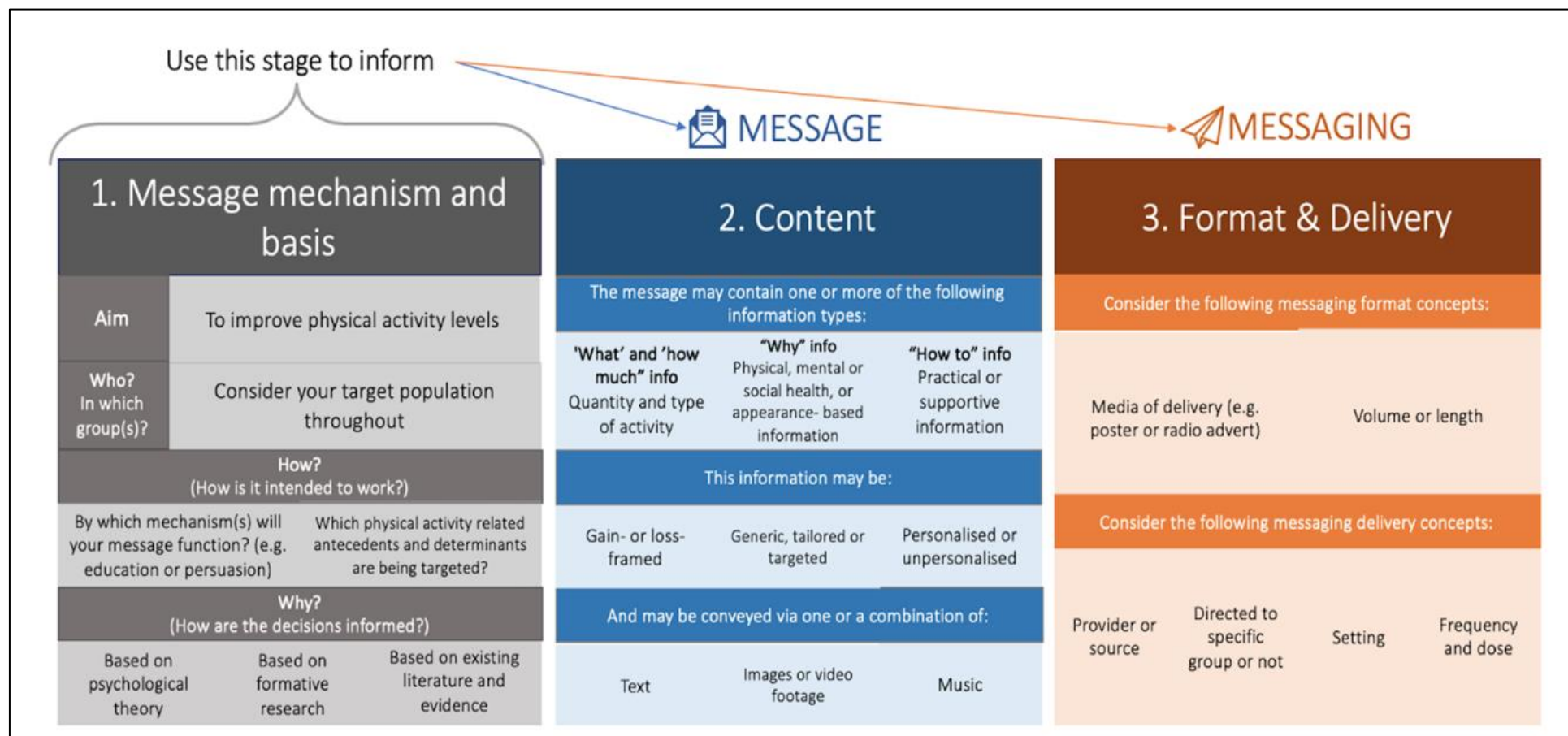


As the scoping review progressed, as did our understanding of the PA messaging research area. Through discussions with my advisory group, it was also realised that there may be use for the framework beyond the purpose of the scoping review; with the aim of helping others (researchers, practitioners, any other relevant stakeholders) who may be trying to understand or create PA messages. Version 0 of the framework was therefore revised based on feedback from an open discussion between the five authors of the published scoping review (CW, PK, GB, NM and AN) where we aimed to identify any missing concepts, discuss further breaking

down of some concepts into multiple sub-concepts, discuss any key issues with the organisation of concepts, and improve usability/usefulness of the framework. This led to development of Version 1 of the framework (Figure 6-6).

As it was intended to be useful for others and serve a greater purpose than aiding organisation of evidence in my own research, Version 1 of the framework was designed to be more user-friendly than Version 0. For this reason, the overall layout was amended to encourage sequential use from section 1 to section 3. The core principle of Version 1 of the framework was to firstly consider the aim and potential mechanisms of the PA message *before* considering message content and delivery. The framework outlined a number of concepts to consider within each of the three overarching concepts and encouraged the user to make decisions based on formative evaluation, theory and existing evidence.

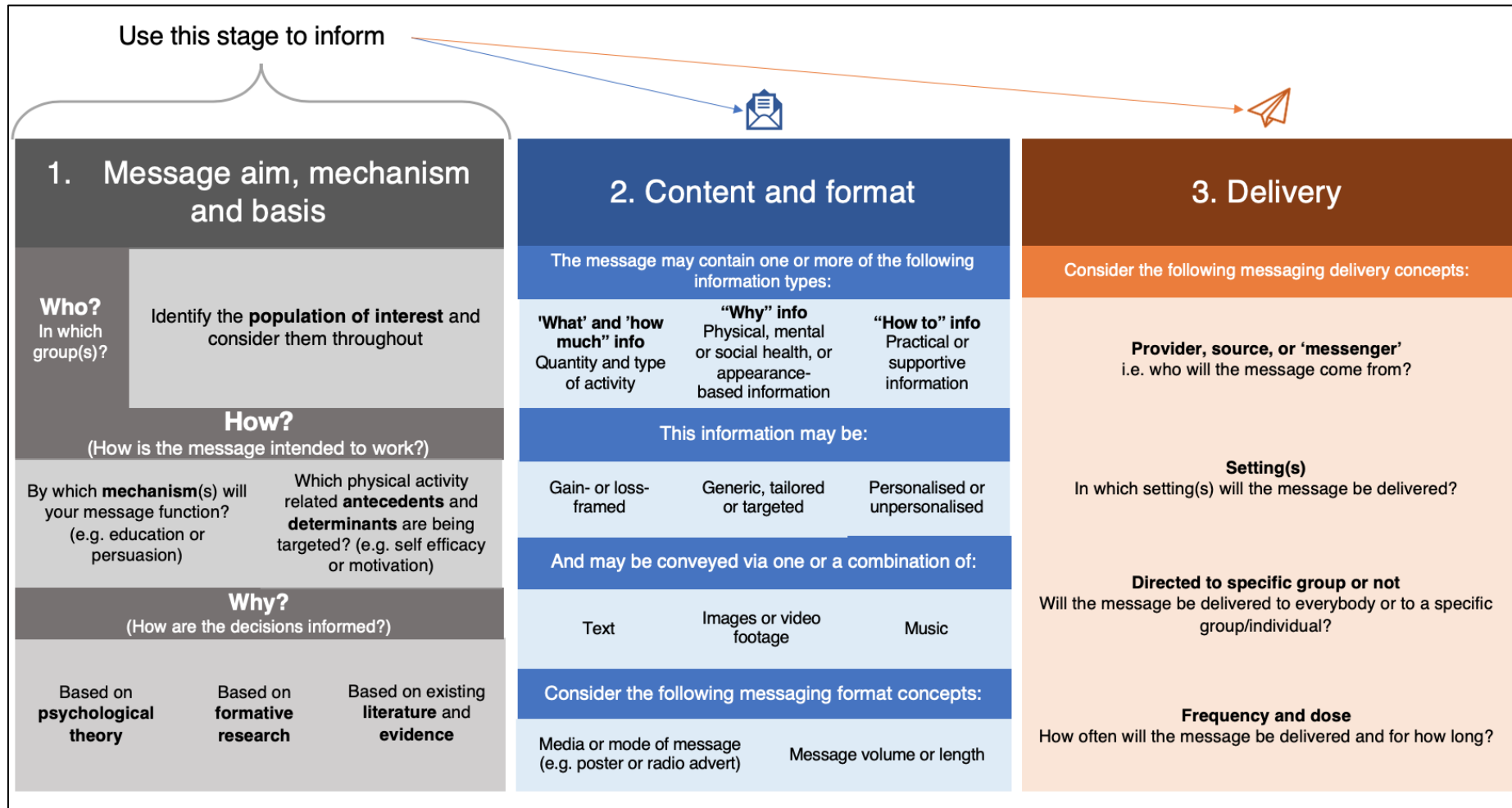
FIGURE 6-6: VERSION 1 OF PA MESSAGING FRAMEWORK



Version 1 of the framework (Figure 6-6) was presented during a workshop titled “*Communicating physical activity messages to the public*” at the Scottish Physical Activity Research Connections (SPARC)⁵ conference in November 2019, as well as made publicly available online as a ResearchGate pre-print (Williamson et al., 2019). Formal feedback was received through evaluation forms during the conference as well as via email in response to the pre-print. Based on this feedback and discussions between the scoping review author group, the framework was revised again resulting in Version 2. Version 2 of the framework includes 21 physical activity messaging concepts organised beneath three high-level and eight lower-level categories (Figure 6-7).

⁵ <http://www.sparc.education.ed.ac.uk/>

FIGURE 6-7: VERSION 2 OF THE PHYSICAL ACTIVITY MESSAGING FRAMEWORK



Pilot testing of the various versions of the framework has also taken place throughout the developmental process outlined in this chapter. Version 0 was used to guide qualitative research by a group at Bristol University who were investigating messaging preferences in underserved populations (Nobles et al., 2020). Version 1 of the framework was shared with Edinburgh Leisure⁶ and Paths for All⁷ as a potential tool to aid construction of PA messages and communications used alongside their programmes. Version 2 of the framework was used to help guide University of Edinburgh MSc Physical Activity for Health and undergraduate Applied Sport Science student dissertations exploring various elements of PA messaging. Version 2 was also used to guide development of a series of blogs and infographics for British Journal of Sports Medicine (BJSM) which aimed to help various populations remain active during the Covid-19 pandemic in April 2020 (Fawkner et al., 2020; Hanson, Kelly, et al., 2020; Neubeck et al., 2020).

Finally, with the aim of facilitating implementation of the developed PA messaging framework, a checklist to augment the framework was developed that could act as a practical tool to guide message creation and evaluation. The checklist contains the same core concepts as the framework but in a format that allows the user to work through each concept one by one and document the process. The version of the checklist to accompany Version 2 of the framework is presented in Figure 6-8. Further information on the

⁶ <https://www.edinburghleisure.co.uk/>

⁷ <https://www.pathsforall.org.uk/>

development of the framework and checklist can be found in study 2, presented in Chapters 7 and 8.

FIGURE 6-8: PRELIMINARY PHYSICAL ACTIVITY MESSAGING CHECKLIST TO ACCOMPANY VERSION 2 OF THE FRAMEWORK

Physical Activity Messaging (PAM) Checklist		
This checklist has been designed to accompany the Physical Activity Messaging (PAM) Framework. The purpose of this checklist is to provide a classification system for physical activity messages that can be used to aid evaluation or creation of such messages. If using the framework and checklist to create a message, the decisions made in Section 1 should be used to inform subsequent sections. If the framework is being used to evaluate a message, the links between each of the 3 sections should be considered.		
What is the purpose of this checklist for you?	Tick all that apply	
I am creating a physical activity message		
I am evaluating a physical activity message		
1. Message mechanism and basis		
1.1. Target population identification		
	Tick all that apply	Additional comments/description
1.1.2. A target population has been identified (<i>specify in additional comments/description box</i>)		
1.2. Message mechanism (how is the message intended to work?)		
	Tick all that apply	Additional comments/description
1.2.2. The mechanism(s) by which the message will function (e.g. persuasion or education) have been identified (<i>specify in additional comments/description box</i>)		
1.2.3. Relevant psychological antecedents and determinants to be targeted have been identified (e.g. self-efficacy or motivation) (<i>specify in additional comments/description box</i>)		
1.3. Message basis (how are the decisions informed?)		
	Tick all that apply	Additional comments/description
1.3.2. Decisions were based on psychological theory or social marketing principles (<i>specify in additional comments/description box</i>)		
1.3.3. Decisions were based on formative research		
1.3.4. Decisions were based on existing literature and evidence		
2. Message content and format		

2.1. Type of information		
	Tick all that apply	Additional comments/description
2.1.2. The message contains “what” and “how much” information (quantity and type of activity)		
2.1.3. The message contains “why” information (physical, mental, social health, or appearance-based information)		
2.1.4. The message contains “how to” information (practical or supportive information)		
2.2. Information framing, targeting, tailoring and personalisation		
	Tick all that apply	Additional comments/description
2.2.2. The message content is gain-framed		
2.2.3. The message content is loss-framed		
2.2.4. The message content is generic		
2.2.5. The message content is tailored to an individual		
2.2.6. The message content is targeted at a group		
2.2.7. The message content is personalised		
2.3. How the information is conveyed		
	Tick all that apply	Additional comments/description
2.3.2. The information is conveyed using text		
2.3.3. The information is conveyed using images or video footage		
2.3.4. The information is conveyed using music		
2.4. Message format		
	Tick all that apply	Additional comments/description
2.4.2. The mode of message delivery has been considered		
2.4.2.1. <i>Radio advert</i>		
2.4.2.2. <i>TV advert</i>		
2.4.2.3. <i>Poster</i>		
2.4.2.4. <i>Leaflet or pamphlet</i>		
2.4.2.5. <i>Social media post</i>		

2.4.2.6. Email		
2.4.2.7. SMS/text message		
2.4.2.8. Other (specify in additional comments/description box)		
2.4.3. The volume or length of the message has been considered (specify in additional comments/description box)		
3.0. Message delivery		
	Tick all that apply	Additional comments/description
3.1. The provider, messenger or source has been considered		
3.1.1. Health care professional (e.g. GP)		
3.1.2. Family or friends		
3.1.3. Peers		
3.1.4. The media		
3.1.5. Celebrities		
3.1.6. Other (specify in additional comments/description box)		
3.2. Message delivery is directed to a specific group (i.e. only sending message to older adults from a specific GP practice) (specify in additional comments/description box)		
3.3. The setting in which the message will be delivered has been considered (specify in additional comments/description box)		
3.4. The frequency and dose of message delivery have been considered (specify in additional comments/description box)		

Next steps

As described in this chapter, the developed framework had already been amended based on various pieces of formal and informal feedback. However, to enhance uptake of the framework, I saw value in conducting a robust study to further revise and improve the framework, and ultimately gain

expert consensus. An established and consensus-driven framework for developing and evaluating PA messages may harmonise and enhance the area of PA messaging, thus potentially contributing to improved population PA levels. Therefore, the aim of the next study was to further develop and improve, and gain international expert consensus on, a standardised framework for creating and evaluating PA messages. Version 2 of the Physical Activity Messaging Framework and the checklist presented in this chapter was used as a starting point for the following study.

Chapter 7 A modified Delphi study to enhance and gain international consensus on the Physical Activity Messaging Framework (PAMF) and Checklist (PAMC)

Chapter Outline

This chapter presents work relating to study 2: a modified Delphi study to enhance and gain international consensus on the Physical Activity Messaging Framework (PAMF) and Checklist (PAMC). Study 2 was published in IJBNPA in August 2021 and is included as part of this chapter. My contributions to the published article can be found in the declaration section (pages 2-4). The published article presented here is preceded and followed by additional commentary expanding on the paper and providing further discussion. This chapter aims to further develop and improve and gain international expert consensus on the preliminary PAMF and PAMC developed in the previous chapter.

Preamble

This preamble provides information relating to the study design and methods than was not included in the published journal article due to journal word limits. Specifically, this section provides further discussion into the Delphi technique and justification for choosing a modified Delphi study design, the use of guidance, the recruitment process and avoidance of bias. Further discussion of the study results (beyond that included in the published article) can be found in the post-amble at the end of this chapter.

Justification for study design

A key step in commencing study 2 to further enhance the developed framework and checklist was to decide on the most appropriate study design. There are several study designs that could be used to investigate expert opinions on and further enhance the developed framework. One example is a traditional survey. However, a traditional survey is not iterative in nature, and generally involves a single survey to gather opinions. Our research aims would benefit from an iterative process that allows us to develop our framework as we go along and ultimately reach consensus.

A further potential option to collect expert opinions on the developed framework was to use qualitative focus groups (Morgan, 1997). This method was developed in the 1940s-1950s and has since been used widely in a variety of research areas (Gallagher et al., 1993). Focus groups tend to consist of 8-12 participants, with the term 'focus' referring to the role of a moderator to keep discussions within the area of interest (Gallagher et al., 1993). Although group discussions whereby participants can openly agree or disagree with one another may result in rich data, there are downfalls of this method. Firstly, participants may feel pressured to agree with opinions of other participants with dominating personalities or high-profile roles. Although the moderator will encourage participation from all members of the focus group, social conformity may suppress minority or subordinate views (Gallagher et al., 1993). Another issue with focus groups is that, although they generate rich qualitative data, ranking of priorities may be difficult and analysis of results requires great time and skill (Gallagher et al., 1993).

Another potential study design that combats some of the shortcomings of focus groups is the nominal group technique (NGT). NGT combines qualitative and quantitative research approaches (Gallagher et al., 1993) and is a structured process for gathering data from groups of people with particular knowledge in an area of interest. The purpose of NGT is to generate new ideas, which are discussed by the group and ranked (Gallagher et al., 1993). Unlike in focus groups, NGT is highly controlled with discussion only permitted during the later stages of the process. Although not entirely, this feature helps reduce some of the issues around social conformity we see in focus groups. However, NGT requires participants to meet face-to-face, and is therefore not suitable for the current study that aimed to gain international level expert feedback.

A final potential method that could address our aims was the Delphi method. The Delphi method involves some anonymity and so reduces risk of social conformity. Also, the Delphi method allows for participants to be geographically scattered. Therefore, to reduce bias and allow for participants to be recruited from across the globe, a Delphi method was adopted over the other methods discussed here.

The Delphi technique

The Delphi technique was developed at the outset of the Cold War to predict the impact of technology on warfare (Custer et al., 1999). It was developed to combat the shortcomings of other methods of forecasting events, e.g. focus groups, in which dominant personalities and social

pressures can influence findings (Dalkey, 1969). The development of the Delphi technique was guided by the premise that combined individual anonymous predictions were stronger than unstructured group predictions (Kaplan et al., 1950). Since the Delphi method was developed, it has been widely used and adapted across a range of disciplines, including PA research (Aarts et al., 2011; Aro et al., 2016; Gilson et al., 2009; Klepac Pogrnilovic et al., 2019; Murray et al., 2018; Pikora et al., 2003; Valente et al., 2015).

The basis of the Delphi method is the assumption that a group opinion is more valid and reliable than an individual's opinion (Keeney et al., 2011). The original definition of the Delphi technique was "a method used to obtain the most reliable consensus of opinion of a group of experts by a series of intensive questionnaires interspersed with controlled opinion feedback" (Dalkey, 1969). Later it was defined more simply as "a multi-staged survey which attempts ultimately to achieve consensus on an important issue" (McKenna, 1994), or as "an iterative process designed to combine expert opinion into group consensus" (Lynn et al., 1998).

Not only have multiple definitions of the Delphi method evolved, but many variations of the Delphi method now exist. For example, "modified Delphi" (McKenna, 1994), the "real-time Delphi" (Beretta, 1996) and the "policy Delphi" (Crisp et al., 1997) as well as many others (Keeney et al., 2011). Although studies may not define themselves as "modified" or "policy" Delphi studies, their characteristics differ from what is termed a "Classical

Delphi”. Some types of Delphi studies and key characteristics, as well as examples within PA research, are shown in Table 7-1.

TABLE 7-1: DELPHI STUDY TYPES AND EXAMPLES WITHIN THE FIELD OF PHYSICAL ACTIVITY

Type of Delphi	Characteristics	Example(s) within physical activity
Classical Delphi	<p>Uses an open first round to generate initial ideas and produce opinions. These ideas are taken into subsequent round and ultimately consensus is reached.</p> <p>Uses three or more postal rounds (can be administered via email)</p>	(Gilson et al., 2009)
Modified Delphi	<p>A modified Delphi may differ from a traditional Delphi in a number of ways. One key example is that often in modified Delphi studies, initial ideas do not come from a postal open round but instead from focus groups, interviews or literature review.</p> <p>May use fewer than three postal/email rounds</p>	<p>(Murray et al., 2018)</p> <p>(Pikora et al., 2003)</p> <p>(Slade et al., 2014)</p> <p>(Hanson, Oliver, et al., 2020)</p>
Policy Delphi	<p>Gathers opinions of experts to come to agreement on future policy of a given topic.</p> <p>Does not necessarily aim to reach consensus, but rather aims to support decisions in policy.</p>	<p>(Aarts et al., 2011)</p> <p>(Klepac Pogrmilovic et al., 2019)</p> <p>(Aro et al., 2016)</p>

Adapted from (Keeney et al., 2011).

In a Classical Delphi, experts are sent questionnaires via post or email in a series of 3 or more rounds. The first questionnaire is open, and involves asking the panel for their opinions on a particular subject in an open-ended manner to generate as many ideas as possible (Keeney et al., 2011). A

Delphi is a multi-stage process with each round building on the responses of the precedent round. Responses to the first round are analysed by the researchers and returned to the expert panel as statements or questions within a second questionnaire. The second questionnaire of a Classical Delphi is based solely on the results obtained from the first round. The expert panel will then rank these questions or statements based on their expert opinion. Rounds will continue until consensus is reached (Keeney et al., 2011). After each round, the panel will normally receive their own responses as well as those of the other panel members and asked if they would like to change their response in light of this.

Modified Delphi

A conceptual framework for PA messaging had been developed, and this study aimed to further improve and ultimately gain consensus on said framework. Therefore, a modified Delphi specifically was deemed to be the most appropriate study design to address the aims. This Delphi study was modified as it did not include an open first round to generate ideas, as the initial idea (the framework) was based on preliminary work that had already been carried out. However, as in a classical Delphi, this study did aim to involve a minimum of 3 rounds of anonymous questionnaires (delivered via email), with the framework being amended each round to ultimately reach consensus.

Use of guidance

Unlike for clinical trials (Schulz et al., 2010) and systematic or scoping reviews (Moher et al., 2009; Tricco et al., 2018), there is no formal,

universally agreed upon guidance on the conduction and reporting of Delphi studies (Keeney et al., 2011). Indeed, many Delphi studies conducted in the field of PA either have not used or have used or fail to adequately report the use of guidance (Gilson et al., 2009; Klepac Pogrmilovic et al., 2019; Pikora et al., 2003). However, some guidance does exist. Recommendations to improve rigour and transparent reporting in Delphi studies have been proposed by authors from a number of disciplines (Black et al., 1999; Day & Bobeva, 2005; Diamond et al., 2014; Hasson & Keeney, 2011; Hasson et al., 2000). However, a set of clear recommendations on the conduct of Delphi studies and a reporting standard that has potential to become generally accepted by peer-reviewed journals was not available until 2017.

In 2017, a methodological review of Delphi studies in palliative care led to the development of Guidance on Conducting and Reporting Delphi studies (CREDES) (Jünger et al., 2017). Although not developed specifically for the PA field, CREDES is the most up to date and comprehensive guidance specifically to inform conducting and reporting Delphi studies. CREDES was therefore used as an overall guidance to inform the overall conduction and reporting of the modified Delphi study presented in this chapter, drawing on aspects of other guidance where appropriate and required.

Selection of expert panel

There are many considerations when selecting the expert panel, and the identification of 'experts' has been a debated topic within Delphi literature

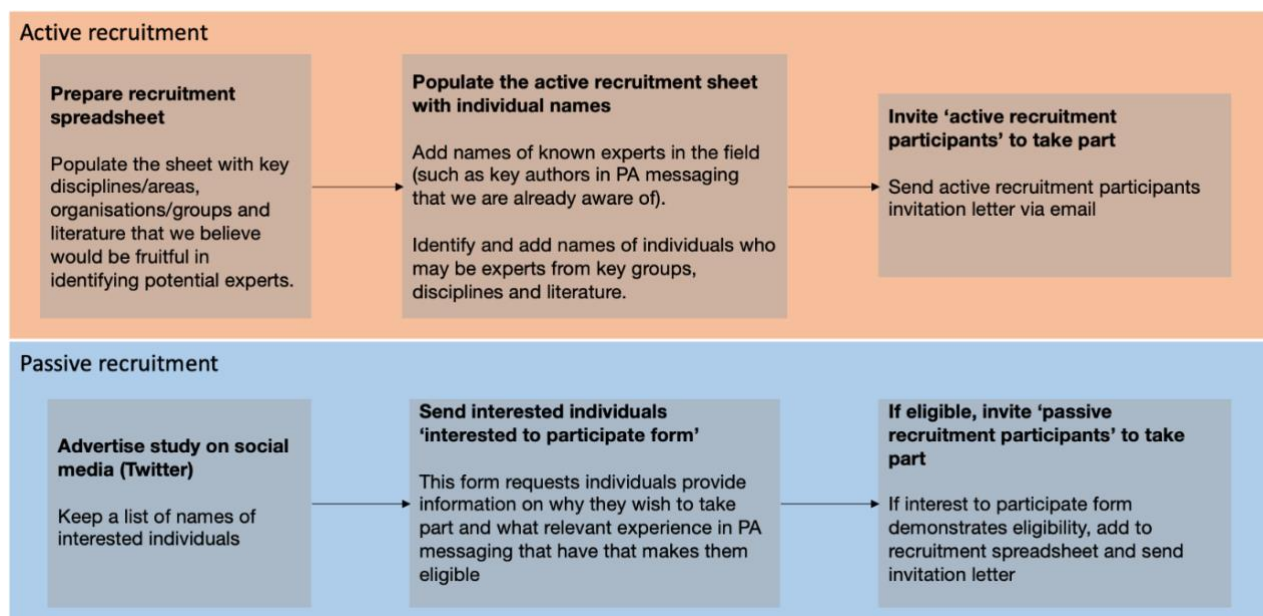
for many years (Keeney et al., 2011). Deciding on who the expert panel will consist of is the first stage of a Delphi and will shape the findings. Thus it is arguably the most important aspect of the study (Green et al., 1999). Yet this stage has raised methodological concerns, such as criticism of the claim of a Delphi study to represent valid expert opinion as untenable and overstated (Sumsion, 1998).

If I were to only recruit experts in PA messaging, it is very plausible that we would not attain a large enough sample size. Therefore, in this Delphi study an “expert” was considered as an individual within the PA for health field with specific knowledge and/or equivalent experience which is relevant to PA messaging. For example, consider an individual with many years of experience in psychology of PA but no specific experience in developing PA messages. This individual’s expertise may still be relevant when understanding the mechanism of messages, and therefore they would be considered for inclusion.

Journal word limits did not allow for a full detailed description of the recruitment process to be included in the published article of Study 2, and this is therefore described here. We aimed to recruit a heterogeneous sample of academics and non-academics who represented a broad range of backgrounds, disciplines, perspectives, and experience. CREDES recommends employing and reporting of clear criteria for a selection of experts. Using both active and passive sampling techniques (Foster et al., 2011) we aimed to (a) recruit ‘known experts’ in the field through our network

of existing relationships and contacts (active recruitment) and (b) identify and recruit other potential experts that we are not aware of and are not in contact with, i.e. 'unknown experts' (passive recruitment). We drew on guidance from Okoli & Pawlowski (2004), originally proposed by Delbecq (1975), who describe a detailed 5-step procedure to identify relevant experts. This process was adapted to include both active and passive recruitment efforts. An overview of the recruitment process is shown in Figure 7-1, with a more detailed description of the process is described below.

FIGURE 7-1: OVERVIEW OF RECRUITMENT PROCESS



Step 1: Prepare an 'active recruitment' spreadsheet

The purpose of this step is to help categorise experts before they are identified to avoid overlooking any important potential group of experts. This step involved listing potential groups of experts by, for example, key disciplines or skills, organisations or key literature/resources that would be fruitful in identifying experts. Delbecq (1975) does not recommend identifying

individuals at this stage, but rather higher-level groups of experts. Following discussions with the wider author group, we organised key groups and literature under a number of categories (see Table 7-2).

TABLE 7-2: KNOWLEDGE RESOURCE NOMINATION WORKSHEET

Key disciplines	Key organisations	Key literature
<ul style="list-style-type: none"> • Academic • Health professionals and other key non-academic disciplines • Government officials and policy makers 	<ul style="list-style-type: none"> • Physical activity academic research groups (e.g. the UK CMO PA communications expert committee) • Physical activity promoting charities and organisations (e.g., paths for All and Sport England) 	<ul style="list-style-type: none"> • General PA messaging research (e.g. key reviews on messaging approaches) • Research specifically on guideline dissemination • Research on the use of mass media/social marketing to promote PA

Step 2: Populate ‘active recruitment’ spreadsheet with individual names

Using each heading or category as a lens to identify and consider experts, this step involved populating the spreadsheet with names of potential individual experts. For each heading, the author group went through personal lists of contacts and identified ‘known experts’. Our author team was carefully designed to include PA messaging experts from countries in which PA messaging research is prevalent. As a result, the author team had contacts in the UK, New Zealand, Australia and Canada/USA. This was imperative to aid active recruitment for this study.

Step 3: Record interest to participate and nomination of additional experts (passive recruitment)

This stage aimed to extend the spreadsheet to include as many potential experts as possible. We advertised the study on Twitter and took recommendations of other potential panel members from participants in the active recruitment arm to create an additional list of potential panel members. We then invited this list of people to fill in an 'interest to participate' form to assess their eligibility to take part.

Step 4: Assessing eligibility to take part

The interest to participate form requested that potential experts explain their interest in taking part and their relevant qualifications and/or experience and was used to assess eligibility. If participants had demonstrable experience in PA messaging and clear justification for wanting to be included in the panel, they were deemed eligible. For example, experience in creating or evaluating PA promotion campaigns, or experience in researching PA messaging. Ideally, for robustness, this procedure would also be carried out in the active recruitment arm, too. However, pragmatically speaking, there was a risk we would miss out on some key participants by burdening them with having to explain why they are suitable panel members.

The scoping review detailed in Chapter 5 found that the majority (87%) of identified messaging research came from Canada, the USA, Australia and the UK. It was therefore not surprising that as recruitment began, many of the identified participants resided in these countries. The author team agreed it was important to include views on PA messaging from

low to middle income countries (LMICs) where PA messaging research was less prevalent. We therefore utilised existing links with ISPAH to target PA for health contacts from LMICs via social media. Eligibility criteria for potential participants from LMICs was loosened to include individuals without specific experience in PA messaging but with experience in PA for health research or promotion as we believed that including views from LMICs was more important than ensuring participants had extensive experience in PA messaging. We hoped that capturing these opinions would improve the usability of the developed framework in LMICs.

Step 4: Inviting experts to take part

All individuals from the active recruitment arm and individuals from the passive recruitment arm that met eligibility criteria were emailed by the principal investigator with an information sheet and invitation letter which provided them with details of what the study involved, estimated survey dates, how much of their time would be taken up, and which invited them to take part in the study. All participants who agreed to take part via email were added to a contact list for survey distribution.

Avoidance of Bias

It is important to consider that the Delphi method produces a 'valid opinion' from experts in the area, rather than facts that are backed up with evidence and can be proven (Keeney et al., 2011). It is assumed that Delphi studies result in meaningful outputs due to feedback given to the panel which allows them to compare their response with the group response. This

process allows panel members to change their opinion based on group opinion, which helps move towards consensus (McKenna, 1994).

Anonymity in a Delphi study allows each panel member to present their own opinions and react to others' opinions without being influenced by identities of other participants (Goodman, 1987). This feature of Delphi studies eliminates subject bias (Goodman, 1987). By keeping participants and their responses anonymous to one another, participants can give honest judgements and opinions without feeling psychological pressure from other panel members with, for example, dominating personalities or influential roles. However, it is important to acknowledge that complete anonymity is not guaranteed, and it is arguably not possible, when carrying out a Delphi study (Keeney et al., 2011). Researchers are aware of the identities of the panel members and of their responses. Also, due to the fact that recruited panel members are selected due to their expertise in a niche area, the likelihood of panel members knowing other panel members and being aware of their participation in the study is considerable.

As outlined at the beginning of this section, this preamble provided additional information relating to study methods that was not included in the published article due to word limits. Further information on the study procedure, including sample size, defining consensus and data analyses, can be found in the following published article.

Published article

Abstract

Introduction: Physical activity messaging is an important step in the pathway towards improving population physical activity levels, but best practice is not yet understood. A gap in the literature exists for a physical activity messaging framework to help guide creation and evaluation of messages. This study aimed to further develop and improve, and gain international expert consensus on, a standardised Physical Activity Messaging Framework and Checklist.

Methods: A modified Delphi study consisting of three online survey rounds was conducted. Each survey gathered feedback from an international expert panel using quantitative and qualitative methods. The framework and checklist were amended between each round based on survey results until consensus (defined *a priori* as 80% agreement) was reached.

Results: The final expert panel (n=40, 55% female) came from nine countries and comprised academics (55%), healthcare and other professionals (22.5%) and government officials or policymakers (22.5%). Consensus was reached in survey 3 with 85% and 87.5% agreement on the framework and checklist, respectively.

Conclusion: This study presents an expert- and evidence-informed framework and checklist for physical activity messaging. If used consistently, the Physical Activity Messaging Framework and Checklist may improve practice by encouraging evidence-based and target audience-focused

messages, as well as enhance the research base on physical activity messaging by harmonising key terminologies and improving quality of reporting. Key next steps include further refining the Physical Activity Messaging Framework and Checklist based on their use in real-world settings.

Introduction

Physical inactivity contributes significantly to the global non-communicable disease burden (Lee et al., 2012) and improving population physical activity (PA) levels will reduce mortality rates (Strain, Brage, et al., 2020; Strain, Wijndaele, et al., 2020). PA messaging, which can be described as “the overall process of creating and delivering PA messages” (Williamson et al., 2020), is an important step in the pathway towards improving population PA levels by targeting individual and social factors such as social norms, perceptions, and awareness of benefits relating to PA (International Society for Physical Activity and Health, 2020; Milton et al., 2020; World Health Organization, 2018). However, best practice in PA messaging is not yet understood (Williamson et al., 2020). A recent scoping review of 123 articles on PA messaging (Williamson et al., 2020) identified four key considerations that formed a rationale for developing a conceptual framework for PA messaging: (i) PA messaging is a complex area of growing interest, (ii) terminologies used for, and understandings of, various PA messaging concepts are inconsistently used, (iii) it is often unclear *how* PA messages will bring about changes in PA behaviour, and (iv) there is limited use of

formative evaluation and theory, such as psychological theory or social marketing principles, to inform message development.

Whilst frameworks within the wider field of health communication that provide guidance on developing and evaluating health messages (William, 1993) and campaigns (Seth, 2012) do exist, they have not been used widely in PA messaging research. There is also a dearth of application tools to aid translation of such frameworks into practice. To the best of our knowledge, there have been no attempts to date to organise the different concepts that may be considered in PA message development into a usable format. We believe that a consensus-driven messaging framework and accompanying checklist that harmonise understandings of key concepts and encourage PA messages based on theory, formative evaluation and existing evidence would be an important contribution to the field.

A recent scoping review (Williamson et al., 2020) identified a number of concepts relating to three broad overarching areas PA messaging: (i) message aims(s) and pathway(s), (ii) message content, and (iii) message format and delivery. Using these concepts and drawing on existing frameworks and theory (Connell et al., 2019; Michie et al., 2011) we developed and revised a provisional Physical Activity Messaging Framework (PAMF) over the course of a year (March 2019 – April 2020) through consultation with researchers, policymakers, and practitioners. Using the provisional PAMF as a starting point, this study aimed to:

1. Further develop and improve a Physical Activity Messaging Framework to guide message creation and evaluation
2. Develop and improve a checklist to accompany the Physical Activity Messaging Framework
3. Gain international expert consensus on the Physical Activity Messaging Framework and Checklist

Methods

Study design

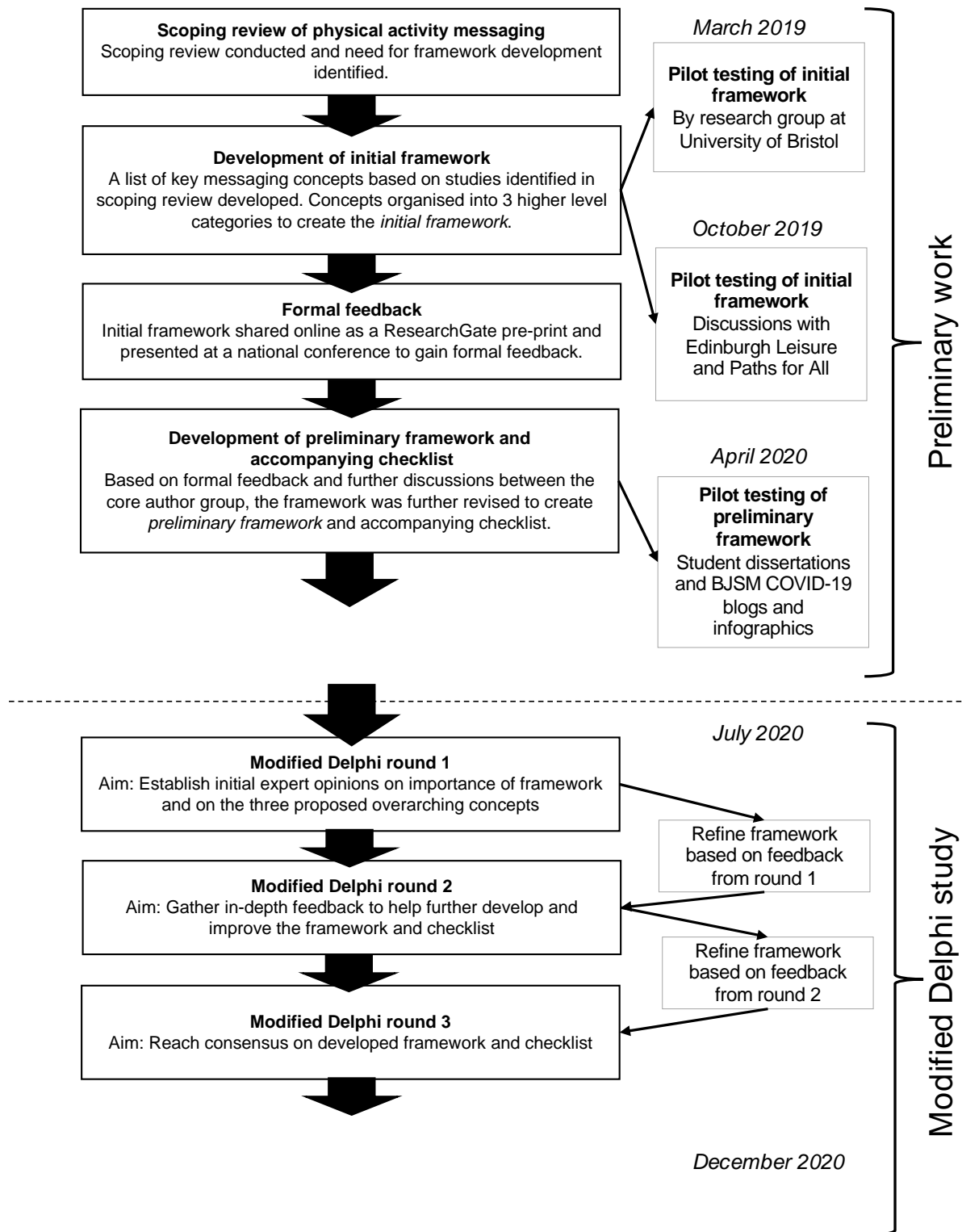
A Delphi study is “an iterative process designed to combine expert opinion into group consensus” (Lynn et al., 1998). A Delphi study was deemed relevant here as it allowed us to seek views from a geographically diverse expert panel and reduced the risk of social conformity associated with other potential study designs, such as focus groups or nominal group technique (Gallagher et al., 1993). This study was a modified Delphi as opposed to a classical Delphi (McKenna, 1994) as it did not include an open first round to generate ideas. Rather, the initial idea (our framework) was based on preliminary formative work (Williamson et al., 2020).

Modified Delphi structure

A preliminary framework was developed through formative work and used as a starting point for this study. The modified Delphi process involved international experts participating in three survey rounds, with the framework being amended following each round based on participant feedback. Figure

7-2 displays an overview of the preliminary work and the modified Delphi process.

FIGURE 7-2: OVERVIEW OF PRELIMINARY WORK AND MODIFIED DELPHI PROCESS



Use of reporting guidelines

We followed the Guidance on Conducting and Reporting Delphi Studies (CREDES) (Jünger et al., 2017).

Selection and recruitment of expert panel

“PA messaging expert” was defined as ‘an individual within the PA for health field with significant and demonstrable knowledge and/or equivalent experience relevant to PA messaging’. To cover a range of perspectives, we aimed to recruit a heterogenous sample of (i) academics, (ii) healthcare and other professionals, and (iii) government officials and policymakers. We drew on and adapted existing Delphi recruitment guidance (Delbecq, 1975; Okoli & Pawlowski, 2004) to identify participants through active and passive recruitment arms (Foster et al., 2011). The active recruitment process involved identifying key disciplines, organisations/groups and literature that we believed would be fruitful in identifying experts before identifying individual experts in each of these areas and inviting them to take part. The passive recruitment process involved advertising the study on Twitter and sending interested individuals an ‘interest to participate form’ to assess their eligibility before inviting them to take part.

Sample size

Unlike traditional surveys, Delphi studies do not aim to generalise expert opinions. We therefore did not base sample size on achieving statistical power; rather, we aimed to recruit an expert panel that would represent a range of key disciplines and various countries (Jünger et al., 2017). Delphi literature suggests at least 10-18 expert members per panel

are required to achieve a range of opinions (Delbecq, 1975; Okoli & Pawlowski, 2004), and many studies include more than this (Hanson, Oliver, et al., 2020; Pikora et al., 2003). We aimed to recruit as many participants as possible to achieve the greatest range of opinions.

Online surveys

Surveys were delivered online using Qualtrics™ (Qualtrics, Provo, UT). Participants were given three weeks to complete each survey round. Participants were sent an initial survey invite via email, and unfinished respondents were sent three reminder emails; the first two generic (“Dear Participant”) and the final reminder personalised (“Dear Name”) to maximise response rate⁸.

Pilot testing of survey materials

Surveys were pilot tested by nine PA professionals and academics who were not members of the expert panel. This group provided feedback on survey clarity, risk of bias, and suggested improvements. Feedback was collated and discussed by the author group and survey materials amended accordingly.

Survey 1

Survey 1 aimed to establish initial views on the importance of developing a PA messaging framework and checklist, and on the three

⁸ Ethical approval (see Appendix 3) was obtained from Moray House School of Education and Sport on 31st May 2020 (reference number 2749), University of Edinburgh prior to commencement of data collection. All participants provided informed consent (collected at outset of survey 1) before participating in this study.

proposed overarching concepts (message aim and pathway, message content, and message delivery). Survey 1 collected basic demographic data including professional role, gender, country of residence, and number of years of experience relevant to PA messaging. Participants were also provided with background information to the study and brief descriptions of the three overarching sections of the framework. The full framework and checklist were not shown in survey 1 to avoid overloading participants with information.

Participants were asked to rate the extent to which they agreed or disagreed on a seven-point Likert scale with three statements relating to the importance of developing a PA messaging framework, the proposed overarching concepts, and the usefulness of a checklist tool to accompany the framework. Each Likert-scale question was followed by an open response question where participants had the opportunity to expand. Survey 1 can be found in Additional File 1.

Survey 2

Survey 2 aimed to gather more in-depth feedback to further refine and improve the (provisional) framework and checklist. Participants were asked to read a summary of survey 1 findings before proceeding. Participants were then shown the framework, which had been updated based on feedback from survey 1, alongside a table of key concepts. Participants then rated the extent to which they agreed or disagreed with a series of statements about seven specific areas of the framework and checklist based on findings from survey 1, such as the role of the framework in aiding message evaluation

and terminologies used within the framework. Each seven-point Likert scale question was followed by an open response box, allowing participants to elaborate. Participants were then given an opportunity to provide any other feedback about any of the three overarching framework areas or the checklist. Survey 2 can be found in Additional File 2.

Survey 3

Survey 3 aimed to either (a) reach consensus on the framework and checklist (updated based on feedback from survey 2), or (b) establish a requirement for a further survey. In survey 3, participants were shown a summary of findings from survey 2 and the updated framework and checklist. Participants then rated the extent to which they agreed or disagreed on a seven-point scale with the following statements: “The Physical Activity Messaging Framework presented here should be the final version” and “The Physical Activity Messaging Checklist presented here should be the final version”, with the opportunity to provide any further feedback on either the framework or checklist. Survey 3 can be found in Additional File 3.

Defining consensus

Definitions of consensus in Delphi studies vary greatly and are often poorly reported (Diamond et al., 2014). No universally accepted cut-off for (non)consensus exists. A methodological systematic review of Delphi studies found that cut off for consensus (or non-consensus) was most commonly based on percentage of agreement (usually 75% or 80%), median score or a combination of both. Aligning with CREDES guidance, our definition of consensus was identified a priori as 80% agreement. Specifically, we

concluded our Delphi study once >80% of the expert panel agreed that the framework and checklist presented should be considered final.

Data analyses

All responses were analysed anonymously and considered equal in weight. Closed questions with Likert scale responses were analysed using descriptive statistics (IBM SPSS Statistics Version 24.0, Armonk, NY) to determine the level of agreement with each statement. We counted the following responses from the seven-point Likert scale as agreement: “*somewhat agree*”, “*agree*” and “*strongly agree*”.

Qualitative data from open responses were analysed using an approach to thematic analysis considered most appropriate for the research aims (Braun et al., 2019). The aim of the open questions was to gather in-depth qualitative data which could be used to enhance the framework. We aimed to identify patterns across these data guided by specific areas of the framework, allowing us to identify key aspects that required discussion and further development. Thus, our approach was most consistent with *codebook thematic analysis* (Braun et al., 2019), involving organic and iterative coding consistent with the broad underlying philosophy of reflexive thematic analysis, but following a more structured approach. In short, this process involved familiarisation with the data, generating codes, and forming themes within pre-determined categories (as informed by the structure of the surveys and areas of the framework). All analyses were conducted by CW with 20% of raw transcripts independently analysed by PK and GB. The authors then took on the roles of ‘critical friends’ (Smith & McGannon, 2018) where we

discussed interpretations of the data, offered alternative interpretations and provided critical feedback, ensuring interpretations were defensible and plausible.

Framework amendments

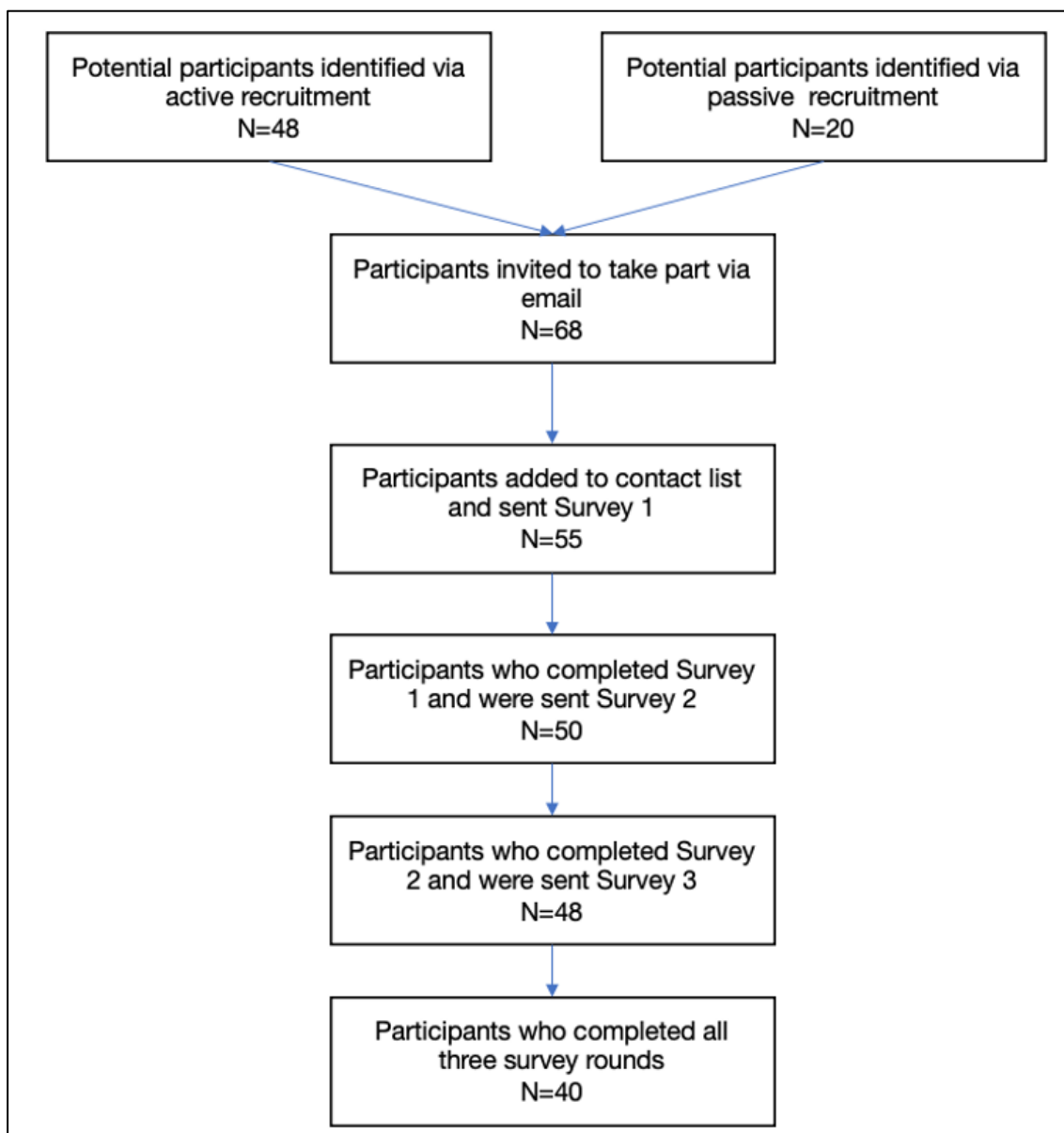
Following each survey, the core author team (CW, PK and GB) met to discuss participant feedback. Where feedback within themes was clear enough to allow full interpretation, the framework was amended to address participant views prior to the subsequent survey. Where feedback was not sufficiently clear for us to take action, questions regarding these themes were included in the subsequent survey to further investigate expert opinions and gain more in-depth feedback that could be considered and used to further develop the framework. For each code, our response and any action taken were logged on an Excel sheet.

Results

Participants

A total of 48 experts were identified through active recruitment and a further 20 were identified through the passive recruitment process, resulting in 68 individuals being invited to take part. Of these, 55 (80.8%) agreed to take part via email and were added to the contact list for survey 1. Of these 55, 50 (90.9%) took part in survey 1. Of the participants who took part in Survey 1 (n=50), 48 (96%) completed survey 2, and 40 (80%) completed survey 3. Figure 7-3 shows the participant flowchart.

FIGURE 7-3: PARTICIPANT FLOWCHART



The final expert panel (n=40) was 55% female (45% male) and comprised academics (55%), healthcare and other professionals (22.5%), and government officials or policymakers (22.5%). The number of years of experience relevant to PA messaging ranged from 0-1 years to 20+ years, with the majority of participants (65%) reporting 5-20 years of experience. Participants were from nine different countries. The majority of the panel

(67.5%, n=27) were recruited via active recruitment, with 13 (32.5%) recruited through passive recruitment. Table 7-3 shows demographic details of the Delphi study participants in each survey round.

TABLE 7-3: DEMOGRAPHIC CHARACTERISTICS OF EXPERT PANEL FOR EACH SURVEY ROUND

	Survey 1 (n=50)	Survey 2 (n=48)	Survey 3 (n=40)
Gender			
Male	19 (38%)	19 (39.6%)	18 (45%)
Female	31 (62%)	29 (60.4%)	22 (55%)
Number of years of experience relevant to physical activity messaging			
0-1 years	3 (6%)	3 (6.3%)	2 (5%)
2-5 years	8 (16%)	8 (16.6%)	7 (17.5%)
5-10 years	15 (30%)	15 (31.3%)	12 (30%)
10-20 years	18 (36%)	16 (33.3%)	14 (35%)
20+ years	6 (12%)	6 (12.5%)	5 (12.5%)
Discipline			
Academia	26 (52%)	25 (52.1%)	22 (55%)
Healthcare professional or other professional	15 (30%)	14 (29.2%)	9 (22.5%)
Government official or policymaker	9 (18%)	9 (18.8%)	9 (22.5%)
Country of residence			
Australia	3 (6%)	3 (6.3%)	2 (5%)
Canada	8 (16%)	7 (15%)	6 (15%)
Costa Rica	1 (2%)	1 (2.1%)	1 (2.5%)
India	2 (4%)	2 (4.2%)	0 (0%)
Indonesia	2 (4%)	2 (4.2%)	2 (5%)
Ireland	2 (4%)	2 (4.2%)	2 (5%)
New Zealand	2 (4%)	2 (4.2%)	2 (5%)
Nigeria	1 (2%)	1 (2.1%)	1 (2.5%)
United Kingdom	27 (54%)	26 (54.2%)	22 (55%)
United States	2 (4%)	2 (4.2%)	2 (5%)

Survey 1

Agreement on importance of framework and key concepts included

Of the 50 participants who took part in survey 1, 47 (94%) agreed that establishing a framework for PA messaging is important. There were 46 participants (92%) who agreed that a PA messaging framework should include the following three overarching concepts: “message aims, mechanism and basis”, “message content and format” and “message delivery”. All participants (n=50) agreed that “a checklist tool to accompany the framework would be useful”.

Qualitative analysis of open feedback

We identified 28 codes that were organised into 13 themes within the three main areas where feedback was requested (or ‘pre-determined categories’). Key themes highlighted a lack of clarity on the role of the framework in message evaluation, the need to use more plain English to cater for all potential users and the consideration of new concepts such as *language* and *timing*. Survey 1 codes, themes and descriptions can be found in Additional File 4⁹.

Subsequent amendments to the framework and checklist

Some minor amendments were made to the framework based on areas where feedback was clear following survey 1. For example, terminologies within the framework were made more user-friendly, such as renaming the heading of section 1 from “Message aim, mechanism and

⁹ This file is available online as part of the published article.

basis” to “What, who, how and why?”. No major amendments were made to the framework at this stage as survey 1 did not collect sufficiently detailed feedback to do so. Indeed, this was not the aim of survey 1. Rather, feedback from survey 1 was used to inform questions in survey 2.

Survey 2

Agreement on key themes that arose in survey 1

Consensus (>80% agreement) was reached on three of seven Likert scale responses: 39 of the 48 participants (81%) agreed that the “wording/terminology used in the framework is user-friendly and suitable for all potential groups of users of the framework”, 45 participants (94%) agreed that “the concepts within the framework are sufficiently delineated” and that “the checklist meets the aim of being a tool that provides a series of considerations for creating and evaluating PA messages”.

Consensus was not reached in the other four of seven Likert scale questions: 30 participants (62.5%) agreed that “the way the framework could be used to evaluate a message is clear”, 37 participants (77%) agreed that “*language* should be included as a concept within section 2 of the framework”, half (n=24) of the participants agreed that “the promotion of target audience testing is adequately represented in the framework”, and 37 participants (77%) agreed that “*timing* should be included as a concept within the framework”.

Qualitative analysis of open feedback

We identified 82 codes that were organised into 45 themes according to the 10 pre-identified categories. Themes identified ranged from minor feedback, such as suggestions to change colours used, to major feedback, such as lack of clarity on how the framework may be used. A full list of themes, codes and example quotes for survey 2 can be found in Additional File 5¹⁰.

Subsequent amendments to the framework and checklist following survey 2

In response to the in-depth feedback from survey 2, a number of amendments were made to improve the framework and checklist. Author responses to each code can be found in Additional File 5¹¹. In summary, key changes were made to clarify the framework's role in various types of evaluation (formative, process, outcome/impact) and to emphasise the importance of engaging with the target audience throughout. We added two dimensions of *language* identified in survey 2; choice of words and message tone, as well as two dimensions of *timing*; time of day and time of year/context. We also added a banner to explicitly encourage consideration of diversity, equity and inclusivity throughout. A number of more minor changes were also made, such as providing further examples in the checklist, adding an arrow to highlight the framework's pathway, and changes to fonts and colours.

¹⁰ This file is available online as part of the published article.

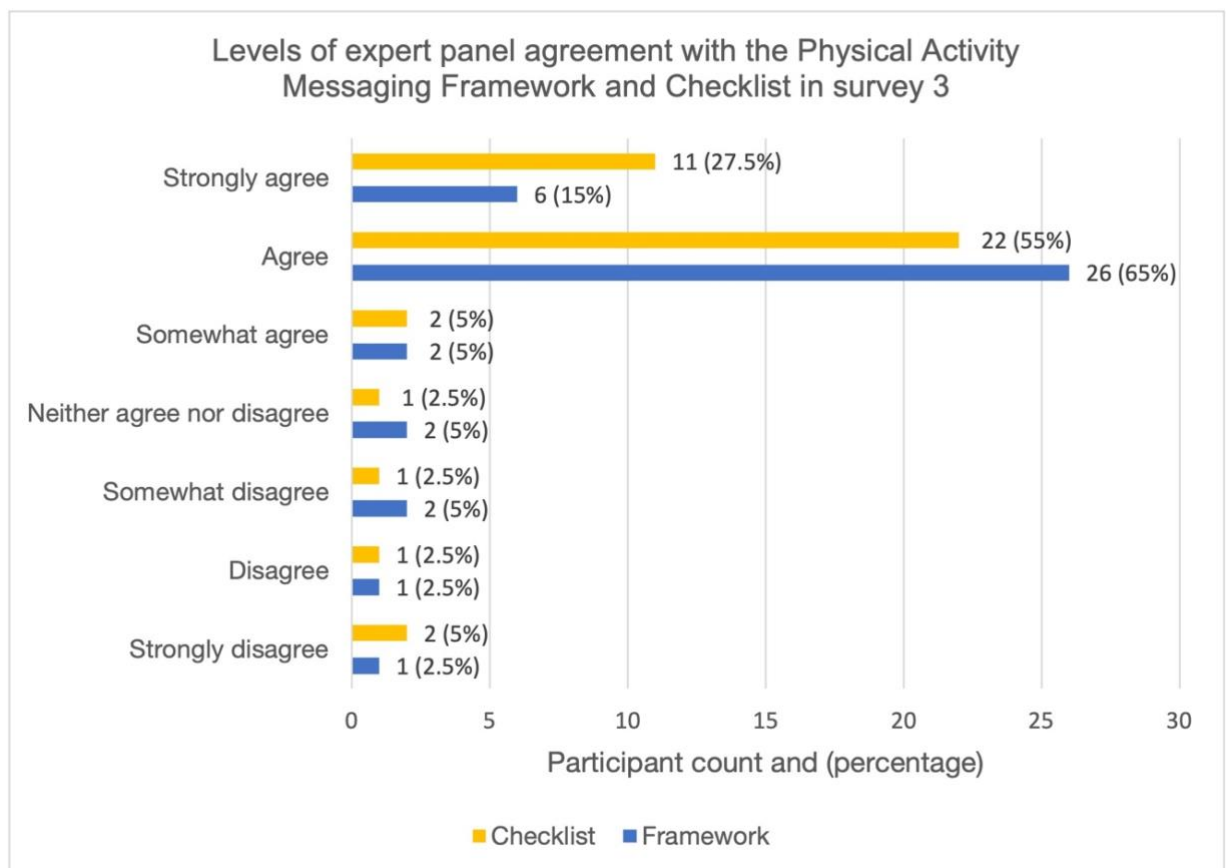
¹¹ This file is available online as part of the published article.

Survey 3

Agreement with final framework and checklist

Consensus (defined as >80% agreement a priori) was reached on both the framework and the checklist in survey 3. Of the final expert panel (n=40), 34 (85%) agreed that the framework presented in survey 3 should be considered final, and 35 (87.5%) agreed that the checklist presented in survey 3 should be considered final. Of these, the majority either *agreed* or *strongly agreed*. Levels of agreement for the Framework and Checklist are displayed in Figure 3.

FIGURE 7-4: LEVELS OF AGREEMENT WITH THE PHYSICAL ACTIVITY MESSAGING FRAMEWORK AND CHECKLIST IN SURVEY 3



Qualitative analysis of open response feedback

We identified 40 codes that were organised into 10 themes and categorised into either feedback on (a) the framework or (b) the checklist. The majority of feedback related to minor amendments in wording, visual aspects of the framework and checklist or additions of further explanations and examples. A full list of themes, codes and example quotes for survey 3 can be found in Additional File 6¹².

Subsequent amendments to the framework and checklist following survey 3

A small number of minor changes were made to the framework and checklist following survey 3. For example, a title was added, 'music' was changed to 'audio' to incorporate music, voiceovers and other sounds, and examples of social and political context were added. Author responses to each code can be found in Additional File 6¹³.

The Physical Activity Messaging Framework and Checklist

The final agreed framework and checklist are shown in Figure 7-5 and Table 7-4, respectively. Working definitions of key concepts within the framework are displayed in Table 7-5. The PAMF and PAMC are divided into three overarching sections: (1) who, when, what, how and why, (2) message content, and (3) message format and delivery. The PAMF and PAMC are designed to be used sequentially, with decisions in each section being used to inform decisions in subsequent sections. Section 1 encourages the user to

¹² This file is available online as part of the published article.

¹³ This file is available online as part of the published article.

identify a target audience, consider the time of year and context of the message, identify specific message aims and potential working pathways, and encourages drawing on psychological theory, formative evaluation and existing evidence to inform message development. Section 2 then guides the user through a series of concepts relating to message content, including the type of information, how this information is framed, and the language and tone of the message. Finally, section 3 encourages the user to consider various concepts relating to the message format and delivery, such as the media or mode of the message, the provider or source of the message and delivery setting. The PAMF provides an overview of messaging concepts for each overarching section and may be a useful visual tool for communications, teaching and training. The PAMC provides a more practical tool for implementing the framework and can be used to guide and document message creation, evaluation, and categorisation. To allow rigour and full transparency, a detailed description of the PAMF and PAMC and how they can be used has been provided in a separate consensus statement and user guide (currently in preparation)¹⁴.

¹⁴ This separate paper is included in Chapter 8.

FIGURE 7-5: THE PHYSICAL ACTIVITY MESSAGING FRAMEWORK

The Physical Activity Messaging Framework (PAMF)

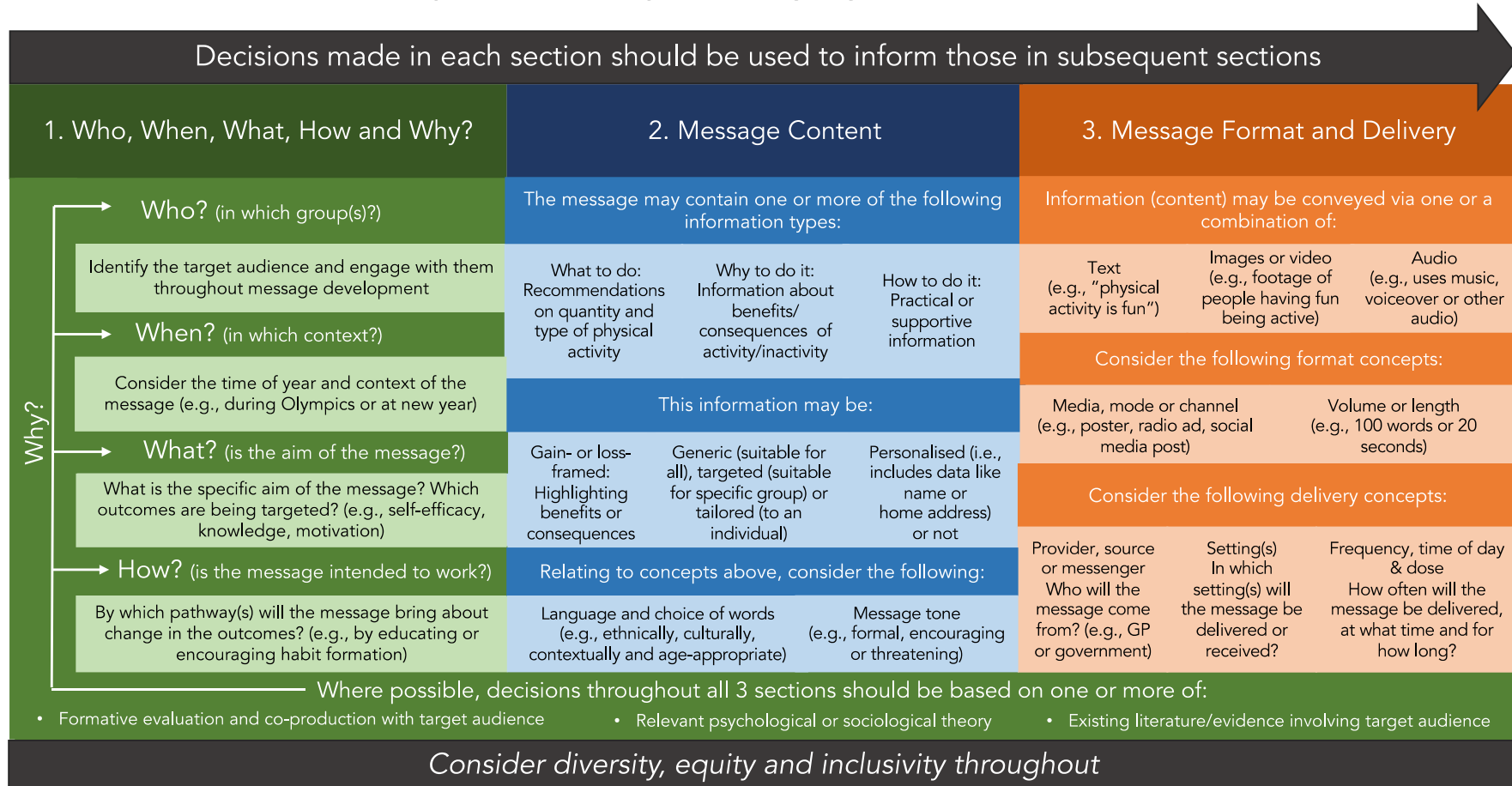


TABLE 7-4: THE PHYSICAL ACTIVITY MESSAGING CHECKLIST

Physical Activity Messaging Checklist (PAMC)		
<p>This checklist has been designed to be used in conjunction with the Physical Activity Messaging Framework (PAMF).</p> <p>When aiming to create new messages: The user is encouraged to work sequentially through the checklist, with the decisions made in Section 1 informing subsequent sections and using the checklist as a reporting framework. This checklist is not a prescriptive set of instructions but rather a set of considerations for creating physical activity messages. The concepts in this checklist may also be used to guide formative research/evaluation with the target audience which in turn can be used to make decisions around message content and delivery.</p> <p>When aiming to evaluate or understand existing messages: The checklist may be used to plan a process, impact or outcome evaluation. It can help identify message aims to inform evaluation and indicators that could be measured. It can also help to understand existing messages by allowing the user to classify messages and identify potential effective message components.</p> <p>The ‘tick those that apply’ column is designed to aid you in keeping track of which concepts have been considered and how and what decisions were made, not to necessarily encourage use of all concepts. A message with more ticks is not by default better than a message with fewer ticks.</p>		
Reason for using checklist	Tick those that apply	Additional comments/description
I am using this checklist to create a new message		
I am using this checklist to understand an existing message, or to inform process and/or impact/outcome evaluation of an existing message		
2. Who, When, What, How and Why?		
2.1. Who? (in which group(s)?)		
	Tick those that apply	Specify below
2.4.4. Target population identified		
2.4.5. Target audience engaged with to inform message development		
2.5. When? (in which context?)		

	Tick those that apply	Specify below
2.5.2. Time of year and social/political context of message considered (e.g., during the Olympics or during the COVID-19 pandemic)		
2.6. What? (is the aim of the message?)		
	Tick those that apply	Specify below
2.6.2. Specific aim of message identified (e.g., to improve self-efficacy, motivation, awareness, perceptions, knowledge etc) and specific outcomes relating to the aim identified and clearly stated		
2.7. How? (is the message intended to work?)		
	Tick those that apply	Specify below
2.7.2. Potential pathway(s) by which message may bring about change in the outcome(s) of interest identified (e.g., targeting beliefs about capabilities)		
2.8. Why? (are the decisions around message creation being made?)		
	Tick those that apply	Specify below
2.8.2. Decisions based on psychological or sociological theory or social marketing principles		
2.8.3. Decisions based on formative evaluation or co-production with the target audience (note: the concepts in this Checklist can be used to inform areas of investigation in research with the target audience)		

2.8.4. Decisions based on existing literature and evidence involving the target audience		
3. Message Content (what is in the message?)		
3.1. Type of information		
	Tick those that apply	Additional comments/description
3.1.2. Message contains “what to do” information (quantity and type of activity). For example: “Aim for 10,000 steps a day!”		
3.1.3. Message contains “why you should do it” information (e.g., physical, mental, social health, environmental benefits or appearance-based information). For example: “Take the stairs – feel less stressed!”		
3.1.4. Message contains “how to do it” information (practical or supportive information). For example: “Did you know that we run a group walk for older adults every Thursday at 12pm?”		
3.2. Information framing, targeting, tailoring and personalisation		
	Tick those that apply	Additional comments/description
3.2.2. Message content is gain-framed (highlights benefits)		
3.2.3. Message content is loss-framed (highlights consequences)		
3.2.4. Message content is generic (suitable for all)		
3.2.5. Message content is tailored to an <i>individual</i> (based on user-specific data such as personal step count goal)		

3.2.6. Message content is <i>targeted</i> at a group (e.g., Type 2 diabetics or inactive older adults)		
3.2.7. Message content is <i>personalised</i> (contains personal information such as name or home address)		
3.3. Use of language		
	Tick those that apply	Additional comments/description
3.3.2. Appropriate language and choice of words considered (e.g., ethnically, culturally, contextually and age-appropriate)		
3.3.3. Message conveyed using a particular tone (e.g., formal, encouraging or threatening)		
4. Message Format and Delivery		
4.1. The way the information (content) is conveyed		
	Tick those that apply	Additional comments/description
4.1.2. Message uses text to convey information (e.g., “physical activity is fun”)		
4.1.3. Message uses images or videos to convey information (e.g., images or footage of people having fun being physically active)		
4.1.4. Message uses music to convey information (e.g., the use of ‘fun’ music in the message)		
4.2. Message format		
	Tick those that apply	Additional comments/description
4.2.2. The media, mode or channel of the message has been considered/specified		
4.2.2.1. <i>Radio advert</i>		
4.2.2.2. <i>TV advert</i>		
4.2.2.3. <i>Poster</i>		

4.2.2.4. Leaflet or pamphlet		
4.2.2.5. Social media post (specify platform e.g., Twitter, Facebook, Instagram, TikTok, Snapchat etc)		
4.2.2.6. Email		
4.2.2.7. SMS/text message		
4.2.2.8. Other		
4.2.3. The message is of a specified length or volume (e.g., 100 words or 20 seconds)		
4.3. Message delivery		
	Tick those that apply	Additional comments/description
3.3.1. The provider, messenger or source has been considered/specified		
3.4.1. Health care professional (e.g., GP)		
3.4.2. Family or friends		
3.4.3. Peers		
3.4.4. The media		
3.4.5. The Government		
3.4.6. Celebrities		
3.4.7. Other (specify in additional comments/description box)		
3.5. The setting in which the message will be delivered has been considered and specified, e.g., at home, at school, at work, at the doctor's surgery, at bus stops etc.		
3.6. The frequency, time of day and dose of message delivery have been considered and specified, e.g., 3		

messages a week, set at 9am, for 3 months.		
--	--	--

TABLE 7-5: WORKING DEFINITIONS OF KEY CONCEPTS WITHIN THE FRAMEWORK

Concept	Working definition	Example(s)
Concepts relating to Section 1: Who, when, what, how and why?		
Target audience	The intended recipient(s) of the message	Older adults, individuals working from home
Context (Pfadenhauer et al., 2017)	The time of year and the geographical, epidemiological, socio-cultural, socio-economic, ethical, legal and political context at the time of messaging	During the winter, at new year, during a global pandemic
Outcomes (Lewis et al., 2018)	Changes expected as a result of messaging	Awareness, understanding, motivation, physical activity behaviour
Pathway (Lewis et al., 2018)	The sequential process from the delivery of the message through to outcome. In other words, <i>how</i> a message works. This may encompass multiple mechanisms or processes.	Education, persuasion, encouraging habit formation, targeting beliefs about capabilities
Formative research/evaluation (Nutbeam & Bauman, 2014)	Evaluation or research used to help inform message development and to assess whether the message is appropriate and acceptable before it is implemented.	Focus groups with target population to investigate message salience, relevant and importance
Co-production	Bringing together citizens with those working in research, policy and industry, and/or practice in an attempt to form equitable partnerships throughout message development	Involving individuals from the target audience in message development
Concepts relating to Section 2: Message content		
'What to do' information	Information regarding the amount or type of physical activity that is recommended	150 minutes of moderate physical activity per week, 10,000 steps per day, a mixture of aerobic and strength activity
'Why to do it' information	Information regarding benefits (or consequences) of physical activity (or inactivity)	Physical health, mental health, appearance, environment
'How to do it' information	Information providing guidance on how to be more active or signposting to opportunities for physical activity.	Guidance on when to be active, where to be active or who to be active with
Use of gain- or loss- framing (Latimer et al., 2010)	The use of framing a message to highlight either the benefits of taking part in physical activity (gain-framed) or the consequences of not taking part (loss-framed).	Gain-framed: "Walking regularly can make you happier" Loss-framed: "Not walking regularly can increase your risk of depression"

Tailoring (Conroy et al., 2019)	Information based on individual user data	Specific feedback on pre-established goals such as step counts
Targeting (Conroy et al., 2019)	Information designed to be relevant to a specific group	Information relevant to inactive individuals or people with Diabetes
Personalisation (Conroy et al., 2019)	The use of static, user-specific information in a message	Messages involving name or home address
Language and choice of words	The dialect(s) and selection of specific wording used in the message	English, Spanish, use of the slang, use of lay-audience friendly language
Message tone	The tone adopted by the message	Threatening, persuasive, encouraging
Concepts relating to Section 3: Message format and delivery		
Text (message format)	The use of words to convey information in a message	Text on posters or social media posts
Images or video (message format)	The use of images and videos to convey information in a message.	Images or footage of individuals being active
Audio (message format)	The use of audio to convey information in a message.	Music, voiceovers, sound effects
Media, mode or channel of delivery	The type of media through which the message is being communicated	Emails, posters, social media posts, radio/television adverts
Message volume or length	The volume or the length of the message relating to the number of words in a message or the amount of time it takes to listen to a message.	100 words, 30 seconds
Provider or source	The provider or source of the message	Doctor, journalist, reporter, friends/family
Setting	The setting in which the message will be received by the intended recipient	Doctor's waiting room, home, work
Frequency, time of day and duration	How often the message is delivered, at what time, and for how long	Emails sent in the morning 3 times a week for 4 weeks

Discussion

This study achieved international expert consensus on the PAMF and PAMC from a panel of academics, healthcare and other professionals, and government officials and policymakers. We encourage the use of this evidence- and expert-informed framework and checklist to (a) develop

evidence-based PA messages and (b) guide evaluation of such messages.

In addition, the PAMC may provide a useful way of understanding and categorising existing messages, for example in evidence reviews.

Comparisons with and contributions to the literature

The overall process of this modified Delphi was similar to other studies that have sought to gain consensus on a topic informed by preliminary work (Hanson, Oliver, et al., 2020). This Delphi study had a comparable initial response rate (80.8%) and between-survey response rates (96% and 80% for surveys 2 and 3, respectively) to other similar studies (Hanson, Oliver, et al., 2020; Pikora et al., 2003). Consensus was reached in round 3 of the current study. This was expected and is comparable to a number of other Delphi studies that have resulted in frameworks or taxonomies relating to PA or sedentary behaviour, such as a Consensus Taxonomy of Sedentary Behaviours (Chastin et al., 2013), the Comprehensive Analysis of Policy on Physical Activity (CAPPA) framework (Klepac Pogrmilovic et al., 2019), and a framework for workplace walking and cycling (Pikora et al., 2003).

There are similarities between the PAMF and existing health communication frameworks. The importance of formative research, setting communication objectives and identifying the target audience are also highlighted in the CDC Framework for Health Communication (Robert, 1995; William, 1993). The importance of considering various types of evaluation (formative, process and outcome) and considering the message itself separately from the message delivery are emphasised in the Audience-Channel-Message-Evaluation (ACME) Framework for Health Communication

(Seth, 2012). To the best of our knowledge, the checklist presented in the current study is the first translational tool specifically designed to assist PA message creation. The agreed PAMF and PAMC have been informed by expert views as well as recent PA messaging literature; an area that has become increasingly researched in the past 5-10 years (Williamson et al., 2020). The PAMF and PAMC build on existing frameworks by illustrating various PA messaging concepts that could be considered when creating and delivering PA messages, encouraging the user to identify plausible pathways by which the message may bring about changes in outcomes, and by providing a novel checklist tool that can be used to document the process.

Strengths and limitations

There are a number of study limitations to consider. Firstly, the Delphi method inherently involves subjectivity on a number of levels: in selection of the expert panel, in the experts' opinions themselves, and in the consideration of feedback and subsequent amendments made to the framework (Hasson et al., 2000). However, this was deemed the most appropriate method to address the aims of this study and gain feedback from a geographically diverse expert panel. Furthermore, Delphi studies are subject to social conformity bias. We attempted to minimise this bias by analysing data anonymously and by ensuring anonymity between participants. However, we cannot fully eliminate social conformity as the nature of this research involved feeding back opinions from the wider panel to the participants, and we cannot assume that participants were unaware of each other's involvement in the study.

Although we aimed to capture rich data and feedback from participants through a mixture of quantitative and qualitative approaches, the nature of Delphi studies means opinions may be paraphrased or shortened, and there is always room for misinterpretation (Keeney et al., 2001). Relatedly, although we reached consensus from an international panel, there are likely insights from others in the wider public health field that would further enhance the framework. Therefore, it may be necessary to further develop and refine the PAMF and PAMC once they have been trialled and tested in applied settings in a variety of disciplinary areas.

Systematic reviews have revealed that almost half (48.8%) of Delphi studies fail to define the percentage threshold for consensus *a priori* (Diamond et al., 2014), and that only around a third of Delphi studies have international scope (Jünger et al., 2017). Therefore, key strengths of the current study are that the consensus was defined *a priori*, and that the framework achieved international consensus. ISPAH recommends messaging and mass media as a best investment across all countries (ISPAH, 2020) and the concepts within the PAMF allow flexibility for people in different settings to make contextually relevant decisions. However, despite attempts to broaden inclusion, our expert panel were predominantly from the UK and other high-income countries. This distribution was expected, as our recent scoping review found that 87% of literature on PA messaging came from UK, Canada, USA and Australia (Williamson et al., 2020), however, it does potentially reduce the applicability and usefulness of the PAMF in other countries, particularly low- and middle-income countries.

Furthermore, due to our high frequency of UK-based participants, much of the feedback used to develop the PAMF and PAMC came from individuals who may have been more familiar with messaging and campaign attempts in the UK. We therefore invite feedback on and adaption of the PAMF from international colleagues. Despite the limitations, the PAMF and PAMC were developed using rigorous methods and provide a more robust starting point for guidance to inform the creation of PA messages than has previously been available.

Implications and future directions

The PAMF and PAMC are evidence- and expert-informed tools that allow a range of users to design and evaluate PA messages to any target audience. The PAMF and PAMC have potential to enhance messaging practice by encouraging development of messages based on theory, formative research and existing evidence with emphasis on understanding plausible working pathways and planning appropriate evaluation. Furthermore, we believe that consistent use of the PAMF and PAMC will improve quality of reporting and harmonise understanding of key PA messaging concepts and their definitions, aiding future synthesis and thus understanding of the evidence base.

It is not the purpose of the PAMF and PAMC to provide the user with answers on which decision(s) to make, for example, whether to use gain- or loss-framed messages. Rather, these tools encourage the user to draw on formative research, wider evidence and theory to inform such decisions. Whilst some evidence does exist to support certain decisions over others

(e.g., existing evidence is slightly in favour of gain-framed over loss-framed) (Latimer et al., 2010; Williamson et al., 2020), there is currently not enough evidence to provide recommendations for all relevant concepts within the PAMF. Future research should aim to utilise the PAMF and PAMC to conduct research to develop recommendations for specific messaging concepts in specific population subgroups and contexts.

Improving the functionality and accessibility of the PAMF and PAMC are also key future directions. As an initial next step, we aim to publish a consensus statement and guide to using the framework and checklist to create new messages and aid evaluation and understanding of messages. We see the PAMF and PAMC as iterative and look to continue revising and improving them based on their use in real-world settings. Questions or reports of efforts to employ the PAMF and PAMC can be shared with the corresponding author. We also seek to develop an online interactive tool that will make the PAMC more user-friendly. Finally, we aim to explore the applicability of the PAMF and PAMC in creating and guiding evaluation of messages focused on other health behaviours such as sedentary behaviour.

Conclusion

PA messaging plays an important role in improving population PA levels. Here, we present a framework and checklist for PA messaging that have consensus from an international expert panel. We believe that the presented framework and checklist, which encourage the design of PA messages based on theory, existing evidence, formative evaluation with the target audience will be an important contribution to our field. If used

consistently, the PAMF and PAMC may improve practice by encouraging evidence-based and target audience-focused messages, as well as enhance the research base on PA messaging by harmonising key terminologies and improving quality of reporting.

Postamble

The modified Delphi study described in this chapter resulted in key outputs from this body of research, the PAMF and PAMC. This chapter and the included published article present the PAMF and PAMC and describe in detail the methods and results of the modified Delphi study. However, there is also a clear need for further information on how the PAMF and PAMC can and should be used. Initially, I attempted to include the user guide for the PAMF and PAMC in the same chapter and article. However, this proved a near impossible task if full transparency and accurate reporting were to be maintained. Therefore, the user guide was written as a separate chapter and journal article. This is presented in the following chapter (Chapter 8).

Chapter 8 The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC): international consensus statement and user guide

Chapter overview

This chapter presents the consensus statement and user guide for the PAMF and PAMC developed in Chapters 6 and 7. This consensus statement and user guide was published in IJBNPA in December 2021. My contributions to the published article can be found in the declaration section (pages 2-4). The published article is presented here and is preceded and followed by additional commentary expanding on the paper and providing further discussion. This chapter aims to present an overview of and describe the various concepts within the PAMF and PAMC, discuss in detail how the PAMF and PAMC can be used for three key purposes, and describe areas for future development and research.

Preamble

As previously mentioned, this chapter presents a second output from the modified Delphi study described in Chapter 7. The decision to write two chapters (and to publish two corresponding journal articles) was based on three key factors. First, discussions with members of my advisory group revealed that simply providing the PAMF and PAMC of outputs without explaining how they can be used would not be useful for relevant stakeholders. Thus, it was agreed that a user guide explaining the PAMF and PAMC (and how they can be used) in full was needed to facilitate implementation of this research. Second, journal word count limits would not

allow inclusion of detailed and transparent reporting of modified Delphi methods or full reporting of study result as well as a detailed description of the PAMF and PAMC and how they can be used, making it a logical decision to split the article into two separate publications. Third, the modified Delphi described in the previous chapter followed CREDES guidance (Jünger et al., 2017). Importantly, CREDES guidance regarding publication and dissemination states that where publication does not allow for a detailed presentation of either the resulting practice guidance (in this case, the user guide for the PAMF and PAMC) or the methodological features of the applied Delphi technique (in this case, the detailed account of the modified Delphi study described in Chapter 7), that a separate more detailed account should be made available elsewhere (e.g., publication of a separate paper) (Jünger et al., 2017, p. 702).

In Delphi studies, there is precedent for inviting all members of the expert panel to be co-authors on the resulting consensus statement. Indeed, this is an approach that has been adopted in existing similar studies within the PA and sedentary behaviour field (Chastin et al., 2013). As such, all 40 members of the expert panel of the modified Delphi described in this chapter were invited to be co-authors of the subsequent user guide and consensus statement. Of these 40, 32 agreed and eight were acknowledged instead. Combining these 32 expert panel members with the core author group resulted in a group of over 40 authors. Managing an author group of this size was a challenge, as it was important to ensure all authors had the opportunity to contribute meaningfully to the manuscript. The approach I took

to overcome this challenge was to use online surveys (administered via Qualtrics). I drafted the manuscript which was then shared via a survey to the entire author group, with feedback requests on the different sections. This approach allowed me to collate all feedback for each section and consider it as a whole. Once feedback had been taken on board and the manuscript amended, the updated manuscript was circulated via Qualtrics once more, requesting any further feedback as well as manuscript approval from all authors, as per journal authorship requirements. The final published article is presented below.

Published article

Abstract

Effective physical activity messaging plays an important role in the pathway towards changing physical activity behaviour at a population level. The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC) are outputs from a recent modified Delphi study. This sought consensus from an international expert panel on how to aid the creation and evaluation of physical activity messages. In this paper, we (1) present an overview of the various concepts within the PAMF and PAMC, (2) discuss in detail how the PAMF and PAMC can be used to create physical activity messages, plan evaluation of messages, and aid understanding and categorisation of existing messages, and (3) highlight areas for future development and research. If adopted, we propose that the PAMF and PAMC could improve physical activity messaging practice by encouraging evidence-based and target population-focused messages with clearly stated aims and consideration of

potential working pathways. They could also enhance the physical activity messaging research base by harmonising key messaging terminologies, improving quality of reporting, and aiding collation and synthesis of the evidence.

Introduction

Physical inactivity is a leading cause of non-communicable disease and premature mortality worldwide (Lee et al., 2012; Strain, Brage, et al., 2020; Strain, Wijndaele, et al., 2020). A systems approach to targeting population level physical inactivity acknowledges that, alongside changes to the physical environment and policy, we must also target social and individual factors such as social norms, perceptions and attitudes (Rutter et al., 2019). The importance of such approaches are reflected in the Global Action Plan on Physical Activity (2018-2030) (World Health Organization, 2018) and the International Society for Physical Activity and Health's (ISPAH) eight best investments that work for physical activity (PA) (ISPAH, 2020). One example of an approach that can target individual and social factors is PA messaging. We have previously defined PA messaging as “the overall process of creating and delivering PA messages”, with a PA message referring to “educational or persuasive materials to be relayed to a specific individual or group with the aim of ultimately increasing PA levels” (Williamson et al., 2020). PA messaging is an area of rapidly growing interest (Williamson et al., 2020). Reflecting this, the World Health Organization (WHO) 2020 guidelines on PA and sedentary behavior include an accompanying paper highlighting the importance of developing effective

messaging of guidelines for the first time (Milton et al., 2020). Therefore, improving practice in this area is of interest to a range of specialisms including public health, behavioural science, and policy implementation.

To advance PA messaging research and practice, we have developed the PA Messaging Framework (PAMF) and Checklist (PAMC) (Williamson et al., 2021). Provisional versions of the PAMF and PAMC were developed between March 2019 and April 2020 using concepts identified in a scoping review of PA messaging (Williamson et al., 2020), drawing from relevant theory and existing frameworks (Connell et al., 2019; Michie et al., 2011) and through consultation with researchers, policymakers and practitioners. The provisional framework and checklist provided a starting point in a modified Delphi study (Williamson et al., 2021). In this Delphi study, we conducted three mixed methods online surveys to gather feedback from an international expert panel (n=40, 55% female) comprising academics (55.0%), healthcare professionals or other professionals (22.5%) and government officials or policymakers (22.5%). The framework and checklist were amended and developed between each survey round based on feedback until consensus (defined *a priori* as 80% agreement) was reached from the panel (Williamson et al., 2021).

A detailed report of the modified Delphi methods and results have been published in a separate paper (Williamson et al., 2021). The current paper presents the resulting consensus statement with accompanying user guide for the PAMF and PAMC. This approach was taken to maximise the

usefulness and facilitate implementation, and is consistent with Guidance on Conducting and Reporting Delphi Studies (CREDES) (Jünger et al., 2017). This consensus statement and user guide may enable researchers, practitioners, and others to adopt and use the PAMF and PAMC consistently. If adopted by the PA for health field and used consistently, the PAMF and PAMC have potential to improve PA messaging practice and strengthen the PA messaging research base.

Aims

In this consensus statement and user guide, we aim to: (1) present an overview of the various concepts within the PAMF and PAMC; (2) discuss how the PAMF and PAMC can be used to create PA messages, plan evaluation of messages, and aid understanding and categorisation of existing messages; and (3) describe areas for future development and research.

The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC)

Overview of the framework and checklist

Figure 7-5¹⁵ and Table 7-4¹⁶ present the PAMF and the PAMC respectively. The PAMF presents an overview of messaging concepts for each overarching section and provides a visual tool for communications, teaching, and training. The PAMC presents these concepts in a more practical format and acts as a tool for implementing the framework that can

¹⁵ Figure 7-5: The Physical Activity Messaging Framework (PAMF) is not repeated in this chapter as it is already presented in Chapter 7.

¹⁶ Table 7-4: The Physical Activity Messaging Checklist (PAMC) is not repeated in this chapter as it is already presented in Chapter 7.

be used to guide and document message creation, evaluation, and categorisation. Working definitions of concepts within the PAMF and PAMC can be found in Table 7-5¹⁷.

Section 1: Who, when, what, how and why?

Throughout this paper, we use the term ‘user’ to describe the individual(s) using the PAMF and PAMC to create, evaluate or understand PA messages. The *Why?* concept extends along the length of the framework and, although placed within section 1 for clarity, is relevant for all concepts within the framework. This section asks the user to first consider, explain and justify “why” section 1 decisions, and then in a sequential manner “why” subsequent section 2 and 3 decisions on content, format, and delivery, were made. Drawing on theory to develop and understand health messaging is likely to improve planning and targeting, help define more explicit message aims and potential pathways, and ultimately result in more effective messages (French, 2017). Existing evidence supports conducting formative evaluation (see Table 7-5) with the target audience and drawing on psychological theory and social marketing principles in the message development (Williamson et al., 2020). However, as with many other health promotion programmes (French, 2017, p. 117), message creators often design and implement the message without conducting formative research or sufficiently understanding the target population (Williamson et al., 2020). Furthermore, many PA messages are created without establishing a clear

¹⁷ Table 7-5 (working definitions of concepts within the PAMF and PAMC) is not repeated here as it is already presented in Chapter 7.

aim and without drawing on theory to inform message development (Williamson et al., 2020). *Why?* encourages the user to have a clear rationale for each decision by making choices based on formative evaluation and co-production with the target audience, relevant psychological or sociological theory, and/or existing evidence involving the target population.

Who? encourages the user to identify and specify a target audience at the outset of message development and to continue engaging with them at all stages of message creation and delivery. For example, is the message aimed at older adults, inactive populations, those in the 'pre-contemplation' stage of change, or children in a specific region? A recent paper on maximising impact of PA guidelines through communication approaches presented a planning framework which shows the importance of situational and stakeholder analyses to identify appropriate target groups (Milton et al., 2020). Dividing the general public into subgroups with similar characteristics/variables or 'audience segmentation' is a key element of social marketing and an important early step in developing targeted health communications (Cross et al., 2017). There are numerous ways in which a population can be 'segmented', for example, by sociodemographic, geographical, behavioural, epidemiological, attitudinal or psychological variables (French, 2017, p. 113), by peer crowds (Lee et al., 2019), or combinations of these variables. We acknowledge that while segmentation is advised, some messages may be targeted at numerous groups or a general population, for example in a national mass media campaign. Engaging with the target audience(s) through formative evaluation and co-production can

provide an understanding of their attitudes, circumstances, challenges and preferences (French, 2017, p. 117). While such approaches may not always be viable or appropriate (Oliver et al., 2019), they offer an opportunity to develop messages that are relevant and salient to the target group, and thus have a higher chance of success (French, 2017, p. 130).

What? encourages the user to identify specific aim(s) of the message(s) and, linked to this, state what the message is trying to achieve in terms of proximal, intermediate and distal outcomes (Williamson et al., 2020). For example, does the message aim to raise awareness or knowledge of PA benefits in older adults, or improve self-efficacy in teenage girls? Relatedly, *How?* encourages the user to state how these outcomes will be achieved by the chosen message(s), that is by which pathway(s) (Connell et al., 2019) or process(es)? It may be particularly useful here to refer to existing theory, such as the Transtheoretical Model, Social Cognitive Theory or the Behaviour Change Wheel (Ajzen, 1991; Bandura, 2001; Connell et al., 2019; Janz & Becker, 1984; Michie et al., 2011; Prochaska & Velicer, 1997), to identify plausible ways in which the message might bring about changes in the outcome(s) of interest. For example, with reference to behaviour change theory (Michie et al., 2011), targeting ‘beliefs about capabilities’ (mechanism of action) may be used to bring about change in self-efficacy (outcome). Or utilising ‘education’ (intervention function) within a message in the form of providing information on health benefits of PA (behaviour change technique) may bring about a change in knowledge (outcome).

Finally, interrelated with all other concepts in section 1 (*who, what, how and why*), *When?* considers the time of year and context in which the message is created and delivered. For example, some message developers may wish to capitalise on certain times when goals are more likely to be set such as new year, or when fewer barriers to PA are present such as during summer months when weather is better and there are more daylight hours (Arnardottir et al., 2017; Glowacki et al., 2017). Context (such as epidemiological, social or political context) (Pfadenhauer et al., 2017) may influence what is perceived as important to the target audience and what is feasible to promote. A recent example is the COVID-19 pandemic, during which government guidance has influenced which types of PA can be promoted (Scottish Government, 2021). During the pandemic, factors most important to the target audience may have shifted from, for example, appearance and physical health to social and mental health. Additionally, many individuals working at home may not have regular access to some delivery channels, such as workplaces and billboards. It is therefore important to consider context when deciding what information should be included in the message and how it should be delivered.

Section 2: Message content

Section 2 has three levels. The first level encourages the user to consider the type of information in the message, of which there are three potential types: (1) *what to do*, (2) *why to do it*, and (3) *how to do it*. Examples of these three information types can be found in Table 8-1. *What to do* information includes information on amount, intensity and type of PA

being promoted. For example: information on the PA guidelines such as 150 minutes of moderate-to-vigorous PA per week (Department of Health & Social Care, 2019; Public Health Agency of Canada, 2020; US Department of Health and Human Services., 2018; World Health Organization, 2020), 30 minutes of PA on most days of the week (Pate et al., 1995), or step count recommendations such as 10,000 steps per day (Choi et al., 2007). *Why to do it* information includes information on any benefits (or consequences) of being active (or inactive). This information can relate to a number of areas, such as physical health (Strain, Brage, et al., 2020; Strain, Wijndaele, et al., 2020), mental health (Kelly et al., 2018; Teychenne et al., 2020), appearance (Gaston & Gammage, 2011; Rhodes & Courneya, 2000) or the environmental impact of PA (Brand et al., 2021), and may refer to immediate, short term and/or long-term effects (Williamson et al., 2020). Current evidence points towards the benefits of promoting immediate short-term benefits of PA, particularly relating to affective state and mental or social health (Williamson et al., 2020). However, formative research and co-production with each target audience may further reveal what information is most salient and important. Finally, *how to do it* information encompasses practical or supportive information that may provide instructions or guidance on how, when and where to be active, e.g., signposting to local opportunities. Note that a PA message may include just one or a combination of these information types, and does not necessarily need to include information on the PA guidelines (Williamson et al., 2020).

TABLE 8-1: EXAMPLES OF DIFFERENT INFORMATION TYPES IN PHYSICAL ACTIVITY MESSAGES

Information type	Examples
What to do	<p>“Adults should aim to accumulate 150 minutes of moderate- to vigorous- physical activity a week”</p> <p>“Aim for 10,000 steps a day or more”</p> <p>“Aim to take part in both aerobic and strength exercises”</p>
Why to do it	<p>“Being physically active can reduce your risk of heart disease later in life”</p> <p>“Take the stairs – feel less stressed”</p> <p>“Cycle for a healthier planet”</p> <p>“A little movement for a little mood improvement”</p>
How to do it	<p>“Try walking during your lunch break to become more active!”</p> <p>“Set weekly goals and smash them!”</p> <p>“Did you know that we run a group walk for University staff every Thursday at 12pm? It starts outside the library. Why not come along next week?”</p>

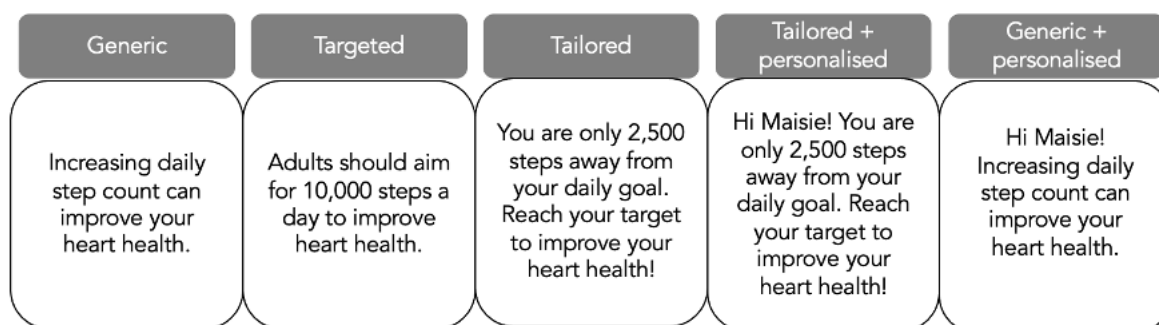
The second level of section 2 relates to the way the information is conveyed. It considers (1) information *framing*, (2) the use of *generic*, *targeted*, or *tailored* messages, and (3) the use of *personalisation*. PA message *framing* relates to whether information is framed to highlight the benefits of taking part in PA or the consequences of not taking part (Latimer et al., 2010). Framing involves both the exposure (PA) and the outcome. For example, where *gain-framed* messages may be: “regular activity can improve your heart health” or “walking daily is good for your mental health”, *loss-framed* alternatives would be: “inactivity increases your risk of dying of heart disease” or “not walking daily may increase your risk of depression”. Existing

evidence generally supports the use of gain-framed messages over loss-framed messages to promote PA (Latimer et al., 2010; Williamson et al., 2020), however, engaging with the target audience may highlight instances where there is no benefit of framing (Gilbert et al., 2021) or where loss-framed messages are preferred. For example, there is evidence to suggest that people with spinal cord injury can be motivated to engage in PA by increasing risk perception through loss-framed messaging (Bassett & Martin Ginis, 2011; Bassett-Gunter et al., 2013).

Information in a PA message may be *generic*, *targeted* (at a group level) or *tailored* (at an individual level). *Generic* information is intended to be suitable for all audiences and may include, for example, information on generic benefits of PA or PA opportunities (Williamson et al., 2020). *Targeted* messages are relevant to a particular group (Conroy et al., 2019). For example, a targeted message aimed at older adults may specifically highlight benefits of PA which are particularly relevant to that group, such as spending time with others and maintaining functional capacity (Dacey et al., 2008). *Tailored* messages include user-specific data (Conroy et al., 2019) such as goals to make messages highly relevant for that individual. For example, messages conveying how close someone is to meeting their personal step count goal. Generally, existing evidence supports the use of targeted or tailored messages over generic messages (Williamson et al., 2020). Finally, *personalising* a message includes using non-PA related data (Conroy et al., 2019) such as name or home address to increase salience of the message.

Figure 8-1 shows how *targeting*, *tailoring* and *personalisation* can be used alone or in various combinations.

FIGURE 8-1: ILLUSTRATIVE EXAMPLES OF COMBINATIONS OF TAILORED, TARGETED AND PERSONALISED MESSAGES



The final level of section 2 relates to the *language* used in the message. The user is encouraged to consider if the language used is ethnically, culturally, regionally, literacy and age-group appropriate for the target population. It is important that message content demonstrates an understanding of cultural sensitivities (Nobles et al., 2020), and message credibility and appeal may be increased when messages reflect the social and cultural world of the target audience (Cross et al., 2017). The user is also encouraged to consider message *tone*. For example, is a formal or encouraging tone suitable for the target population and message aim(s)? Can threatening, condescending, or demanding tones be recognised and avoided? Existing evidence suggests threatening or forceful tones are at best ineffective and at worst may have detrimental effects on PA and PA-related outcomes such as intentions, motivation and affect (Brenngman et al., 2010; Hatchell et al., 2013; Quick & Considine, 2008).

Section 3: Message format and delivery

The final section of the PAMF and PAMC relates to message format and delivery. First, the user is encouraged to consider how the content of the message may be conveyed: via *text* or *words*, for example “physical activity is fun!”, using *images* or *video*, for example showing footage of people having fun being active, or using *audio*, for example including a voiceover or using ‘fun’ music in the message. Second, the user is encouraged to consider message format by considering both the *media, mode* or *channel* of the message (e.g., poster, Instagram post, radio advert), and the message *volume* or *length* (e.g., 100 words or 20 seconds). Existing evidence suggests message format preferences vary from group to group (Williamson et al., 2020). It is therefore important to draw on existing literature and utilise formative evaluation to inform such decisions.

Finally, the PAMF and PAMC guide the user through a series of delivery concepts. The first is the message *provider, source* or *messenger* (e.g., the Government, healthcare professionals, a certain organisation, or a credible role model or celebrity). Message provider characteristics (such as appearance, gender, age, organisation credibility etc) may impact the acceptability of a message (Green, 2015; Hubley, 1993), and different populations have different message provider preferences (Williamson et al., 2020). Some populations may value credible information from experts, whereas others may find expert advice overpowering (Cross et al., 2017), once again highlighting the importance of formative evaluation and co-production with the target audience. The *setting(s)* should be considered for

message delivery, such as doctor's office, at home or at work. Finally, the framework encourages (where relevant) consideration of *frequency, time of day and duration* of the message. For example, a Tweet that is sent 3 times a week between 9 and 10am and will be sent for 6 months. The PAMF and PAMC link message delivery and format decisions with message aim(s), target audience, and what is most appropriate based on theory, formative research and/or existing evidence.

Ensuring equity, diversity and inclusivity in the messaging process

Addressing inequalities is a well-known challenge in PA promotion (Beenackers et al., 2012; Demarest et al., 2014; Hunter et al., 2015; Lehne & Bolte, 2017), and therefore considering diversity, equity and inclusivity when creating PA messages is crucial. It is important to consider equity when creating and delivering PA messages and aim to avoid creating or worsening biases between groups that differ socially, economically, demographically or geographically. We can learn from previous communication efforts in other health behaviours here. For example, smokers from more deprived neighbourhoods with higher smoking prevalence are less equipped to change behaviour in response to anti-smoking promotions (Acheson, 1998). Similarly, consistent with the knowledge gap deficit model (Gaziano, 1982; Kwak, 1999), evidence from the Canadian ParticipACTION campaign suggests that individuals with a higher level of education have higher motivation to attend to PA health messages (Spence et al., 2018). Some groups may, for example, need more practical advice on how to increase PA, have differential access to social media, or may not have safe green spaces

nearby to act on messages they see. Indeed, in some groups, messaging may not be an appropriate or priority strategy to target PA. It is therefore important that we utilise formative evaluation to assess the need for messaging, adapt message content and delivery based on what will work best for each population where messaging is appropriate, and continue to view messaging as part of overall PA promotion.

Although we may aim to target messages to specific groups, these target audiences are not homogeneous. Therefore, to ensure messages reach and appeal to diverse groups it is critical to involve and consider individuals from a range of different sociocultural backgrounds in message creation where appropriate to gather as many viewpoints as possible (Kreuter et al., 2003). Some cultural adaptation models suggest having researchers (in this case, message co-creators) of similar cultural backgrounds to that of the target population (Emma M et al., 2013). Furthermore, existing evidence suggests that individuals may respond more positively to messages with relatable content and models in their images/videos (Nobles et al., 2020; Smith & Wightman, 2019; Williamson et al., 2020). Similarly, when using images and video footage in PA messages, it may be important to represent the various individuals in that target audience by including, for example, individuals from various social and cultural backgrounds, different genders, body types, fitness levels and sexual orientations. One example is the This Girl Can campaign (Sport England, 2019a) which targets the population of 'women in England'. Developed as a result of formative research with various subgroups of women, the final

campaign images and videos used models who represented a broad range of women, enhancing relatability (Sport England, 2015, 2019b). Alternatively, message creators may wish to avoid using models at all and use more generic icons or images instead. This approach was taken recently in the logo of the Move Your Way® campaign (USA) (Bevington et al., 2020).

Finally, PA messages should cater for marginalised groups in society as well as mainstream audiences (French, 2017), using inclusive language and accessible delivery formats. The importance of considering inclusivity in PA messaging has been highlighted by a recent editorial (Smith et al., 2021) in which the authors explain how some commonly used PA messages aiming to tackle physical inactivity and sedentary behaviour such as ‘sit less, move more’ are ableist. Working with often overlooked or marginalised groups to co-produce messages will ensure inclusivity. Indeed, the PAMF’s emphasis on formative evaluation and co-production can contribute towards addressing this.

Application of the PAMF and PAMC

Using the PAMF and PAMC to create new messages

One use of the PAMF and PAMC is to create new messages. These could include standalone messages or, for example, a group of messages to be included in a mass media campaign. When creating messages, the PAMF and PAMC are intended to be used sequentially with decisions in section 1 being used to help inform subsequent decisions. The checklist can be used throughout the message creation process to ensure all relevant concepts within the framework have been considered and to document this process.

There may be different levels at which an individual or organisation uses the framework and checklist. At one end of the scale, the user(s) may have their own established messaging approach and may simply wish to use the PAMF and PAMC in a 'light-touch' way to inform or check their process. On the other end, the user(s) may wish to be prescriptively directed by the PAMF and PAMC from start to finish.

Where the PAMF and PAMC are being used in a more prescriptive way, new messages may be created using an interdisciplinary team of academics/researchers and practitioners/professionals and consumers, systematically considering each concept in the framework, and drawing on each group's strengths to inform various decisions. However, we acknowledge that practically speaking this may not always be possible, and that there will likely be situations where resource realities (restrictions on time, personnel, and funding etc) will limit the level of framework consideration. Indeed, demonstrations of pragmatic use of the PAMF and PAMC in various circumstances with varying levels of resources will provide valuable insight into their implementation in practice-based settings (Barnish & Turner, 2017). We believe that messages created with at least some consideration of the framework will be more effective than those that have not considered any of the included concepts.

In some cases, it is plausible that a brief has been issued or some key decisions regarding content and delivery have already been made. For example, a university may task the user with designing a poster to encourage

students to use the stairs in the library. Here, some aspects around message aim, format and setting have been decided. The PAMF and PAMC can still be used to record which decisions were pre-specified, and which decisions and concepts were subsequently considered and guided by the framework. Alternatively, you may be given the brief of developing the communication strategy for national PA guidelines. In this case the PAMF and PAMC can be used prospectively to guide a range of options and approaches, identifying which may have the best supporting evidence.

Although the PAMF is designed to specifically aid PA messaging, there may be parallels and overlaps with other sub-types of PA communication, or approaches that rely heavily on communication, such as public lectures, counselling, or advocacy (Milton et al., 2020). We encourage the use of principles from the PAMF in other types of PA communication where appropriate and useful.

Using the PAMF and PAMC to evaluate messages

The PAMF and PAMC may also assist with the evaluation of PA messages (see Table 8-2). In formative evaluation, the framework and checklist may aid in planning research with the target audience to help understand the need for messages in that group and inform the development of new messages. As highlighted throughout, concepts from the framework may be used to guide development of data collection methods in qualitative or quantitative research (e.g., focus group topic guides or questionnaires) exploring messaging preferences. The framework and checklist themselves are not tools to conduct process or impact/outcome evaluation of messages

but may help identify important indicators of message success and therefore aid in the development and planning of process and impact/outcome evaluation.

TABLE 8-2: TYPES OF EVALUATION

Evaluation type	Working definitions (adapted from Bauman & Nutbeam, 2014) (Nutbeam & Bauman, 2014)
Formative evaluation of physical activity messaging	Gathering data to help inform message development and to assess whether the message is needed, appropriate and acceptable before it is implemented. (e.g., using focus groups to test alternate messages, and establish messaging preferences).
Process evaluation of physical activity messages	Establishing whether or not the message was delivered as intended (e.g., what was the message reach? Was the message delivered successfully to the intended target audience, at the correct time, in the desired setting?)
Impact/Outcome evaluation of physical activity messages	Establishing whether or not the message produced changes in the desired indicators (e.g., did the message bring about changes in awareness, attitudes, or physical activity behaviour?)

Using the PAMF and PAMC to understand and classify messages

Using the framework and checklist as classification tools may be useful in a range of scenarios. The framework and checklist may be useful in retrospectively classifying and comparing existing messages to understand the features included. This may assist in identifying concepts that were not considered, highlighting which messaging concepts are most important and providing direction for future research. For example, if two existing mass media campaigns both aimed at the same target audience had varying levels of success in improving perceptions towards PA, we may use the checklist to deconstruct and classify included messages to identify effective components.

Similarly, the PAMF and PAMC may be used to classify or compare messages regarding various elements or formats of national or international PA guidelines. For example, messages comparing various formats of the aerobic guidelines (150 minutes per week, 2.5 hours per week or 30 minutes 5 times per week), or messages highlighting the aerobic guidelines versus those highlighting strength and balance guidelines. Another scenario may be using the checklist to categorise different messages included in a systematic review of PA messaging or in an existing mass media campaign. The use of the PAMF and PAMC as classification tools may also help improve quality of message reporting going forward, ultimately enhancing the messaging evidence base.

Potential benefits of framework and checklist

Overall, the PAMF and PAMC aim to harmonise and enhance the area of PA messaging. Specifically, we propose that the framework and checklist may have five potential benefits. First, they provide an illustration of important and common PA messaging concepts that could be considered when creating, evaluating or categorising PA messages. Second, they may standardise and facilitate our understanding and use of key PA messaging terminologies and concepts. Third, they encourage engagement with target audiences and the use of relevant theory and existing evidence in message development. Fourth, they aim to address the often missing step of stating and understanding working pathways in the process of messaging in PA behaviour change and designing and evaluating messages accordingly. Finally, the PAMC provides a translational checklist tool that can be used by

academics, practitioners, and any other relevant stakeholders to develop and evaluate PA messages.

Future directions

For all different uses, the level of engagement with PAMF and PAMC will vary based on available resources. It is highly plausible in applied scenarios (beyond academic settings) that rapid message creation or evaluation is needed. In such situations, perhaps the PAMF and PAMC will only provide “top level” guidance. Exploring how to facilitate this is a key priority moving forward.

Improving functionality and usefulness of the PAMF and PAMC for various groups of users are also key future directions. Developing an online interactive tool may be helpful in improving usefulness of the PAMF and PAMC for different groups of users and make documenting the messaging process more comprehensible. Making training available to facilitate the adoption and uptake of the PAMF and PAMC may also be a useful future direction.

The PAMF and PAMC presented in this article have consensus from a group of international experts, but may evolve further, along with the working definitions of included concepts. Similar to the evolution of existing reporting guidelines (e.g. PRISMA (Moher et al., 2009) and CONSORT (Schulz et al., 2010)), the PAMF and PAMC will be revised based on their use in applied settings and future examination in academic study. Furthermore, although the PAMF and PAMC were developed with input from a multidisciplinary

panel, it may need terminology adaptation in cross-disciplinary settings, for example in media disciplines.

Future research may retrospectively evaluate messages to illuminate important or effective concepts or test the effectiveness of messages created using the PAMF/PAMC (versus those created not using the PAMF or control messages) in different trial designs. Furthermore, global and national PA guidelines now also include reference to reducing sedentary behaviour. Indeed, recent 24-hour movement guidelines for Canadian adults have faced a new challenge of creating messages not only for PA guidelines, but for integrated guidelines that cover sleep, sedentary behaviour and PA (Faught et al., 2020). Future research may therefore also explore the applicability of the PAMF in creating and guiding evaluation of messages focusing on related health behaviours such as sedentary behaviour and sleep either combined with PA messages or independently.

Conclusion

Effective PA messaging plays an important role in the pathway towards changing PA behaviour at a population level. In this article we have described the outputs of a recent modified Delphi study, the Physical Activity Messaging Framework and Checklist, and discuss how they can be used to create new messages, plan message evaluation, and help understand and categorise existing messages. If used consistently, we propose that the framework and checklist have potential to improve PA messaging practice by encouraging evidence-based and target population-focused messages.

Further, this framework and checklist could augment PA messaging research by improving quality of reporting, harmonising messaging terminologies and aiding collation and synthesis of evidence.

Post-amble

This chapter has presented the user guide and consensus statement resulting from the modified Delphi study described in the previous chapter (Chapter 7). Following publication of the articles presented in Chapters 7 and 8, I have reflected on my use of the terms “formative evaluation” and “co-production”, and the way in which it could be seen that I use them almost interchangeably at times despite acknowledging their distinct definitions. The term co-production was included in the PAMF and PAMC following feedback from expert Delphi panel members (in study 2, Chapter 7) who had non-academic roles that suggested this was a term they were more familiar with than formative evaluation. With an appreciation that both co-production and formative evaluation feature involvement of and learning from the target audience in the process of message development, both terms were included in the PAMF and PAMC.

However, co-production as a concept is gaining increasing interest in academic and research settings, including in the field of PA for health. A recently published resource to guide co-producing research in sport, exercise, and health sciences highlights that traditionally, research in our field has involved conducting work on participants, or explaining their experiences for them, but that a shift is occurring with calls in our field for a

“participatory turn” that will see research in our field conducted with or by non-academic collaborators (Smith et al., 2022). The issue of other types of research being incorrectly labelled as co-production and how they may lead to co-production becoming a “meaningless buzzword” has also been raised (Williams et al., 2021). The recently developed resource presents a typology of co-production which includes three key types: (1) citizens’ contributions to public services, (2) integrated knowledge translation, and (3) equitable and experientially-informed research (Smith et al., 2022). This evolving understanding and conceptualisation of co-production in our field has enabled me to understand that although formative evaluation and co-production may overlap, these are not interchangeable processes or terms. Going forward, research progressing from this thesis will seek to utilise these terms carefully, and future PA messaging research should appreciate the differences in these approaches when applying the PAMF and PAMC.

In terms of next steps, several future directions for the PAMF and PAMC were identified in this chapter and in the previous chapter. This once again provided several potential focuses for the third and final study of this PhD, as detailed in the ‘future directions’ section of the published article above. In line with the overarching thesis aim of contributing towards improving PA messaging practice, one approach that I felt was a logical next step was to ‘test’ the PAMF and PAMC in a real-world setting. This would address more than one of the outlined future directions for the PAMF and PAMC by identifying ways of improving their usefulness and functionality, as well as exploring how to facilitate various ‘levels’ of use of the PAMF and

PAMC. This was key justification for guiding study 3, which is detailed in the following chapter (Chapter 9).

Chapter 9 Formative evaluation: Using the Physical Activity Messaging Framework to investigate physical activity messaging preferences in new mothers

Chapter overview

This chapter contains work relating to the third and final study of the thesis: a qualitative investigation into PA messaging preferences in new mothers. For consistency with previous chapters, the study is presented here in a journal format (Introduction, Methods, Results and Discussion), preceded by a brief preamble, and followed by a post-amble to provide further context and rationale. This study has not yet been submitted for publication. Overall, this chapter aims to provide targeted PA messaging recommendations for a population subgroup, as well as reflect on the use of the PAMF and PAMC in formative evaluation to aid message development.

Preamble

The work presented in this thesis so far highlights a need for improved PA messaging practice. As outlined in the postamble of Chapter 8, a clear next step following gaining expert consensus on the PAMF and PAMC was to test their ability to aid generation of messaging recommendations. This next step could be achieved through a proof of concept or feasibility study. Furthermore, the developed PAMF and PAMC emphasise the importance of formative evaluation and co-production with the target audience in PA message development. Therefore, for the final study of this PhD I sought to conduct formative evaluation to investigate PA messaging preferences in a specific population subgroup to develop targeted PA messaging

recommendations in a proof-of-concept study. Not only could such a study provide targeted messaging recommendations, but it could also provide me with insights into how the PAMF and PAMC can be used in practice.

However, due to the Covid-19 pandemic, there were limitations on the types of research that could be safely conducted, meaning any planned research must be conducted remotely. Furthermore, there was no additional funding and limited time remaining in this PhD. Thus, given these constraints on time and other resources, the best available option to proceed with this study was to use the PAMF and PAMC to conduct formative evaluation in collaboration with the Northumbria Healthcare Trust (England, UK).

Collaborators involved in an 'Active Hospital' pilot site contacted me following presentation of the PAMF at an ISPAH webinar in February 2021. As part of their ongoing work, the Trust were looking to improve their messaging practice, particularly relating to PA messaging for women on the maternal pathway. I therefore seized this timely opportunity to collaborate with these practitioners in the following study.

Study in journal format

Abstract

Introduction: Physical activity (PA) messaging plays an important role in the pathway towards changing PA behaviour at a population level and improving practice in this area is of global interest. This study aimed to apply the newly developed Physical Activity Messaging Framework (PAMF) and

Checklist (PAMC) in a real-world setting to develop messaging recommendations for the specific target subgroup of postpartum women.

Methods: In this formative research study, one-to-one telephone interviews were conducted with seven new mothers from North Tyneside and Northumberland (mean age 33.6 years). The interview schedule sections aligned with sections of the PAMF: message aim and pathway, message content, and message format and delivery. Interviews were audio recorded and transcribed verbatim. Framework analysis (a form of thematic analysis) was carried out to identify trends, similarities, and differences in the data.

Results: Key findings related to the three overarching sections of the PAMF. Relating to section 1 of the PAMF, this study identified important potential aims and working pathways for messages to this group, such as reducing barriers to PA and educating new mums on benefits of PA. Relating to section 2 of the PAMF, principal findings included that tone and language used in messages should be empathetic and reassuring (as opposed to forceful), and that messages should be positive and gain framed. Specifically, new mums value the social and acute mental health benefits of PA, such as connecting with other mums and relaxing. This study also demonstrated the importance of using realistic and inclusive images in PA messages targeted to new mums. Furthermore, results showed that new mums may find the 150-minute PA guideline unachievable, with a preference for shorter bouts of PA and clear, practical advice on how to be active. Finally, relating to section 3 of the PAMF, social media was identified as an

important delivery platform for new mums, and healthcare providers were identified as important messengers.

Conclusion: This is the first study that has used the new PAMF and PAMC to develop PA messaging recommendations. The PAMF and PAMC were used to inform data collection, data analysis and organisation of findings, and led to generation of several key findings. Numerous findings relating to message aim and pathway, message content, and message format and delivery were identified, and specific targeted PA messaging recommendations for new mums were provided. Future research should apply the PAMF and PAMC to explore different ways they can be used to aid message development, such as the use of quantitative surveys, as well as to investigate messaging preferences in other populations.

Introduction

Physical inactivity is a key contributor to the global non-communicable disease burden (Lee et al., 2012) and improving population physical activity (PA) levels will reduce mortality rates (Strain, Brage, et al., 2020; Strain, Wijndaele, et al., 2020). Global trends show that females are less active than their male counterparts, with 23.4% and 31.7% inactivity in males and females, respectively (Guthold et al., 2018). PA trends in the maternal pathway are particularly concerning, with evidence to suggest PA levels decline during pregnancy (Evenson et al., 2009; Kieffer et al., 2002) and remain low during the postpartum period (Blum et al., 2004). Improving PA in both pregnant and postpartum women is important for various reasons. A

recent umbrella review concluded that there is strong evidence to suggest moderate-intensity PA does not only reduce the risk of excessive gestational weight gain, gestational diabetes, but also symptoms of postpartum depression (Dipietro et al., 2019).

In addition to environmental barriers such as lack of access to affordable and appropriate activities, qualitative research has identified several personal barriers that may contribute to low PA levels in postpartum women, such as lack of motivation and confidence (Saligheh et al., 2016). Such factors may be targeted by communication approaches.

Effective PA communication plays an important role in the pathway towards changing PA behaviour at a population level by targeting individual and social factors related to PA. PA communication is an area of rapidly increasing interest in PA research, and the importance of such approaches are reflected in the GAPPA (2018-2030) (World Health Organization, 2018) and the ISPAH Eight Best Investments that work for Physical Activity (PA) (ISPAH, 2020). Moreover, specific PA evidence for pregnant and postpartum women was considered and guidance for these groups presented in the UK CMO 2019 PA guidelines for health (Department of Health & Social Care, 2019). Therefore, understanding how best to communicate PA information, such as PA guidelines and related information, with women in the maternal pathway is important to aid dissemination of such guidance.

Communication based interventions have been previously conducted in postpartum women and have demonstrated some promising effects. The

efficacy and feasibility of 'MobileMums' (a theory-based PA intervention delivered to postnatal women through mobile or SMS) was tested in a randomised controlled trial with 88 women (Fjeldsoe et al., 2010). The 12-week intervention included face-to-face PA goal-setting consultations as well as three to five tailored text messages a week targeting constructs of social cognitive theory. Results showed that the intervention significantly increased PA frequency by 1.82 days per week by 13 weeks, and walking for exercise frequency was increased by 1.08 days per weeks by 13 weeks (Fjeldsoe et al., 2010) and that effects were mediated by changes in SCT constructs, namely goal-setting and barrier self-efficacy (Fjeldsoe et al., 2013). Another study involved a process evaluation of a 12-month counselling intervention (delivered to healthy inactive mothers) comprising regular telephone counselling calls to discuss participants' barriers to being active and achievement of specific PA goals (Albright et al., 2015). This study demonstrated that telephone counselling can somewhat facilitate reducing barriers to PA and achievement of MVPA goals.

A further communication approach that has not yet been explored in postpartum women is PA messaging. We have previously defined PA messaging as "the overall process of creating and delivering PA messages", with a PA message referring to "educational or persuasive materials to be relayed to a specific individual or group with the aim of ultimately increasing PA levels" (Williamson et al., 2020). Compared with other communication approaches such as one-to-one counselling, PA messaging is a cost-effective solution with potential to reach a larger number of people at a

comparatively lower cost. Our recent scoping review of PA messaging (study 1, Chapter 5) found some evidence relating to message content and delivery in women on the maternal pathway, but this evidence only existing in pregnant women, with no specific evidence for postpartum women. Furthermore, the scoping review identified multiple specific research gaps relating to PA messaging preferences in this group, including the use of framing, the use of tailoring or targeting, preferences for mode of delivery, message provider and frequency and dose (Williamson et al., 2020). Therefore, further research to explore PA messaging preferences in postpartum women is required.

Existing literature has noted that research exploring maternal beliefs, barriers and enablers to PA in postpartum women has lacked qualitative, open ended data collection methods (Saligheh et al., 2016). For example, although Evenson et al., integrated qualitative approaches, only two of the questions asked were open-ended, potentially limiting depth of data collected (Evenson et al., 2009). Therefore, a need for research into PA messaging preferences in postpartum women specifically using open-ended qualitative methods is warranted.

A Physical Activity Messaging Framework (PAMF) and Checklist (PAMC) recently gained international expert consensus through a modified Delphi study (Williamson et al., 2021) (Chapter 7). Key next steps identified as part of this modified Delphi study included utilising the PAMF and PAMC to conduct research to develop recommendations for specific messaging

concepts in specific population subgroups and context (Williamson et al., 2021), and the accompanying user guide outlined the importance of exploring the use of the PAMF and PAMC in practice to guide message development through, for example, formative evaluation (Williamson et al., 2021).

Aims

This study therefore aims to develop targeted messaging recommendations for postpartum women using the PAMF and PAMC. To achieve this aim, this study will address the following objectives, guided by the three overarching sections of the PAMF and PAMC:

- Relating to section 1 of the framework: explore awareness of PA guidelines, perceptions of physical activity and potential PA message pathways
- Relating to section 2 of the framework: explore preferences for PA message content
- Relating to section 3 of the framework: explore preferences for PA message format, and delivery

Methods

Ethics

Ethical approval was obtained from Moray House School of Education and Sport Ethics Sub-Committee on 19th May 2021 (Ref: CWIL12052021) prior to the study commencing (see Appendix 4).

Participants

This study involved working alongside collaborators from the Northumberland Active Hospital Pilot trust. Participants were new mothers residing in Northumbria or North Tyneside who had given birth shortly before or during the Covid-19 pandemic (up to 24 months post-partum from commencement of study in May 2021).

Study design

Formative evaluation is a recommended step in developing PA messages, as guided by the PAMF and PAMC (Williamson et al., 2021), and is acknowledged as a fundamental method for gaining target audience feedback in the early stages of developing interventions (Nutbeam & Bauman, 2014). To gather in-depth insights into PA messaging preferences of new mothers, a qualitative data collection approach was used over a quantitative approach. Specifically, one-to-one interviews were conducted to facilitate collection of rich, detailed data (Clarke et al., 2015, p. 229). Interviews were conducted remotely (via telephone) as this was deemed the most suitable option given the ongoing Covid-19 pandemic. Interviews were chosen as opposed to other qualitative data collection methods such as focus groups to limit social desirability bias (Gallagher et al., 1993), enabling new mothers to openly share their thoughts and feelings without the presence of other mums. Furthermore, one-to-one interviews were able to be conducted via telephone, whereas focus groups would have required use of an online platform, such as Zoom or Microsoft Teams, that some potential

participants may not have had access to. One-to-one interviews were therefore also a more inclusive option.

Sample size

Unlike in quantitative approaches, there is no 'power calculation' to determine the required sample sizes in qualitative research (Malterud et al., 2016). As a result, researchers often demonstrate poor transparency regarding sample sizes and justifications for them (Carlsen & Glenton, 2011). A concept that is commonly (and arguably wrongly) used to justify sample size is data saturation. This concept, coined by Glaser and Strauss (1999), refers to the idea that at some point the addition of further participants beyond a certain number does not contribute anything new to the analysis. However, this concept was developed as part of Grounded Theory in which sample size is appraised as an element of the ongoing analysis (Glaser & Strauss, 1999), and is therefore not suitable for other analysis types (Malterud et al., 2016).

Malterud et al., (2016) published a pragmatic model for the assessment of sample size in qualitative studies in an attempt to make qualitative research methods more robust and defensible. They proposed the concept of information power; "the larger information power the sample holds, the lower N is needed, and vice versa" (Malterud et al., 2016, p. 1754). There are five key items that impact information power: (1) the study aim, (2) sample specificity, (3) use of established theory, (4) quality of dialogue, and (5) analysis strategy. The impact of these five items and subsequent considerations for the current study are summarised in Table 9-1.

TABLE 9-1: ITEMS IMPACTING INFORMATION POWER AND SAMPLE SIZE IN QUALITATIVE RESEARCH

Item impacting information power	Implications for sample size	Considerations for current study
Study aim	A broad study aim requires a larger sample size than a narrow aim.	The aims and objectives of the current study are narrow, focusing on applying the PAMF and PAMC to investigate PA messaging preferences in specific population subgroup.
Sample Specificity	A less extensive sample is needed where participants hold characteristics that are highly specific for the study aim.	The participants of this study hold characteristics that are highly specific for the study aim, as this study aims to develop targeted messages in line with the needs of the stakeholder, therefore participants must be from the same specified audience segment (new mothers residing in the Northumbria Healthcare Trust area).
Use of established theory	A study supported by limited theory requires a larger sample size.	The study is supported by (and structured around) theory in the form of the evidence- and theory-based PAMF and PAMC.
Quality of dialogue	A study with strong and clear communication between researcher and participant requires a smaller sample size.	The communication between researcher and participant will be strong and clear given the researcher's experience in the topic area and qualitative data collection.
Analysis strategy	Exploratory cross-case analysis requires more participants compared with a project aiming for in-depth analysis of narratives or discourse details from a few selected participants.	Analysis will examine individual cases as well as looking across cases to identify patterns relevant for the study objectives.

Items within table summarised from Malterud et al., 2016.

Considering the five items outlined in Table 9-1 in the context of the current study, a smaller sample size allowed the study aims to be appropriately addressed. Also supporting the decision to recruit a smaller sample size is the fact that this was a final PhD study with limited time available, aiming to demonstrate rapid use of the PAMF and PAMC. Clarke, Braun and Hayfield recommend a sample size of 5-10 for 'small' projects 6-15 for 'medium' projects and 15-20 for 'large' projects using thematic analysis approaches (Clarke et al., 2015, pp. 228-229). Given the size of studies 1 and 2, it is appropriate to class this study (study 3) as a small project. Taking all of this into account, a target sample size of 5-10 participants was established. Malterud et al., (2016) suggest that appraisal of information power should be repeated along the process and supported by preliminary analysis. Therefore, this target sample size of 5-10 was iterative and reviewed as data collection and analysis were ongoing.

Recruitment, data collection and handling

A study advertisement (Appendix 5) was developed for our collaborators at Northumbria Healthcare Trust who then shared through appropriate social media channels. The advertisement requested that interested individuals contact the lead researcher via email. A short survey including participant information sheet, informed consent and basic demographic questions was then shared via Qualtrics with individuals who registered interest in taking part via email (Appendix 6). Following receipt of informed consent and demographic information, eligible participants were

contacted via email to arrange a time and date to conduct a one-to-one interview.

One-to-one telephone interviews were conducted throughout August 2021. Telephone interviews were conducted on loudspeaker in a private space and recorded using a Dictaphone. Interview recordings were transcribed verbatim with all participant names omitted and replaced with pseudonyms. Interview recordings, transcripts, the framework matrix, participant consent forms and demographic data were stored on the secure University of Edinburgh OneDrive.

Interviews

The interview schedule was structured around the study aims and objectives (and thus the PAMF). Pilot testing of the interview schedule was conducted with two individuals: one academic and one non-academic. Subsequent amendments were made to improve clarity and further prompts added where required prior to commencement of interviews.

The interview schedule comprised three overarching sections, each correlating with study objectives and overarching sections of the PAMF: (1) exploring PA perceptions, guideline awareness, and potential message pathways, (2) exploring preferences for message content, and (3) exploring preferences for message format and delivery.

Each section of the interview aimed to explore the various concepts within the corresponding section of the PAMF. Section 1 aimed to explore information relating to the message context, aim and potential working

pathways. Section 2 aimed to explore preferences for information types to be included in messages, preferences for framing and targeting of this information, and preferences for language and tone. Finally, section 3 aimed to explore preferences for how the information is presented, preferred delivery modes or channels, volume or length, provider, or messenger, setting and messaged frequency and dose.

Each question aligned with or aimed to address one or more concepts within the PAMF. For example, the PAMF concept relating to message pathway (*by which pathway(s) will the message bring about change in the outcomes?*) was addressed using the question “How do you think a physical activity message might aid in changing your behaviour?”. The interview schedule sections and how they align with study objectives are displayed in Table 9-2, and the full interview schedule can be found in Appendix 7.

TABLE 9-2: LINKS BETWEEN STUDY OBJECTIVES AND INTERVIEW SCHEDULE SECTIONS

Study objective	Relevant interview section(s) - <i>Example questions</i>
Explore awareness of PA guidelines, perceptions of PA and potential PA message pathways	Section 1: Exploring physical activity perceptions, guideline awareness, and potential message pathways - <i>Can you please tell me what physical activity means to you?</i> - <i>What do you know about the physical activity guidelines for health?</i> - <i>How do you think a physical activity message might aid in changing your behaviour?</i> - <i>Are there any key barriers you face to being active?</i> - <i>Do you think a physical activity message could help address some of these barriers?</i>
Explore preferences for physical activity message content	Section 2: Message content - <i>What type of information would you like to see in a message?</i> - <i>What would make a message more relatable or relevant to you?</i>
Explore preferences for physical activity message format and delivery	Section 3: Message format and delivery - <i>What media or mode would you like to see physical activity messages in?</i> - <i>Who would be your preferred source or messenger?</i>

Data analysis

Qualitative data from interviews were analysed using the Framework Method (Ritchie & Lewis, 2003) as this was the approach to thematic analysis considered most appropriate for the research aims and objectives (Braun et al., 2019). The Framework Method is a type of codebook thematic analysis; a school of thematic analyses that uses a structured approach to coding with the broadly qualitative underlying philosophy of more traditional reflexive thematic analysis (Braun et al., 2019). This more structured approach was relevant in this study as we sought to analyse the data within

three pre-determined categories that aligned with the study objectives and interview sections (as outlined in Table 9-2).

Specifically, the Framework Method involves the use of a coding framework or matrix that evolves as the analysis process progresses. The Framework Method provides a systematic model for organising and mapping qualitative data (Gale et al., 2013). The Framework Method is particularly useful for analysis of interview data where the researcher aims to generate themes by making comparisons within and between cases (in this case, individual interviews), whilst also maintaining context of each piece of data by retaining the connection to other aspects of each participant's account (Gale et al., 2013). The seven steps of the Framework Method of thematic analysis, as guided by Gale et al (2013), were followed and are outlined below. All steps of Framework analysis were conducted by the lead researcher (CW).

1. Transcription

Interviews were audio recorded and transcribed verbatim.

2. Familiarisation with the data

Interview recordings were listened to again and transcripts were re-read.

Notes taken during interviews were also revisited to allow familiarisation with the data.

3. Coding

During this stage, transcripts were printed, read line by line, and paraphrases or labels (codes) were applied to describe what was interpreted as important within each passage. The study was both inductive and deductive at this

stage. The inductive element involved open coding, or coding of anything that might be relevant within each of the pre-determined categories. The deductive element involved searching for elements of the PAMF within the transcripts. Codes were highlighted in different colours depending on which pre-determined category they related to. An 'other' category was also created so that data not clearly aligning with other themes within the pre-determined categories were not overlooked. The coding at this stage aimed to classify the data so that each interview transcript could be compared systematically with the others.

4. Developing a working analytical framework

After the first two (of seven) transcripts had been coded, all codes were reviewed and added to a working analytical framework. The analytical framework was structured by pre-determined category and by participant/transcript number.

5. Applying the analytical framework

The codes included within the analytical framework were then applied to (or searched for in) all subsequent transcripts, with new codes being highlighted and added to the analytical framework as they were being discovered. The analytical framework was therefore not complete until all transcripts had been coded.

6. Charting data into the framework matrix

An Excel spreadsheet was used to generate a matrix based on the analytical framework. The matrix included all codes, grouped by pre-determined

categories, as well as illustrative and interesting quotations from the transcripts.

7. Interpreting the data

The groups of codes were refined to form themes and, in some cases, sub-themes within each of the pre-determined categories. The organisation of the framework matrix allowed for trends, similarities, and differences in the data to be observed. For example, it became clear where the same theme was identified across multiple interview transcripts.

Results

Participants

A total of 11 potential participants provided informed consent and demographic data via the Qualtrics survey. All 11 potential participants were emailed to request an interview. Of these 11, nine responded and agreed to take part in an interview. Of these nine, seven participants took part in interviews. The final sample of seven participants comprised new mothers residing in Northumbria or North Tyneside (up to 24 months post-partum from commencement of study in May 2021) with a mean age of 33.6 years (range 31 to 40 years). Participants were 100% White (85% identified as English, Welsh, Scottish, Northern Irish or British, 15% identified as Irish). Participants were from two areas of residence, North Tyneside (42%) and Northumberland (58%). The majority (85%) of participants had only one child, and the other 15% had two children. The number of months since their most recent child ranged from one to 12 months, with an average of 4.8 months.

Narrative summary of findings

Study findings from the Framework Analysis are presented below organised by each of the three pre-determined categories (aligning with the study objectives and sections of the PAMF). All themes and subthemes are presented in tables in each section, however only principal themes and subthemes are reported in the narrative summary, including those that appeared across multiple interview transcripts and those most relevant to the study aims. The full Framework Analysis matrix (including themes, sub-themes, and codes) can be found in Appendix 8.

Section 1: Explore awareness of PA guidelines, perceptions of PA and potential PA message pathways

Overview of themes

In this section, 11 themes and 31 sub-themes were identified. All themes and sub-themes are displayed in Table 9-3, with key themes described in the following narrative summary.

TABLE 9-3: SECTION 1 THEMES AND SUBTHEMES

Themes	Subthemes
Perceptions of PA and PA messaging	<ul style="list-style-type: none"> • Perceptions about their own PA behaviour • Perceptions about what 'counts' as PA • Perception that they would not respond to a point of decision prompt • Perception that changing behaviour is difficult • Perception that previous communications have not been helpful
Experiences of mental health benefits of PA	<ul style="list-style-type: none"> • Baby classes present an opportunity to socialise with other mums • General positive mental health experiences
The way in which new mums are physically active/types of PA	<ul style="list-style-type: none"> • Walking is a key form of PA • Participation in a range of PAs
Changes to PA behaviour since becoming a new mum	<ul style="list-style-type: none"> • PA decreased following birth of baby • PA has become more difficult/physical abilities have changed • PA types have shifted since giving birth
Effect of COVID-19 pandemic on new mums	<ul style="list-style-type: none"> • Effects of pandemic on PA behaviour • Psychological effects of pandemic on new mums • Pandemic caused concerns around children not socialising
Barriers to PA in new mums	<ul style="list-style-type: none"> • Personal barriers • Social barriers • Environmental barriers • Helping overcome barriers as a pathway
Awareness/perceptions of PA guidelines for health	<ul style="list-style-type: none"> • Unable to recall current PA guideline (150 minutes) • Aware of some elements of guidelines (current or previous versions)
Having support from family and friends facilitates PA	No subthemes for this theme

Persuasion¹⁸ as a potential pathway	<ul style="list-style-type: none"> • Relatedness or connectivity to a message • Encouraging 'taking stock' as pathway • Prompts, nudges • Inducing feelings of guilt • Changing mindset • Encouraging creation of habits/routine • Providing a purpose
Education¹⁹ as a potential pathway	<ul style="list-style-type: none"> • Knowledge does not equal behaviour • Balance between education and patronisation • Understanding benefits of PA may be a pathway to behaviour change
Different types of PA may have different useful pathways	No subthemes for this theme

Perceptions of physical activity, awareness of guidelines and the way in which new mums are active

Participants generally perceived themselves as physically active, with some expressing that PA is important to them, for example, Charlotte stated that she “needs PA in [her] life” and that it is “key to [her] being”. Most participants were aware that incidental PA ‘counts’, for example, Sophie explained that “cleaning’s probably one of the biggest physical things [she does] it’s not actually intentional exercise it’s just things that have to be done”. Other examples of incidental PA that participants believe ‘count’ towards overall PA include “spending a day in the garden” (Charlotte), “taking the stairs instead of the lift” (Suzanne), and “running about after your kids” (Amy). In addition to the perception that incidental PA counts, some mums

¹⁸ Persuasion defined as “using communication to induce positive or negative feelings or stimulate action” (Michie et al., 2011)

¹⁹ Education defined as “increasing knowledge or understanding” (Michie et al., 2011)

also expressed beliefs that PA is about raising heart rate, trying to keep healthy and fit and moving your body with a purpose.

Relating to PA perceptions, 'awareness/perceptions of PA guidelines for health' was also an identified theme. No participants believed that they knew what the UK PA guidelines for health were. However, there were indications of knowledge of previous guidelines (such as the 30 minutes 5 times a week guidelines). For example, "is it something like an activity that raises your heart rate five times a week for at least half an hour?" (Jade). Some participants also expressed the belief that guidelines encourage daily PA.

Within the theme of 'the way in which new mums are physically active', an important finding was that new mums consistently reported walking as a key form of PA. Also relating to walking, within the theme of "changes to PA behaviour since becoming a new mum", many participants reported a shift from gym-based PA to PA that could be undertaken outdoors and including the baby, such as walking (either carrying baby or with baby in buggy).

Experiences of mental health benefits of PA

A further theme that was identified when exploring PA perceptions was 'experiences of mental health benefits of PA'. This theme captured insights into participants' views on how PA benefits their mental health. Jade explained that "it's nice to get out and get some fresh air... I find it clears my mind as well. I find it relaxing." Other participants agreed with this, with

Charlotte stating that PA “really does help [her mind]” and Sophie describing walking the dog as “very therapeutic”.

Effects of the COVID-19 pandemic on new mums

New mums consistently reported that the pandemic took away PA opportunities and changed their frame of mind about gym environments: “and [going to classes] might begin to be on the cards again but I probably won’t do it just do be on the safe side” (Jennifer). Psychological effects of the pandemic on new mums were also identified, with mums reporting negative experiences of being a new mum and feelings of loneliness or isolation.

“You know there was no place to even kind of go for a walk and sit and have a coffee when you got there, there was no groups to go to, and so that was difficult in general mental health wise. Nobody was able to come round, I wasn’t able to go round to anybody else’s. I found myself at one point like loitering around the fruit and veg aisle in ASDA hoping for somebody just to talk to, just for a bit of adult conversation.” (Sophie).

Barriers to PA in new mums

Within the theme “barriers to PA in new mums”, insights into aspects that make PA more difficult for new mums were identified, relating to personal, social and environmental factors. The most consistently identified barriers were being busy and having lack of time, as well as having difficulty scheduling/planning PA due to meeting the baby’s needs. Jennifer explained that the main thing is “finding the time to able to sort of fit it in” and described

“not knowing when [she’s] going to have the opportunity”. Suzanne echoed this when she explained that her baby “feeds on demand” and so she “[hasn’t] gotten to the point where [she’s] felt confident that [she] could go and leave her and go do like an exercise class”. Reduced income on maternity pay was also identified as a key barrier: “I suppose it’s got a bit of a financial thing as well in the sense that I’m on maternity leave and I’m not getting paid as much... I’m thinking, can I afford it on maternity leave, and will I make the most of it?” (Rachel). Other barriers identified included the need to recover or being in physical pain, fatigue, being embarrassed, and lack of childcare. Furthermore, helping overcome some of these barriers, such as cost and time, was identified as a potential message pathway.

Persuasion as a pathway

Within the theme of persuasion as a pathway, seven subthemes relating to different potential pathways were identified all relating to the definition of persuasion provided by Michie et al. relating to the BCW (Michie et al., 2011, p. 7). The most consistently identified potential psychological pathway was ‘giving someone a purpose/challenge/goal’. For example, Charlotte suggested that charity challenges can “inspire people” and lead to them “having a purpose”. Sophie described a potential pathway in “[giving] us a goal and something to work on and achieve”, and Jade supported this by saying “it’s something to aim for”. Conversely, new mums suggested that making someone feel guilty or like they aren’t doing enough is not a helpful pathway. Charlotte stated that she thinks “making people feel like they’re not doing enough is a really dangerous thing” and Suzanne expressed that she

is “someone who would start to feel really guilty when [she’s] not active, so negative messages would make [her] feel worse”.

Other potential pathways identified included helping change mind-set, encouraging ‘taking stock’ of current PA behaviour, relating or connecting to a message, prompts or nudges, and aiding creation of habits or routine.

Education as a pathway

Within this theme, three subthemes were identified that demonstrated education (as described by Michie et al. 2011 and relating to the BCW) as a potential messaging pathway. A few participants described that being educated on the benefits of PA could be a potential pathway. For example, Sophie explained that she thinks a lot of people are not “informed”, and that many might not know that “quite a small amount of exercise can have such a big effect”. However, despite education being identified as a pathway, some mums did express the opinion that knowledge (a potential outcome of education) does not necessarily translate to behaviour. For example, Charlotte stated “I’m not sure a message saying you should exercise 5 time a week motivates anybody to do it”.

Section 1 findings overview

To summarise, new mums perceive themselves as physically active and feel PA is important to them, particularly in relation to mental health, but knowledge of PA guidelines in new mums is low. New mums face several barriers to being active including not having the flexibility or time to be apart from their baby. Reducing such barriers was identified as potential working

pathways for messages, as well as pathways relating to persuasion and education.

Section 2: Exploring preferences for physical activity message content

Overview of themes

Seven themes and 32 subthemes were identified within the pre-determined category of exploring preferences for PA message content. All themes and subthemes are displayed in Table 9-4, with key themes discussed in the following narrative summary.

TABLE 9-4: SECTION 2 THEMES AND SUBTHEMES

Themes	Subthemes
Impact of language and tone	<ul style="list-style-type: none"> • Use of forceful language • Use of lay-friendly language • Appearance-based language • Importance of empathetic tones • Different individuals respond differently to certain language • The use of reassuring language
Preferences for message framing	<ul style="list-style-type: none"> • Dislike toward loss-framed messages • Preference for gain-framed or positive messages
Preferences for ‘why do it’ information	<ul style="list-style-type: none"> • Physical health benefits • Mental health benefits • Social health benefits • Environmental benefits • Other benefits
Preferences for ‘what to do’ information	<ul style="list-style-type: none"> • Perception that information on what exercises a new mum should do is missing • Different PA appeals to different people • Perception that there should be greater focus on post-birth recovery exercises • Support for “every little helps” type messages • Desire for clear guidance • Bite sized PA appealing • Prefer to make up guidelines how they want • Preferences for guideline format in messages • Usefulness of numerical element
Preferences for ‘how, when, where to do it’ information	<ul style="list-style-type: none"> • Interest in opportunities that include baby • Want for clear advice on how/where to be active
Different people need different messages (importance of message targeting or tailoring)	<ul style="list-style-type: none"> • No subthemes for this theme
Other message content preferences	<ul style="list-style-type: none"> • Perception that mums already know what they ‘should’ be doing • Message should include focus on mum • Mixed messages can be confusing • Mums want to know what ‘counts’ • Different/multiple types of information useful • Preference for plain and simple/to the point messages • Message relatability

The impact of language and tone

A key subtheme here concerned the use of forceful language, namely that new mums felt negatively towards language like “should”, “must” or “need”: Charlotte suggested that “saying you *need* to be doing XYZ or you *should* be doing XYZ isn’t really helpful. It can really make people who might already be aware that there is an issue get depressed” and that new mums have a “list of 50 things you *must* do already, [they] don’t need anything else on it”. This view was also held by Amy who explained that messages should “keep it nice. None of the ‘oh you should be doing this or that’. It is really hard being a new mum and you’re finding your feet and you don’t need to be made to feel bad”. New mums also suggested that using a forceful tone in a message may have the opposite of the intended effect: “the more someone says you *should* do this it makes you not want to do it” (Rachel).

A preference for the use of lay-friendly language was identified across the transcripts. Specifically, new mums felt that messages should avoid scientific jargon and that the use of lay friendly language encourages inclusivity: “Something that’s understood by all different types of people like who are novices to experts of exercise, because then it’s opening the door to everybody” (Rachel). Furthermore, new mums consistently expressed the desire for empathetic tones and reassuring language. This was illustrated through the following quotes: “I feel like a message should tell you that if you’re doing anything as a new mum you’re doing pretty well” (Charlotte), and “specific messages say like you might not have a lot of time to yourself...

something that shows an understanding of the challenges I guess and how you can sort of offer solutions” (Jennifer).

Preferences for message framing

All mums demonstrated a preference towards positive or gain-framed messages, and a consistent dislike towards negative messages was identified: “I think people tend to go for the carrot rather than the stick” (Jennifer). Specifically, new mums found that positive messages produced more positive feelings and could motivate or encourage participation in PA: “I think ‘aw, that’s amazing, that makes me want to do that!’. Just a more positive language makes us want to participate” (Rachel). On the other hand, participants found that negative messages can feel condescending, “preachy” and like they are being “told off”: “I need to see something that seems fun and engaging rather than feeling like I’m getting a bit of a bollocking!” (Charlotte).

Preferences for ‘why do it’ information

New mums showed clear preferences for mental and social health benefits of PA in messages. Consistently, new mums demonstrated the desire to connect with other mums, expressed the importance of the social aspect of PA, and described how new mums offer each other social support and reassurance:

“I feel like something that all new mums do is cling onto other mums. Somebody who’s going through something similar to you. Because then if you’re in a group where, you know, whether it’s activity based

or whether you're just meeting for a coffee or whatever, you're in a group and you get that reassurance and stuff. You immediately get your support network and the ability to get reassurance from others just by the fact you're with other new mums" (Charlotte).

This quote is echoed by Suzanne: "Being a first-time mum... things are kind of new and it's a bit about that reassurance as well, like being reassured by speaking to other mums... helps you see you're not alone, and that it is hard". The link between social and mental health issues was also raised by participants: "I think for me [social health] links with mental health... because I think it is important to connect with other people" (Jennifer).

Participants also explained that they can struggle with mental health issues: "There's been days where I've felt like oh goodness I've really struggled today" (Suzanne), and that they feel the mental health benefits of PA are important: "I think it's much more appealing to think about the mental health benefits now... I think that the mental health aspect is the biggest appeal now" (Rachel). The acute mental health benefits of PA were also deemed important by new mums. Amy reported that PA makes her feel "happy" and that the fresh air "calms [her]", Jade explained that she does "relax massively when [she] exercises", and Rachel explained that "you don't get fitter after exercising once but you do feel better".

Other aspects of 'why do it' information identified by new mums included physical health benefits ("like heart and lifespan, that sort of thing" (Suzanne)), environmental benefits ("the environment – that would be one

that I would definitely want to read about” (Sophie)), and “getting back to the old you” (Charlotte).

Preferences for ‘what to do’ information

The most consistently reported finding relating to preferences for ‘what to do’ information was that 150-minute PA guidelines seem unattainable or unrealistic to new mums. Charlotte stated that “saying to them that you need to do 150 minutes a week for example is pointless because anyone’s just going to be like ‘have you met my child?!’”, and Jennifer explained that “as a new mum 150 minutes sounds like a lot... because of breastfeeding [she doesn’t] get that big of a block of time away from the baby and that might put [her off]”. Interestingly, however, new mums did consistently report that a numerical element in a message could be useful in providing a goal. Jade explained that she is “target driven” and that “having a number or something really helps [her]”, and Sophie described that “[she] thinks it would just give [her] a goal and something to work on and achieve... if [she] knew that walking 10,000 steps a day was going to be beneficial [she’d] think ‘right I’ve got 10,000 steps to do’”. Some mums suggested that 2 and a half hours or 30 minutes 5 times a week of PA seems more feasible or is easier to imagine than 150 minutes, and several mums expressed a preference for PA in bite sized chunks and making up the guidelines “how they want”:

“I don’t get [150 minutes] away from the baby. Whereas when you can do it in smaller chunks and you can kind of fit it around then I think it’s much more doable in my head. I think as well having [150 minutes]

away from the baby is quite daunting, whereas half an hour a day doesn't feel that bad" (Jennifer).

Some participants held the view that different PA appeals to different people (for example some new mums may prefer more gentle exercise suggestions). New mums also had the perception that everybody is capable of doing a little bit more or making small changes, and that a 'do what you can' type of message or a message promoting small changes would be acceptable: "So it should just be like do as little or as much as you can because it's going to have a positive impact anyway... it doesn't need to be making huge sacrifices, just making small changes" (Suzanne).

Preferences for 'how, when, where to do it' information

Within this theme, two subthemes were identified. Firstly, new mums consistently expressed a need or desire for PA opportunities that include their baby: "you need to be able to take the baby with you" (Charlotte), but that such opportunities are not widely advertised: "I just happen to be lucky that I've got friends that have babies... I know [for] a lot of people it hasn't been as easily available, or the information's not been there" (Jade) and "I don't know how anybody found out about it because it wasn't advertised anywhere" (Amy). Linked with this, participants consistently described a want for clear advice on how and where to be active. Jennifer explained that "[she] would like the really practical like where to go and what to do stuff", and Amy stated that if "[she] could actually see a thing that said what it was and where and when to meet up that would be good".

Different people need different messages

Highlighting the importance of message targeting and tailoring, new mums clearly acknowledged that different messages resonate differently depending on the individual. Sophie explained that all new mums are “going through different walks of life” and that how “[she reads] something, somebody else might read it completely differently”. Supporting this, Rachel believed that “people are all kind of inspired by stuff in different ways and make decisions based on different things”. New mums showed an awareness that different people have different PA needs and abilities (“10,000 steps to one person isn’t going to have the same effect as 10,000 to another” (Jade)), and some described accepting the fact that their abilities had changed since becoming a new mum: “for me it’s been quite a change to just be able to walk instead of going to the gym a lot, and that’s okay!” (Charlotte).

Other message content preferences

Several ‘other’ message content preferences were identified. New mums stated that messages should be relatable to them, and that including certain elements like testimonial style pieces and lived experiences can increase message relatability. Mums also felt that they already know what they ‘should’ be doing, that they would value information on what ‘counts’ as PA and showed an appreciation for messages that contain a mixture of information types.

“Like in Northumberland where I live there’s loads of cycle routes. And I love that sort of thing you know they’re saying ‘cycling is better on

your knees than running'. You know what? That's a good fact, I like that fact, I want my knees to be there when I'm older, okay? Then they say 'you can go on these cycle routes around Northumberland' and I think right that's a good bit of information for me, I can go and think about that and talk to other people about it... it gives you more information to work on." (Sophie).

Section 2 findings overview

To summarise, new mums expressed the importance of messages using empathetic and reassuring tones and language, as opposed to being forceful. Connecting with other mums for support and reassurance is important to new mums and may struggle with negative mental health. New mums have a preference for positive or gain-framed messages and particularly value the acute mental and social health benefits of PA. New mums find the 150-minute guideline message unachievable and would prefer to have that broken up into shorter bouts or bite sized chunks, with the ability to make up the guidelines how they want to. New mums expressed a strong desire for clear information signposting to opportunities to be active with their babies. Finally, the importance of message targeting and tailoring was clear, with a key theme being that different people need different messages.

Section 3: Explore preferences for physical activity message format and delivery

Overview of themes

Five themes and 19 subthemes were identified within the pre-determined category of exploring preferences for PA message format and

delivery. All themes and subthemes are displayed in Table 9-5, with key themes discussed in the following narrative summary.

TABLE 9-5: SECTION 3 THEMES AND SUBTHEMES

Themes	Subthemes
Preferences for media, mode, setting or platform	<ul style="list-style-type: none"> • Use of social media in message delivery • Physical media (e.g., posters or leaflets) • Message setting
Importance of use of modelling²⁰	<ul style="list-style-type: none"> • Commercial gym messaging is damaging • Importance of inclusive/representative models
Preferences for messenger, provider or source	<ul style="list-style-type: none"> • Health care professionals as messengers • Celebrities/influencers as messengers • Lack of trust in government • NHS viewed as trustworthy source • Reputable brands as messengers • Other mums as messengers • Messenger needs to have a genuine interest
Preferences for frequency and dose	<ul style="list-style-type: none"> • Time of day • Frequency • Length/duration
Other format and delivery preferences	<ul style="list-style-type: none"> • Accessibility considerations • Do not assume tone will be clear via text alone • Design considerations • Importance of being able to revisit message or find out more

Preferences for media, mode, setting or platform

Social media was consistently reported as an important delivery platform for PA messages targeted at new mums, potentially due to its on-demand nature: “when you’re a new mum you spend an awful lot of time on your phone... and it works because you can access it when you have the time” (Charlotte). This was supported by Suzanne (“we’re always on our phones”) and Amy (“you’d reach more mums on social media because

²⁰ Modelling defined as “providing an example for people to aspire to or imitate” (Michie et al., 2011)

everybody has social media these days”). New mums also described social media groups (such as Facebook groups) as important platforms where they can find information and reassurance. Jennifer explained that “Particularly for new mums, I think [they] can be a little bit isolated and not kind of get out... whereas social media is kind of a companion and a way to stay connected”, and Suzanne described how by being part of a Facebook group, she was able to “see what was going on”.

Conversely, new mums perceived some physical media such as leaflets and posters to be dated, irrelevant or easily forgotten: “...because sometimes you look at a poster and think ‘oh God, how old’s that thing?’, it might not be relevant anymore... so it needs to be updated and relevant” (Suzanne). Perhaps related to the preference for social media, new mums believed home to be the most sensible delivery setting as they are likely to spend a lot of their time there. In terms of design, new mums believed visual elements can help capture attention, and they felt positively towards the use of colours and text bubbles to make messages visually appealing.

Importance of use of modelling

Within this theme, several codes aligning with Michie et al.’s definition of modelling (relating to the BCW) were identified. New mums consistently expressed a desire for models in messages to be relatable to new mums. Suzanne explained that “if [she sees] kind of people that relate to [her] more” then it feels “more real or achievable”. New mums believed certain aspects could make models in messages more relatable, such as including “someone who isn’t airbrushed” (Charlotte), has “bags under their eyes” (Jennifer), and

not being “scared to show stretch marks” (Amy). On the other hand, mums expressed that they found commercial gym messaging with typical fit models to be damaging, and that seeing unrealistic models “doesn’t make them feel great” (Charlotte) and can be “a bit intimidating” (Jade).

Preferences for messenger, provider or source

Relating to several other themes, it was evident from the data that new mums valued other mums as messengers. Charlotte explained it as important for mums to “ask each other questions and get reassurance”. New mums also consistently believed the NHS to be a trustworthy messenger: “The NHS is somebody that you feel is qualified to give you those messages. Like if I did see a social media post and it had the sort of NHS stamp on it that would make it more trustworthy for me” (Jennifer). Relating to this, healthcare professionals including GPs, midwives and health visitors were viewed as important and trustworthy messengers by new mums. Charlotte described health visitors as important because new mums are “quite reliant on them in the first couple of weeks”, and Amy said that she “would’ve really listened if [her] health visitor had told [her] stuff”.

Some new mums also suggested that reputable organisations or brands could make good messengers: “Kind of reputable organisation I suppose... or brands. You’ve got big baby brands that potentially could advertise... I feel like I would take it well from them” (Rachel). On the other hand, some new mums showed a negative perception or lack of trust in the government: “Cause after the Covid situation I just don’t believe [the government] ... I think a lot of people feel like that now” (Amy).

Most participants had a negative perception of celebrities or influencers as messengers. Jade explained that “they don’t appeal to [her]” as their lives are [so far removed from [hers] that [she] doesn’t find it relatable”. However, some mums suggested that celebrities and influencers could be good messengers if they are down to earth and relatable: “real mums on Instagram with large followings and bloggers who are really down to earth... I like it because you’re kind of like ‘oh yeah I relate to that” (Charlotte).

Preferences for frequency and dose

New mums had mixed opinions on the time of day that they would prefer to receive a PA message (for example in the morning or the evening), but a consistent finding was a preference for messages to be received at a time that allows new mums to plan or act on them. In terms of frequency, there was a consistent finding that too frequent delivery of messages may be a negative thing. Jennifer explained that she did not want to feel “harassed”, Suzanne stated that daily messages may be “overkill”, and Jade expressed that she “[doesn’t] want to feel like it’s rammed down [her] throat”. However, there was a perception that repeated exposure to the same message may help it “stick”, and some mums suggested that fortnightly or monthly delivery may be appropriate. In terms of message duration, there was a consistent preference for short and sweet or ‘to the point’ messages. However, some mums indicated that the length of the message did not matter if the message is engaging enough.

Other format and delivery preferences

The importance of being able to revisit a message to find out further information was another finding relating to format preference. For example, Jennifer described a short and clear message with “a link... somewhere to go and find out more information”.

Section 3 findings overview

To summarise, social media was identified as an important delivery platform for new mums due to its on-demand nature. New mums also expressed a desire to see relatable and realistic models in PA messages. The NHS and healthcare professionals (including GPs, midwives, and health visitors) were identified as important messengers for this population. Finally, new mums want to receive messages at a time when they can act on them and appreciate being able to follow up for further information (for example, via a link).

Use of PAMF and PAMC to develop messaging recommendations

This is the first example of using the consensus driven PAMF to create PA messaging recommendations. As such it can be seen as an attempt to provide “proof of concept” and an exploration of the feasibility of using it in this way. First, it was used to inform the message aims and objectives. Second, it was used to inform the interview schedule. Third, it was used to inform data analysis. Finally, it was used to inform presentation of findings. As recommended in user guidance (Williamson et al., 2021) the PAMC was used to document key study findings and messaging recommendations based on these findings (see Appendix 9).

Discussion

Principal findings

This study was the first to apply the evidence- and expert-informed PAMF and PAMC and aimed to develop messaging recommendations for the specific population subgroup of new mothers. This study identified important potential aims and working pathways for messages to this group, such as reducing barriers to PA and utilising the intervention functions of education and persuasion. Other principal findings included that tone and language used in messages should be empathetic and reassuring (as opposed to forceful), and that messages should be positive and gain framed. Specifically, new mums value the social and acute mental health benefits of PA, such as connecting with other mums and relaxing. This study also demonstrated the importance of using realistic and inclusive images in PA messages targeted to new mums. Furthermore, results showed that new mums may find the 150-minute PA guideline unachievable, with a preference for shorter bouts of PA and clear, practical advice on how to be active. Finally, social media was identified as an important delivery platform for new mums, and healthcare professionals (GPs, midwives and health visitors) were identified as important messengers. The PA messaging recommendations that were shared with collaborators from Northumbria Healthcare Trust are displayed in Figure 9-1.

FIGURE 9-1: SUMMARY OF PHYSICAL ACTIVITY MESSAGING RECOMMENDATIONS FOR NEW MUMS

Physical activity messaging recommendations for new mothers in Northumberland and North Tyneside

- Walking is a feasible PA to promote in new mums
- Messages should aim to reduce barriers to PA in new mums (e.g., flag free opportunities or opportunities where they can bring their baby)
- Messages should make it clear that the 150-minute (or 2.5 hour) PA guideline can be built up in bite sized chunks or whatever way suits them
- Messages should be framed positively, highlighting benefits of PA rather than consequences of physical inactivity
- Messages should focus on the social benefits of PA (such as connecting with other new mums) and the acute mental health benefits (such as relaxing)
- Messages should use empathetic and reassuring tones, and avoid forceful tones
- Messages should avoid scientific jargon
- Messages should feature realistic and relatable images and models
- Social media could be an effective delivery platform
- Messages should be short and to the point but should include opportunity to follow up or find out more (e.g., via a link)
- The NHS, GPs, midwives, and health visitors should be used to deliver PA messages to new mums

Comparisons with and contributions to the literature

This study found that PA behaviour in new mothers has shifted from gym-based exercise to outdoor PA that can include the baby, with walking identified as a key form of PA in almost all participants. These findings are consistent with previous findings that mothers with young children participating in a PA intervention reported participating in outdoor activities, with walking as the most popular form of PA (Develin & Currie, 2000). These findings suggest that promotion of walking in messages targeted at new

mums is feasible, likely due to its variable intensity and the ability of mothers to walk with their babies.

This study identified several barriers to PA in new mums, including lack of time, being unable to plan PA into their day and having a reducing income on maternity pay. These finding aligns with previous qualitative research findings, in which lack of time was cited as one of the most common barriers (Evenson et al., 2009; Saligheh et al., 2016) and with one mum stating that they always had a child 'attached' to them (Saligheh et al., 2016). Also consistent with the current study findings, being on low income or cost of PA being too high were identified as barriers to PA in new others (Saligheh et al., 2016). Relatedly, this study also found that reducing barriers to PA such as those described above may be a potential working pathway for PA messages in new mothers. Although not directly comparable, this finding is supported by a previous study in which effectiveness of general versus specific exercise recommendations among postpartum mothers was examined. That study concluded that regardless of recommendation type, postpartum mothers may benefit from interventions that teach strategies for overcoming barriers to PA (Mailey & Hsu, 2019). Where possible, therefore, PA messages targeted to new mums should aim to reduce barriers. For example, based on the study findings, PA messages may work by signposting new mums to opportunities that are free or low cost, or which allow mums to bring their babies with them.

The intervention functions of education and persuasion (as described by Michie et al., 2011) were both identified as a potential working pathways to PA messages in this study. For example, educating new mums on the benefits of PA (education), and providing a purpose or encouraging habit formation (persuasion). Both of these pathways have potential links with the motivation element of the COM-B model (Michie et al., 2011) as introduced in Chapter 4. Motivation within the COM-B model is divided into two types: reflective and automatic. Reflective motivation involves the individual making evaluations and plans, whereas automatic motivation involves emotions and impulses that arise from associative learning or from an individual's inherent dispositions (Michie et al., 2011). Michie et al. (2011) propose that education is linked with reflective motivation (involves making valuations and plans), whereas persuasion is linked with both reflective and automatic motivation. Overall, this study found evidence that education and motivation are both potential messaging pathways, linked with motivation, to improving PA behaviour in postpartum women.

This study also found knowledge of PA guidelines to be low in new mums, with no participants being able to recall the 150-minute PA message. Knowledge of PA guidelines may therefore serve as potential future aim to achieve through education. However, the importance of new mums knowing the guidelines must be considered carefully, as a further key finding was that new mums perceived 150 minutes of PA to be unachievable. Rather, new mums showed a preference for building up the guidelines how they want to and in shorter bouts or bite sized chunks. This aligns with findings from

Mailey & Hsu (2019) who found general exercise recommendations (i.e. did not receive specific recommendations but rather were encouraged to accumulate PA in a way that suited them) to result in larger and better sustained increases in PA in new mothers than specific exercises recommendations (received a specific recommended exercise protocol) (Mailey & Hsu, 2019).

A possible explanation for these findings may relate to barriers to PA in new mums described above such as lack of time, as planning short bouts of PA may seem more feasible. A further explanation may relate to the aspect of choice. In line with SDT, autonomy (or choice) in setting one's own PA goals is an important factor in improving PA, and prescribing PA in scientific thresholds or doses (e.g., 150 minutes) impedes autonomy (Segar & Richardson, 2014). Also highlighting the importance of autonomy, when exploring preferences for language and message tone, new mums had a negative perception of language such as "should", "need" or "must". According to SDT, different types of motivation (controlled vs autonomous) directly influence adherence to behaviour (Ryan & Deci, 2000). Engaging in a behaviour because someone believes they 'should' is a form of controlled motivation. On the other hand, when a person engages in a behaviour because they value the benefits or pleasure and satisfaction the behaviour brings (autonomous motivation), this can lead to higher quality motivation and more sustainable PA (Teixeira et al., 2012). Therefore, messages should focus more on what new mums value and PA benefits that they deem as important and less on what they 'should' do.

Relating to the above, this study identified a clear preference for positive and gain-framed messages that highlight the benefits of PA in new mums, as opposed to negative or loss-framed messages that highlight the consequences of not being active. This finding is consistent with recent reviews (Williamson et al., 2020) and primary studies (Nobles et al., 2020). Specifically, this study found that new mums value the social benefits of PA (such as connecting with other mums), and the acute mental health benefits (such as feeling relaxed). This finding is supported from our previous scoping review of PA messaging which found that the evidence supports promotion of short-term mental and social health outcomes (Williamson et al., 2020). New mums taking part in this study also expressed experiences of negative mental health and feelings of isolation and loneliness as a result of being a new mum, exacerbated by the Covid-19 pandemic. This finding is supported by a recent Italian survey which found high anxiety and depression scores in 61.9% of new mothers that had given birth during lockdown (Stampini et al., 2021). The finding that social support from other mums is important is supported by existing evidence which found that social networks are considered highly important for new mums to share their experiences and create opportunities to be active (Saligheh et al., 2016). These findings may provide a possible explanation for new mums valuing the social and mental health benefits of PA over other benefits such as physical health. Messages targeted to new mums should provide information on the social and mental health benefits of PA, such as getting out in fresh air, connecting with other mums, and feeling more relaxed.

In addition to benefits of PA, this study found a desire for clear and practical guidance on how, when, and where to be active in new mums (such as signposting opportunities for new mums to be active with their babies) in messages, and that such opportunities are not well advertised. This finding aligns with an existing study in which around half of postpartum women did not know about available opportunities or how they might access support in their area (Saligheh et al., 2016). The desire for clear, practical messages has also been identified in pregnant women (Harrison et al., 2019). Messages targeted to new mums should therefore include clear information on how, when and where they can engage in PA, such as signposting local classes, buggy walks, or other opportunities.

A further key finding of this study was that messages to new mums should use empathetic and reassuring tones. Although in a different population, the desire for reassurance and empathy in communications between has also been identified in high risk pregnancies in care settings (Pozzo et al., 2010) and research investigating the functions of communication between pregnant women and their health care providers (Delaney & Singleton, 2020). Messages targeted a new mothers should therefore demonstrate empathy by, for example acknowledging the hardships of being a new mum and provide reassurance where possible.

With relevance to the importance of empathetic messages, a further key finding was that the NHS and healthcare providers including GPs, midwives and health visitors are potentially important messengers for new

mums as they are perceived as trustworthy sources. Existing qualitative research also supports message delivery through credible sources such as healthcare providers in pregnant women (Harrison et al., 2019). This is important, as effective provider-patient communication can promote better health practices and provide emotional support to encourage health behaviours such as PA in women (Nicoloro-SantaBarbara et al., 2017). Therefore, messages to new mums should be delivered or supported by the NHS and healthcare providers.

Finally, this study found social media to be an important delivery platform for new mums due to its on-demand nature, and the fact that new mums reported spending a lot of time on their phone. New mums also explained that social media groups provided connections to other mums and therefore can serve as a source of social support. Having a form of social support is crucial in new mothers and is a key factor in alleviating challenges faced by new parents (Negron et al., 2012). The internet has been identified as a key source for PA information in the general adult population (Berry, Spence, et al., 2011), and a social media-based approach was well positioned to provide antenatal care and support to pregnant women during the Covid-19 pandemic (Chatwin et al., 2021). The women in the current study described the use of Facebook groups as an example of a social media based social support network where they could seek reassurance from other mums as well as find out about and share PA opportunities. Messages targeted at new mums should therefore be shared on relevant social media platforms.

Strengths and limitations

This study is the first to prescriptively apply the PAMF and PAMC to develop targeted PA messaging recommendations for a specific target population subgroup, and, to the best of my knowledge, the first study to focus specifically on PA messaging preferences in postpartum women. The findings from this study will be of use to the stakeholder in developing targeted PA messages for new mothers, but the study also provides a case study example of how the PAMF and PAMC can be used to help create PA messages for any target group.

The study is not, however, without its limitations. Firstly, the participant sample comprised all White participants, and findings are therefore potentially not representative of the views of all new mums residing in North Tyneside and Northumberland. However, Northumberland county council reported that 98.4% of the Northumberland population were classed as White in 2011 (Jamieson, 2013), and the aim of this study was not to produce findings that could be generalised to other groups of new mothers. Rather, this study aimed to provide targeted messaging recommendations for new mums specifically in Northumberland and North Tyneside. Although the findings from this study may provide further insights to other groups in the maternal pathway (such as pregnant women) and women in other geographical locations than was previously available, it is recommended that the PAMF and PAMC are used in future research and practice to develop unique messaging recommendations for various target groups.

A further limitation was the drop out from recruited participants (i.e., those who completed informed consent) to those who took part in an interview (n=11 to n=7, 63.6%). This was likely due to postpartum women being a busy and hard to reach group. Despite this, however, the data collected were rich and sufficient information power was achieved to address the study aims and objectives.

Several potential methods to developing rigour in qualitative research have been proposed in the literature. For example, Tracy (2010) outlines eight universal criteria for “excellent qualitative research”. A further strength of the current study is that it addressed many of the descriptors of these criteria, including investigating a worthy topic (relevant, timely, interesting), drawing on theoretical constructs, using appropriate data collection and analysis processes, being transparent about methods and challenges, appropriate ethics, and using methods and procedures that fit the aims (Tracy, 2010). However, the application of universal criteria to determine rigour of qualitative research has since been described as problematic, as it requires a researcher to judge any qualitative study in predetermined and set ways, regardless of its aims and purposes (Smith & McGannon, 2018). Rather, Smith & McGannon propose other approaches to improve rigour such as the use of ‘critical friends’, wherein there is a critical dialogue between researchers, sharing their interpretations of the data and offering critical feedback. This approach was applied in study 2 (detailed in Chapter 7). However, due to time constraints, this approach was not used in the current study.

The lack of use of techniques to enhance rigour in qualitative research (such as the use of critical friends) may also therefore be viewed as a study limitation. However, this study served the purpose of demonstrating how the PAMF and PAMC may be used in applied settings. It is unreasonable to assume that stakeholders interested in developing PA messages will always have the resources available to conduct rigorous formative evaluation. The current study utilised appropriate qualitative methods given the resources available and provides one of example of how the PAMF and PAMC can be used to inform message development. Future research may wish to use apply these tools more rigorously or in a lighter touch way depending on their aims and resources available, highlighting versatility as a strength of the PAMF and PAMC.

Future directions

This study resulted in PA messaging recommendations specifically for postpartum women in the Northumberland Healthcare Trust area. In terms of practice, the Trust may wish to use these messaging recommendations to guide their PA messaging practice targeted to this group in future. In terms of research, an interesting next step would be to develop messages based on the recommendations from this study and test said messages in a trial design involving postpartum women to observe the short- and longer-term effects on various outcomes (proximal to distal), using the PAMF and PAMC to inform outcome and impact evaluation plans. Future research could also seek to replicate this study in other population groups (such as other PA guideline groups) to develop sets of population specific targeted messages.

Conclusion

Improving PA messaging practice may play an important role in promoting PA to different population groups. This study aimed to use the recently developed PAMF and PAMC to conduct formative evaluation and develop PA messaging recommendations for postpartum women. The PAMF and PAMC were used for the first time to inform data collection, data analysis and organisation of findings. Numerous findings relating to message aim and pathway, message content, and message format and delivery were identified, and specific targeted PA messaging recommendations for new mums were provided. Future research should apply the PAMF and PAMC to explore different ways they can be used to aid message development, such as the use of quantitative surveys, as well as to investigate messaging preferences in other populations.

Postamble

This study aimed to develop PA messaging recommendations for a population subgroup using the PAMF and PAMC developed during this PhD. Here I present some critical reflection on using the PAMF and PAMC in study 3 outlined in this chapter.

I found that the PAMF and PAMC were useful tools in the current study to inform qualitative formative evaluation and to develop targeted messaging recommendations for new mums. I found them to have utility throughout the research process. Specifically, and as described in the methods section of the current chapter, I used them to inform research questions/aims, data collection, data analysis and presentation of results in a qualitative design,

ultimately resulting in a set of targeted PA messaging recommendations. I found that using the PAMF and PAMC to inform each of these study elements beneficial for a number of reasons. First, they provided a clear structure that helped maintain alignment between study aims, methods and results. Second, due to the rigorous development methods of the PAMF and PAMC and their comprehensive nature, using these tools ensured that no elements of PA messaging were overlooked when exploring preferences. Third, they helped maintain study focus and structure by guiding limits of study collection as well as aiding identification of the most relevant results.

However, there are some key areas for reflection relating to using the PAMF and PAMC in a robust qualitative study. First, I found that this study took more time and researcher effort than anticipated. With no funds to offer incentives to participate, recruitment of this specific target population was a key challenge for me, as described in the study limitations in this chapter. Furthermore, all data collection and analysis were conducted by me alone, including verbatim transcription of all seven interviews. Adding to this, the study outlined in this chapter is the first fully qualitative study that I have led. Therefore, learning about and applying appropriate techniques for data collection and analysis within the limited time available was also an obstacle that I had to overcome. This suggests that using the PAMF and PAMC in the way they were applied in this study may not be a feasible option for many other users with comparable resource constraints and levels of experience and confidence in qualitative approaches. Key next steps therefore include

exploring the different ways in which the PAMF and PAMC can be applied from rapid or light touch to more prescriptive and rigorous applications.

Furthermore, the usefulness of the PAMF and PAMC should be investigated. This study took the approach most suitable for the aims, using qualitative data collection methods and a small, targeted participant group. However, larger studies, such as large-scale quantitative or mixed-methods surveys, have potential to gather views from numerous population groups and recruit larger samples. Such approaches may require less resources than robust fully qualitative approaches and may therefore be more acceptable to some users of the PAMF and PAMC.

Additionally, the rigorous process through which the PAMF was developed (modified Delphi study, see Chapter 7) led to improvements in the wordings and terminologies from the earlier versions of the PAMF and PAMC, and made them more user friendly to various potential users, including practitioners, researchers and government officials or policymakers. This resulted in many of the PAMF concepts being easily translated into questions that were suitable for the participant group, and during interviews I largely found myself gaining the type of data I hoped for. However, for full transparency, even as the researcher that led development of the PAMF and PAMC, I found translating some of the concepts into questions that were suitable to ask study participants a challenge.

For example, exploring potential message working pathways was difficult, and questions asked often had to be worded in multiple different ways and

several prompts given before the participant fully understood the question. This is likely due to the fact that message pathway is a complex area and, as this concept is heavily based in psychological theory, potentially more difficult to translate to lay language and provide clear, understandable examples. A further future direction therefore may be to provide some form of training on how to use the PAMF and PAMC for various purposes, including how to translate these tools into questions (to be included in qualitative or quantitative research) to optimise participant understanding and thus facilitate collection of meaningful data.

The following chapter presents the overall discussion of the body of research, wherein further reflections of this thesis as a whole and future directions for practice and research as described.

Chapter 10 Discussion

In this chapter, I discuss the thesis as a whole. I summarise the principal findings relating to the thesis aims, discuss key findings and describe contributions to knowledge, discuss strengths and limitations of my PhD research, consider the impact of my PhD research, and suggest future research priorities in the field of PA messaging.

Summary of thesis aims, findings and outputs

As stated in Chapter 1 at a broad level, this thesis (comprising three studies) aimed to (a) further our understanding of the role of PA messaging in improving population PA levels and (b) contribute towards improving the PA messaging evidence base and practice. Several more specific aims aligning with each of the PhD studies (Chapters 5-9) were addressed with the goal of achieving these overarching aims.

Chapter 5 (study 1) aimed to map the literature around PA messaging to investigate what was already known, identify key research gaps, and to provide recommendations for PA messaging to various subgroups of the public. There are four key findings of study 1. First, PA messaging is complex and multidimensional in nature, and comprises several concepts. The extent to which each of these concepts has been researched is variable. Second, the results of this study support the use of positive or gain-framed messages over negative or loss-framed messages across all population subgroups. Specifically, the evidence supports framing messages to promote the short-term mental health and social health benefits of engaging in PA. Third, the

evidence reviewed highlighted the importance of message targeting and tailoring. Fourth, evidence reviewed in study 1 supports the use of formative evaluation, theory, and social marketing principles to inform message development, as well as a lack of these elements in practice. The work relating to study 1 (Chapter 5) resulted in one peer reviewed publication (Williamson et al., 2020).

The second overarching aim of this thesis and the objectives within it became more defined as I progressed with my PhD research, as the need for high level practice-focused research was elucidated in the first study. Chapters 7 and 8 (study 2) therefore aimed to further develop and improve the PAMF and PAMC (of which preliminary versions were developed in Chapter 6: rationale for and development of a framework for PA messaging) and gain international expert consensus on these tools. In study 2, consensus on the PAMF and PAMC (85% and 87.5% agreement, respectively) was reached from a panel of 40 international experts. How the evidence- and expert- informed PAMF and PAMC can be used to create new PA messages, help plan evaluation of messages and aid understanding and categorisation of existing messages was discussed in Chapter 8. The output of study 2 was the first consensus driven framework specifically designed to aid creation and evaluation of PA messages. The work relating to study 2 (Chapters 6, 7 and 8) resulted in two peer reviewed publications (Williamson et al., 2021; Williamson et al., 2021).

Chapter 9 (study 3) aimed to user-test the PAMF and PAMC in a real world setting to develop targeted messaging recommendations for a specific population subgroup. Principal findings from study 3 relate to the three overarching sections of the PAMF. Relating to section 1 (who, when, what, how and why?), study 3 identified important potential and aims and working pathways for messages to new mums, such as reducing barriers to PA and using education and persuasion. Relating to section 2 (message content), study 3 found that tone and language used in messages should be empathetic and reassuring, and that messages should be gain-framed with particular focus on short term mental and social health benefits. Also relating to section 2, findings highlight the importance of using realistic and inclusive images in PA messages, show a preference for shorter bouts of PA that can be built up how they want, and a desire for clear, practical advice. Relating to section 3 (message format and delivery), social media was identified as an important delivery platform and healthcare providers were identified as important messengers. Study 3 also helped to identify future directions for the PAMF and PAMC.

Discussion of key findings and contributions to knowledge

Considering this thesis as a whole, five key findings warrant further discussion. These key findings have been chosen due to their prominence in relation to the overall thesis aims and/or due to the fact they were consistent across more than one study.

Key finding 1: Evidence supports the use of positive and gain-framed messages

First, evidence to support the use of positive or gain-framed messages in several populations was identified in studies 1 and 3. As discussed in study 1 (Chapter 5), this finding conforms with previous research. Prior to conduction of study 1, systematic review level evidence relating to PA messaging “cautiously” recommended gain-framed messaging over loss-framed messaging for PA. The findings from my PhD thesis have helped to strengthen this recommendation going forward.

Since the publication of study 1 (Chapter 5), a systematic review on the effects of message framing characteristics on PA education was published (Williams et al., 2019). This systematic review used a broader definition of message framing than the one used in this PhD by considering not only the effects of gain- versus loss-framing but also other aspects including of source credibility, type of activity being promoted, and ease of imagination. This systematic review, which included 13 randomised trial studies, concluded that it could not recommend one set of message characteristics which should be used, and did not advocate for the use of gain- framing over loss-framing or vice versa (Williams et al., 2019). The exclusion of qualitative research in the Williams et al., systematic review may be one explanation for the lack of support for positive or gain-framed messages, as this was a key source of insight into messaging preferences in the current thesis. To the best of my knowledge, there has been no primary research since the completion of

study 1 to contradict a preference for positive messages, and this therefore remains a key recommendation from this body of research.

As described in Chapter 5, message framing originates from Prospect Theory, which suggests individuals will respond differently to factually equivalent messages highlighting either the benefits of engaging in behaviour or the consequences of not engaging in the behaviour (Tversky & Kahneman, 1981). Previous literature suggests that, in line with Prospect Theory and the implications of risk, loss-framed appeals should be more persuasive in situations where an individual is deciding whether to adopt a behaviour that they perceive to be high risk. Conversely, gain-framed appeals should be more persuasive when in situations where an individual is deciding whether to engage in a behaviour that they perceive to be safe and free of adverse outcomes (Rothman & Updegraff, 2010; Rothman & Salovey, 1997). Relating to this, studies that have focused on promotion of 'detection' behaviours (such as cancer screening) have shown an advantage for loss-framing (Cox & Cox, 2001; Finney & Iannotti, 2002). Conversely, studies that have investigated the role of framing in promotion of 'prevention' behaviours (such as PA) have found an advantage for gain-framing (Jones et al., 2003; Latimer et al., 2010). From a framing perspective, this therefore separates PA from some other health behaviours in which messaging approaches are often used (such as smoking, alcohol consumption, sunbathing).

This PhD adds to the growing evidence base that supports positive and gain-framed messages in PA promotion. However, the reason(s) *why* gain-

framing in PA messaging is preferable are not as clear. In Chapter 5, I presented the ability of gain-framed messages to include information targeting psychological determinants of PA as a plausible explanation for this finding. Building on this, we can consider this finding through a theoretical lens to further understand how and why gain-framed PA messages may be preferable.

From a theoretical perspective, it is difficult to imagine a loss-framed or negative PA message that could positively impact antecedents of PA (such as self-esteem, self-efficacy, or PA perceptions). This idea is in line with several potential underpinning theories of PA messaging as outlined in Chapter 4 and summarised in Table 4-2, as well as with the all-encompassing BCW and COM-B model (Michie et al., 2011). For example, communicating the benefits of PA (gain-framed) may make it easier for individuals to weigh up the pros and cons of taking part in PA, an important precursor to behaviour according to Health Belief Model (Becker, 1974). The Theories of Reasoned Action (Fishbein & Ajzen, 1975) and Planned Behaviour (Ajzen, 1991) describe the importance of a person's attitudes towards a certain behaviour in behaviour change. It would be reasonable to assume that positive or gain-framed messages are best suited to create positive attitudes towards PA, encouraging viewing PA as something to enjoy and benefit from rather than a punishment or a method of avoiding negative outcomes.

SCT (Bandura, 2001) states that individuals will act in ways they believe will lead to favourable outcomes. Gain-framed messages may therefore potentially function through producing more positive outcome expectations. Furthermore, according to social marketing theory, behaviour change can occur when the benefits are offered in exchange for adopting a desire behaviour (Xia & Deshpande, 2016). By offering benefits of PA through gain-framed messages, therefore, we may make this exchange more appealing.

Finally, all plausible explanations discussed above for the finding that evidence supports positive and gain-framed messages to promote PA can be placed within the BCW and COM-B model. There is clear relevance and learning here for the motivation element of the COM-B model with regards to message framing. As outlined in Chapter 4, Michie et al. (2011) differentiate between two types of motivation, reflective motivation (which can be achieved through increasing knowledge and understanding which in turn elicits positive or negative feelings about PA), and automatic motivation (achieved through associative learning that elicits positive (or negative) feelings and impulses (or counter impulses) relating to PA) (Michie et al., 2011). Importantly, this thesis supports aiming to elicit positive feelings about PA when using PA messaging to target reflective or automatic motivation.

Overall, the implications that message framing may have on important antecedents to PA (such as perceptions, attitudes, and motivation) are evident and this research highlights the importance of drawing on theory to inform message development (as promoted in the PAMF) to inform decisions

on message framing in practice. Study 1 found evidence to support the use of messages created drawing on theory, as is advocated in wider PA promotion. However, study 1 also revealed that the use of theory in PA message development is lacking, with only 62% of empirical studies identified reporting use of theory to inform messaging. Therefore, further theory-driven research investigating the potential ways in which gain-framed messages specifically may improve PA is warranted. Future research may seek to utilise the BCW, with particular focus on the motivation element of the COM-B model to investigate the pathways through which gain-framed messages may elicit changes in PA behaviour.

Key finding 2: Evidence supports promotion of acute mental and social health benefits of physical activity

With clear links to the above finding that evidence supports the use of gain-framed messages in PA promotion, a second finding that emerged from both studies 1 and 3 that is that the evidence supports promoting the acute mental and social health benefits of PA in several populations. Given that the PA for health field often has the long-term physical health benefits of PA at the forefront of research and subsequent communications, this finding, in my opinion, is not only a novel one but a particularly important one. These findings are corroborated by recent evidence that intrinsic messages focusing on things that people value like meaningful relationships and enjoyment were ranked more favourably in adults than extrinsic messages such as those focusing on appearance (Pope & Pelletier, 2021).

Importantly, this second finding aligns with theories within the humanistic/organismic framework (as described by Rhodes et al., 2019 and outlined in Chapter 4), such as SDT. To recap, SDT informs our understanding of motivation, and posits that motivation exists on a spectrum, and that more self-determined or intrinsic motivations (such as engaging in PA because it is enjoyable) are better indicators of PA behaviour and maintenance than less self-determined motivations (such as being active because you feel it will please somebody else). The short term social and mental health benefits of PA would fall more towards the self-determined side of the spectrum, suggesting that promoting these benefits in PA messages may be more effective at fostering more intrinsic motivation.

This second key finding is also in line with the dual process framework, including dual processes theories and theories of emotional or affective response (also described in Chapter 4). To recap, these theories posit that affect and cognition are under control of distinct and somewhat independent systems, and that thoughts and behaviours can arise through two distinct routes: (1) implicit/impulsive (automatic), or explicit/reflective (controlled, conscious). Therefore, messages that tap into affect (such as those promoting immediate short term and social benefits) may have faster and more impulsive effects on thoughts and behaviours than messages that require individuals to use cognition. Notably, in study 1 it was identified that of the primary studies that did draw on theory, more than twice as many focused on theories within the social-cognitive framework than focused on theories within the humanistic/organismic and dual-process frameworks.

Therefore, as the findings of this thesis highlight a potentially important role for such theories in understanding PA messaging, future messaging research may look to explore PA messaging using humanistic/organismic or dual-process approaches.

The finding that messages should promote acute PA benefits also link with, and may be partially explained by, evidence relating to PA and pleasure. Ekkekakis argues that pleasure is the missing essential ingredient in PA prescription, as there is strong link between pleasure and human motivation for action (Ekkekakis, 2013). In research investigating reasons for engaging in PA, variants of pleasure (including enjoyment, feeling energised, feeling proud and relaxed) have been commonly reported in multiple populations, including adults and children (Allender et al., 2006), new mothers (study 3, Chapter 9), older adults (Sjörs et al., 2014), adolescents (Ketteridge & Boshoff, 2008), and in primary care patients with osteoarthritis (Hendry et al., 2006).

Relatedly, and linking with dual process theory, the Affective-Reflective Theory of physical inactivity postulates that experiences of either pleasure or displeasure in relation to PA will form an “automatic affective valuation”, and that pleasure and displeasure are intrinsically linked to corresponding instincts to either take part in or avoid PA, respectively (Brand & Ekkekakis, 2018). In other words, if a person has repeatedly experienced pleasure (such as enjoyment, feeling relaxed, feeling proud) in a PA context, they are more likely to impulsively want to engage PA in the future. In 2019, a key future

challenge outlined in this area was to develop methods to help replace negative automatic valuations of PA with more positive ones (Ekkekakis & Brand, 2019). Developing PA messages that promote pleasurable outcomes of PA (including acute mental and social health benefits) may play a key role in this.

However, a key challenge in developing such messages is that different activities, intensities, and durations may be pleasurable or enjoyable to different individuals or groups for different reasons (e.g., a specific PA may be relaxing for some and energising for others). Therefore, which acute benefits and variants of pleasure do we promote in PA messages? This relates to the third and fourth key findings that warrant further discussion: the importance of message tailoring and targeting for specific individuals or population subgroups, and the importance of co-production or formative evaluation with the target audience.

Key finding 3: The importance of message tailoring and targeting

In study 1 (Chapter 5), I described the finding that evidence supports the use of tailoring or targeting in PA messaging to be intuitive, and highlighted that by customising messages, salience can be increased (Kreuter et al., 1999), leading to greater information processing and behaviour change (Marcus, 2010; Napolitano & Marcus, 2002). In Chapter 8, I outlined audience segmentation as a key element of social marketing and described some of the different ways a population may be segmented. Acknowledging that there are some situations where a generic 'one size fits all' message

may be the goal, this thesis recommends the use of targeted messages to specific population segments. What is then included in the message (for example, which short term mental or social health benefits are promoted) depends on what is important to that specific segment.

Key finding 4: The importance of formative evaluation and co-production

What is important to us as academics and researchers in PA may not be what is important to members of the public, and these insights are therefore important to gain when developing messages. The PAMF encourages drawing on existing evidence with the target audience, theory and, importantly, formative evaluation or co-production to gain such insights. The importance of using formative evaluation in PA messaging was identified in study 1 (chapter 5), considered carefully in the development of the PAMF (study 2, chapters 6-8) and applied in study 3 (chapter 9). Future PA messages should be developed where possible by involving the target audience through formative evaluation. Exactly what that formative evaluation may look like will vary depending on resources available.

In addition to study 3 of this thesis, there are a further two key recent examples of co-production in PA message development. The first comes from Nobles et al. who involved members of the public (adults, young people, older adults and Somali women) in participatory workshops to explore and understand preferences of under-served communities relating to PA guideline messaging (Nobles et al., 2020). A second example comes from Smith et al., who recently conducted co-production to develop the infographic

for the new UK CMO PA Guidelines for Disabled Children and Young People (Smith et al., Forthcoming). Led by Durham University and the University of Bristol, this co-production involved academic teams working with a diverse group of disabled children and young people to identify different ways of messaging the PA guidelines through a series of workshops. This work was defined as a collaborative research process, with the lived experience and knowledge of the target audience considered essential (Smith et al., Forthcoming). Both of these examples used approaches in line with recommendations from the PAMF and may provide useful examples for development of future PA guideline communications.

Key finding 5: Insights into physical activity guideline messaging

Fifth and finally, relating to PA guidelines, a set of findings with particular importance for PA messaging practice going forward is preferences for guideline communication. This is a complex and under-researched area in which there are many questions to consider. As a start, we can consider the two key questions. First, is it important that the public know what the PA guidelines are? Second, (if the answer to question one is yes) is how do we best message the PA guidelines to the public?

Although not an aim of this thesis, when exploring broader messaging, I did not identify any evidence to support that knowing the guidelines is associated with adhering to the guidelines. Existing evidence suggests PA guideline knowledge in the UK is low (Scottish Government, 2012), and qualitative data from study 3 supported this finding in postpartum women.

However, as raised in Chapter 4, the assumption that knowledge translates to behaviour (a position held by some theories and assumption often made in health communication) is open to critique. Furthermore, data from Scotland suggest that guideline awareness is low in those that do not meet guidelines as well as in those that do meet guidelines (Scottish Government, 2012). However, no research to date has specifically explored the relationship between guideline knowledge and adherence. Therefore, research dedicated to exploring relationships between knowledge of guidelines and adherence to guidelines in various groups would be a useful contribution to this ongoing debate. Furthermore, all findings relating to PA guidelines identified in this thesis were specific to the aerobic element of the guidelines, with no insights gained into how to best message other elements such as the “forgotten” strength and balance guidelines (Strain et al., 2016) (see Table 2-1 in Chapter 2 for summary of PA guidelines). Thus, a further recommendation for future research may be to explore optimal messaging preferences for messages relating to strength and balance PA guidelines. The PAMF and PAMC developed as part of this thesis provide useful tools to guide such research.

Relating to the second key question, overall, evidence identified in this thesis relating PA guideline communication was limited. Study 1 concluded that evidence to date did not support one ‘amount’ over another in PA messages but did find that presenting 150 minutes as a minimum may be damaging to perceived benefits of shorter bouts, and that adult populations show high willingness to increase PA by short bouts. Study 3 then provided

some further insights into this area, by demonstrating that 150 minutes may seem unattainable to certain groups, that “2.5 hours” was clearer than “150 minutes”, and that the ability to make up the guidelines in shorter bouts and in the way that suits them best was important. Therefore, based on the findings of this thesis, future messages aiming to communicate PA guidelines specifically should avoid presenting 150 minutes as a minimum threshold, and should make it clear that the 2.5 hours per week can be built up in flexible shorter bouts.

Furthermore, it was found that although participants from study 3 were unable to recall the 150-minute message, several new mothers did recall elements of current or previous PA guidelines. For example, several participants demonstrated knowledge of either “30 x 5” or “30 minutes every day” message, and several also demonstrated awareness that guidelines encourage activity every day. This range in awareness may be reflective of the frequently changing messages that have accompanied PA guidelines since 1995. As outlined in Chapter 2, guidelines first recommended 30 minutes on most days, then 30 minutes 5 times a week, or 20 minutes 3 times a week if vigorous, before the current guideline of 150 minutes of PA messaging. Given the mixed knowledge of elements of different versions of the guidelines, future guideline committees should carefully consider the potential impact of changing the recommendations on public health messaging and guideline awareness amongst the public. Again, this point relates the question of whether the public need to know what the PA guidelines are, or whether PA messaging should focus on other information.

In summary, there are a number of key thesis-level findings that demonstrate how this body of research has contributed to the evidence base on PA messaging and communication. These findings have contributed to earlier cautious notions, challenged some preconceptions in different areas, and helped identify key areas for future research and practice. In this section, I discussed how my findings relate to empirical and theoretical literature. In the following section, I will consider and reflect on the impact that my PhD research has had to date.

Impact

There is evidence that this body of research is already informing research, practice, and policy in Scotland and beyond. Below I describe the impact of my PhD under the following subheadings: research uptake, research use, and impact. These headings align with the sections of the Research Contribution Framework; a tool for assessing the impact of research (Morton, 2015).

Research uptake

In terms of outputs, this body of research has resulted in three peer-reviewed publications, six blogs and five national and international presentations. Full details of these outputs can be found in Appendix 1. All three peer-reviewed publications from this research have been published in *IJBNPA* (impact factor 6.714), and steps were taken to enhance dissemination for each paper (for example, creation of infographics to share on social media and Twitter threads summarising findings). The first peer-

reviewed publication was a result of study 1: a scoping review of PA messaging (see Chapter 5) (Williamson et al., 2020) and was published in April 2020. The second peer reviewed publication detailed the methods and results of study 2: a modified Delphi study enhance and gain expert consensus on the developed PAMF and PAMC (Williamson et al., 2021) and was published in August 2021. The third and final peer reviewed publication was a user guide for the PAMF and PAMC, and was published in December 2021 (Williamson et al., 2021). My contributions to each of these publications are detailed in the declaration section (pages 2-4).

In addition to these peer reviewed publications, this work contributed to six blogs written for the BJSM, several of which have been highly accessed. In March and April 2020, drawing on principles from the PAMF, I contributed to a series of blogs (and corresponding infographics) that aimed to promote PA during the Covid-19 pandemic to various groups, including adults aged 18-65 who were working from or staying home (Hanson, Kelly, et al., 2020), vulnerable or at risk groups (Neubeck et al., 2020), school-aged children (and their parents) (Fawkner et al., 2020), and for parents with babies (Tomaz et al., 2020). A further blog was then published to summarise and collate this series (Hanson, Hanson, et al., 2020). Additionally, in November 2020, I wrote and published a blog on how to best message PA to the public, drawing on key findings from my PhD (Williamson, Kelly & Baker, 2020).

Furthermore, work from this thesis has been presented both nationally and internationally. Work from this PhD was first shared at a conference when preliminary findings from study 1 (Chapter 5) were shared via poster presentation at the SPARC conference in November 2018. Then, in November 2019, I delivered a workshop at the following SPARC conference alongside Dr James Nobles (University of Bristol) that was structured around an early version of the PAMF. In October 2020, findings from this body of research were presented internationally in a symposium as part of the ISPAH virtual congress. In January 2021, I presented my research as part of the keynote session at the I-PARC conference. Finally, in February 2021, I presented work from studies 1 and 2 at an international webinar as part of the 2021 ISPAH and WHO series “WHO guidelines on physical activity and sedentary behaviour”. Findings from study 3 are planned to be shared with the Northumbria Healthcare Trust in February 2022, as well as at the 2022 SPARC conference in November.

Research use

First-authored peer-reviewed publications from my PhD have been cited over 40 times (as of January 2022). Importantly, findings from study 1 (Chapter 5) were cited in ISPAH’s Eight Best Investments that Work for PA; a seminal advocacy document for embedding PA in national and subnational policies (ISPAH, 2020), as well as in a commentary related to the global 2020 PA guidelines in the most recent Lancet PA series on comprehensive and inclusive recommendations to active populations (Ding et al., 2020). The principles from the PAMF have also been used to guide published formative

research for UK Guideline communications (Nobles et al., 2020) and were included in an article on the critical role of communication strategies in maximising the impact of global and national PA guidelines (Milton et al., 2020), where I was invited to contribute as a co-author given the topic of my PhD.

My research in this area resulted in me being invited to be a specialist member of the UK CMO Expert Committee for Communication (February 2020 – August 2020) as well as a member of the expert group tasked by the Department of Health and Social Care to produce the first UK CMO PA Guidelines for Disabled Children and Youth (June 2021 - present). These roles have involved attending committee meetings to discuss communication of the 2019 PA guidelines, providing feedback on written reports, presenting findings from my PhD research to the wider committees, and providing messaging recommendations for PA communications during the ongoing Covid-19 pandemic. My contributions in the role were acknowledged through a letter from the UK CMOs (see Appendix 10).

Impact

Internationally, my framework helped inform the messaging strategy of the 2020 Canadian 24-hour movement guidelines (Public Health Agency of Canada, 2020) by providing structure and guidance on how to proceed with co-created messages that were impactful, evidence-informed, inclusive, and equitable. Various concepts within the PAMF were drawn on to shape the communication process, namely co-production, consideration of context,

consideration of potential working pathway, the use of gain-framed messages, and the use of images and text in message. Further detail on how the PAMF informed this practice can be found in a letter from the Knowledge and Translation Lead for the Canadian 24-Hour Movement Guidelines for Adults 18-64 Years and 65+ Years, Dr Jennifer Tomasone (Appendix 11). I have been invited to present the findings from my research at various points throughout my PhD with local and national stakeholders, including Paths for All, Edinburgh Leisure, the Daily Mile and Sustrans. Sport New Zealand have also contacted me with a view to using the PAMF to guide their upcoming PA Communication Campaigns.

Most recently, my framework, and the principles within it, are being used to inform ongoing strategy development of PA in Scotland. Specifically, Public Health Scotland are leading the development of a whole systems approach to PA, and the outputs of this thesis including study 1 findings and the PAMF are being used to inform best practice principles applied to national and community-based campaigns within the “communication and public education” investment. The impact of my research in this capacity has been outlined in a letter from the Health Improvement Manager for PA from Public Health Scotland, Flora Jackson (Appendix 12).

Finally, research from this thesis has informed teaching at undergraduate and postgraduate levels at the University of Edinburgh (UoE) and beyond. The Psychology of PA Messaging is now a core component of the Psychology of Physical Activity 3 course at the UoE and this year (2022) will

be delivered for the third consecutive year. The PAMF has also been used to inform multiple undergraduate dissertations, one of which was published in a peer-reviewed article (Gilbert et al., 2021), as well as in two MSc student dissertation (in which I acted as supervisor). I have also delivered guest lectures to two external institutions based on my research (Liverpool John Moores University and Perth College, University of the Highlands and Islands).

Overall, my research has already had demonstrable impact on PA messaging research, practice and policy both nationally and internationally, as described in the above section. In the following section, I will present my reflections on the strengths and limitations of the thesis as a whole.

Reflections, strengths, and limitations

Broad, overarching strengths and limitations of this body of research are presented here. Limitations for individual studies that have been previously described can be found in Chapters 5 (study 1), 7 and 8 (study 2) and 9 (study 3) and, though they may be referred to or elaborated on, will not be repeated in detail here.

Relating to the overall PhD aims, this thesis made valuable contributions to our understanding of PA messaging and its potential role in improving population level PA (evidenced predominantly by studies 1 and 3) and contributed towards improving the PA message evidence base and practice (evidenced predominantly by study 2). Contributions towards these aims and evidence of impact to date indicate that the work conducted during

my PhD has addressed an important research gap, has been conducted to a high standard using methods that were appropriate to address the PhD and individual study aims, and that the findings have been communicated successfully with important stakeholders (as outlined in the impact section of this chapter). This thesis has advanced the field by identifying and organising and defining key PA messaging concepts, resulting in the first consensus-driven framework for PA messaging to date. The impact so far of this output is demonstrable, and it is my hope that this tool will continue to inform PA messaging research and practice going forward.

One potential limitation described in study 2 (Chapter 7) that warrants further explanation is that the developed PAMF and PAMC (and indeed this thesis as a whole) do not tell users what decisions to make. As this thesis did not experimentally examine the effectiveness of certain messaging approaches over others in any specific population(s), the PAMF does not tell the user, for example, which information to include or which framing approach to take for a given population subgroup. Like other existing frameworks and guidance (Craig et al., 2008; Schulz et al., 2010), the PAMF and PAMC were not designed to be prescriptive, but to provide a set of consensus-driven concepts that are important to think through and report transparently on to improve the field of PA messaging. Furthermore, producing such prescriptive recommendations would have required in depth focus into a specific population subgroup and a considerably smaller subset of PA messaging concepts. Rather, this thesis took a broader approach as, following study 1, this was deemed most useful for the field. As such,

although conclusive statements about effectiveness of certain messaging techniques in specific populations have not been provided in this thesis, the fact that the PAMF and PAMC are useful for any target audience means the findings are of wide-ranging relevance. Future research investigating effectiveness of PA messaging approaches in various populations can now use the PAMF and PAMC to guide and document their research and findings.

Related to the above point, the fact that this thesis did not test or evaluate PA messages may be viewed as a limitation. This was originally an intention of this research, however, as the PhD progressed it became clear that there were different priorities that needed to be addressed in order to achieve the overarching aims. Having said this, the PAMF developed in study 2 strongly recommends the use of formative evaluation to guide message development. Therefore, conducting an experimental study that compared, for example, effectiveness of message A and B in study 3 would have missed a step and gone against PAMF guidance. Had more time been available in this PhD, the study 3 findings would have been used to construct messages and these messages would have been tested in postpartum women. It is my ambition to continue this research post-PhD and will aim to address this limitation. Indeed, the lack of evaluation of messages is a field-wide issue. In practice, many messaging attempts such as campaigns are either not evaluated or are evaluated using arguably unimportant outcomes. For example, a campaign may measure the number of 'clicks' on social media as opposed to outcomes such as PA perceptions, attitudes and

awareness. It is my hope that, as described in Chapter 8, the PAMF will make a positive contribution by helping plan not only formative evaluation as demonstrated in study 3, but also meaningful impact and outcome evaluations of PA messages in practice.

Although the expert informed PAMF was used for the first time to guide formative evaluation in this thesis, a further potential limitation may be that this formative evaluation required significant time and researcher skill, as discussed in the postamble of Chapter 9. Therefore, ensuring that the PAMF and PAMC are applied appropriately and more efficiently could enhance their impact in practice. It is for this reason that key future directions for this research include exploring ways to facilitate appropriate and more efficient use of the PAMF, such as developing an online interactive version of PAMF and PAMC and providing training to relevant stakeholders on how to apply these tools in practice.

A final consideration of this thesis is that, due to the mixed methods nature of my research, I have not developed as strong qualitative or quantitative research skills as I would have had I chosen to adopt just one of these approaches. Having said this, the data collection methods chosen for each individual study were those more suitable to address the study aims. Furthermore, working with a range of stakeholders in study 2 and the collaborative nature of study 3 facilitated translation of my findings into practice and provided me with experience in working and communicating with not only academics, but also those in other professions. I am therefore

finishing this PhD as a more well-rounded and experienced researcher than when I began three years ago.

Is physical activity messaging enough?

In Chapter 2, the argument for adopting a systems approach to improving population PA levels was presented. In line with this approach, the GAPP (World Health Organization, 2018) and ISPAH Eight Best Investments (ISPAH, 2020) highlight the importance of communication approaches alongside other systems, such as the physical environment. I chose to focus specifically on PA messaging for several reasons outlined in Chapter 3. Nearing the end of this body of research, it is important now to reflect on whether PA messaging is a worthwhile area of study, and if it is 'enough' to promote change population PA levels.

Study 1 (presented in Chapter 5) explored the potential role of PA messaging in improving PA levels through a broad lens. Overall, this study found that across various population subgroups, existing PA attempts to date have generally had less of an effect on behaviour itself yet have shown more promising effects on less distal outcomes, such as awareness, attitudes, motivation, and intent to be active. While it could be argued that PA messaging's limited effect on behaviour itself is a downfall, feasibility of detecting an effect in the real world and whether behaviour itself is an appropriate aim of messaging should be considered.

The theoretical underpinnings of PA messaging (described in Chapter 4 and discussed in relation to thesis findings in the current chapter) highlight

the importance of psychological antecedents in predicting and fostering PA behaviour itself. In line with theories discussed in this thesis, people are unlikely to be active unless they *want* to be (and this want may arise through various pathways). Therefore, on reflection, perhaps a more appropriate alternative question to “is messaging enough?” is “what is the role of messaging within the wider systems approach?”. As argued in Chapter 2, it will likely take a combination of individual-level and environmental and policy-level interventions to achieve and maintain substantial improvements in PA behaviour, reflecting the importance of having all systems working ‘well’, and working together.

Importantly, and as described in Chapter 3, PA communication approaches have the potential to influence change at individual, social, environmental and policy levels or systems. This means that, even though PA messaging alone is unlikely to be enough to change behaviour, it still has a role to play in supporting PA behaviour change across the different systems by influencing important PA antecedents. The importance of creating messages that are evidence-based and likely to have positive impact should therefore not be overlooked.

Room for improvement is evident in current PA messaging. To give a recent example, on the 21st of December 2021, the WHO tweeted the following PA message: “insufficient physical inactivity puts you at risk of noncommunicable disease such as cardiovascular diseases, cancer and diabetes”. This PA message is not in line with the findings of this thesis or

recent published research. Not only is it negative and loss-framed, but it also highlights long term physical health consequences of inactivity. Therefore, the need for research undertaken during this PhD and disseminating findings to those carrying out PA messaging is clear.

Indeed, the full potential of PA messaging and the extent of its role in PA promotion cannot be fully understood until PA messaging practice is improved. The research conducted as part of this PhD makes an important contribution towards achieving this goal. Promisingly, PA messaging research was identified as an area of rapidly growing interest in study 1, indicating acknowledgement from the field that this is an important area of study. Also encouraging is the uptake of the PAMF and PAMC and other findings from this PhD to date, as detailed in the impact section above. Consistent use of these tools in the future could lead to improved PA messaging research and practice, thus making a valuable contribution to the overall systems approach to improving population level PA.

Future directions

Throughout this thesis I have suggested several research directions that may be helpful to developing the PA messaging evidence base and would contribute towards the overall thesis aim of furthering our understanding of PA messaging and its role in improving population PA levels. These recommendations are summarised here.

Study 1 (Chapter 5) identified a potential need for systematic reviews and meta-analyses in areas where sufficient PA messaging evidence has

accumulated for specific concepts within specific populations (see evidence matrix in Figure 5-3, Chapter 5). As an example, one such evidence synthesis could explore effectiveness of different types of information in messages targeted adults; an area in which consistent evidence from various study types has accumulated. Relatedly, several areas where PA messaging evidence has not (yet) accumulated was also identified in this thesis (see gaps matrix in Figure 5-3, Chapter 5). Therefore, future research may wish to address some of these concept- and population- specific gaps. For example, optimal message frequency and dose should be explored in various population subgroup as this remains a clear gap.

Furthermore, this thesis as a whole highlighted the importance of drawing on theory to understand and inform PA messages. Investigation into the role of different theories in messaging, including the extent to which they have been used in PA messaging may be warranted. Specifically, this thesis has identified humanistic/organismic and dual-process frameworks, and the BCW and COM-B model, as being particularly useful in helping to explain findings. Future research exploring the use of theory in PA messaging may therefore look to utilise these theories.

Study 3 of this thesis used the PAMF and PAMC to guide formative evaluation to explore PA messaging preferences in a qualitative study design. In future, formative evaluation (either qualitative, quantitative, or mixed methods) guided by the PAMF and PAMC should be conducted in various population subgroups to establish messaging preferences and

establish potential working pathways. Linking with the previous recommendation, such formative research may be guided by theoretical frameworks such as the COM-B model. Furthermore, messages developed using the PAMF and PAMC should be implemented and evaluated in various population subgroups, for example, in pre-post studies or randomised trials. The PAMF and PAMC can be used at this stage to help plan impact/outcome evaluation.

Finally, given the policy importance and relevance of PA guidelines at this time, specific research into the messaging of guideline information is warranted. For example, there is a clear need for dedicated research to explore the links between guideline awareness and PA behaviour, as well as optimal messaging of the aerobic PA guidelines and how these findings may vary between different population subgroups. Furthermore, the PAMF and PAMC could be applied in future to explore preferences for messaging of other guideline elements, such as strength, balance and sedentary behaviour guidelines.

Several implications relating to future PA messaging have also been identified throughout this thesis. To summarise, future message creators may consider using the PAMF and PAMC to guide message development and plan message evaluation. In terms of future directions for the PAMF and PAMC, ways to facilitate various levels of use of these tools (from rapid, light touch use to prescriptive use) should be explored. For example, the use of a quantitative or mixed methods survey to determine messaging preferences

could be investigated. Furthermore, to facilitate use of the PAMF and PAMC in practice, an online interactive version of these tools should be developed, and formal training on using these tools for their various purposes should be provided.

Conclusions

Although unlikely to address global physical inactivity alone, PA messaging plays an important role in a systems approach to improving population PA levels by targeting individual and social factors. This thesis comprises research that achieved the aims of furthering our understanding of PA messaging and its role in improving PA levels, as well as contributing to improving PA messaging research and practice and informing policy. The first study of this thesis mapped the literature around PA messaging to identify key research gaps and provide PA messaging recommendations for various population subgroups. The second study developed, and gained international consensus on, an expert and evidence informed PA messaging framework and checklist: the PAMF and PAMC. In study 3, the PAMF and PAMC were applied to develop messaging recommendations for a specific population subgroup. There is already clear evidence of this work informing research, practice, and policy in the UK and beyond. The PAMF and PAMC should continue to be used in future research and practice to create new PA messages to any target population, guide evaluation of messages and help understand and categorise existing messages.

References

- Aarts, M.-J., Schuit, A. J., van de Goor, I. A. M., & van Oers, H. A. M. (2011). Feasibility of multi-sector policy measures that create activity-friendly environments for children: results of a Delphi study. *Implementation Science* : *IS*, 6(1), 128-128. <https://doi.org/10.1186/1748-5908-6-128>
- Abbasi-Kangevari, M., Abd-Allah, F., Adekanmbi, V., Adetokunboh, O. O., Al-Mekhlafi, H. M., Ancuceanu, R., . . . Yahyazadeh Jabbari, S. H. (2020). Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet (British edition)*, 396(10258), 1223-1249. [https://doi.org/10.1016/S0140-6736\(20\)30752-2](https://doi.org/10.1016/S0140-6736(20)30752-2)
- Acheson, D. (1998). *Independent inquiry into inequalities in health : report*. London : Stationery Office.
- Adams, R. (2000). Shown to be useful. Survey shows positive results for first-ever set of national physical activity guidelines. *Canadian family physician Médecin de famille canadien*, 46, 2061-2062.
- Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett Jr, D. R., Tudor-Locke, C., . . . Leon, A. S. (2011). 2011 compendium of physical activities: A second update of codes and MET values. *Medicine and science in sports and exercise*, 43(8), 1575-1581. <https://doi.org/10.1249/MSS.0b013e31821ece12>
- Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Akbari, M., Lankarani, K. B., Tabrizi, R., Heydari, S. T., Vali, M., Motevalian, S. A., & Sullman, M. J. M. (2021). The effectiveness of mass media campaigns in increasing the use of seat belts: A systematic review. *Traffic injury prevention, Ahead of print.*, 1-6. <https://doi.org/10.1080/15389588.2021.1921168>
- Albarracin, D., Wang, W., & Leeper, J. (2009). Immediate increase in food intake following exercise messages. *Obesity (Silver Spring, Md.)*, 17(7), 1451. <https://doi.org/10.1038/oby.2009.16>
- Alberga, A., Fortier, M., Bean, C., & Freedhoff, Y. (2019). Youth get a D+ grade in physical activity: How can we change public health messages to help reverse this trend? *Applied Physiology, Nutrition, and Metabolism*, 44, 567-570.
- Albright, C. L., Saiki, K., Steffen, A. D., & Woekel, E. (2015). What Barriers Thwart Postpartum Women's Physical Activity Goals During a 12-Month Intervention? A Process Evaluation of the Nā Mikimiki Project. *Women & health*, 55(1), 1-21. <https://doi.org/10.1080/03630242.2014.972014>
- Allender, S., Cowburn, G., & Foster, C. (2006). Understanding participation in sport and physical activity among children and adults: a review of qualitative

studies. *Health education research*, 21(6), 826-835.
<https://doi.org/10.1093/her/cyl063>

Almestahiri, R. d., Rundle-Thiele, S., Parkinson, J., & Arli, D. (2017). The Use of the Major Components of Social Marketing: A Systematic Review of Tobacco Cessation Programs. *Social Marketin Quarterly*, 23(3), 232-248.
<https://doi.org/10.1177/1524500417704813>

American College of Sports Medicine. (1978). Position statement on the recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults. *Medicine and science in sports*, 10(3), 7-x.

Andersen, M. H., Ottesen, L., & Thing, L. F. (2019). The social and psychological health outcomes of team sport participation in adults: An integrative review of research. *Scandinavian Journal of Public Health*, 47(8), 832-850.
<https://doi.org/10.1177/1403494818791405>

Arksey, H., & Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, 8(1), 19-32. <https://doi.org/10.1080/1364557032000119616>

Arnardottir, N. Y., Oskarsdottir, N. D., Brychta, R. J., Koster, A., Van Domelen, D. R., Caserotti, P., . . . Sveinsson, T. (2017). Comparison of Summer and Winter Objectively Measured Physical Activity and Sedentary Behavior in Older Adults: Age, Gene/Environment Susceptibility Reykjavik Study. *International journal of environmental research and public health*, 14(10), 1268. <https://doi.org/10.3390/ijerph14101268>

Aro, A. R., Bertram, M., Hämäläinen, R.-M., Van De Goor, I., Skovgaard, T., Valente, A., . . . Merry, A. (2016). Integrating research evidence and physical activity policy making—REPOPA project. *Health Promotion International*, 31(2), 430-439. <https://doi.org/10.1093/heapro/dav002>

Aune, D., Norat, T., Leitzmann, M., Tonstad, S., & Vatten, L. J. (2015). Physical activity and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis. *European journal of epidemiology*, 30(7), 529-542.
<https://doi.org/10.1007/s10654-015-0056-z>

Bagnall, A.-M., Radley, D., Jones, R., Gately, P., Nobles, J., Van Dijk, M., . . . Sahota, P. (2019). Whole systems approaches to obesity and other complex public health challenges: A systematic review. *BMC public health*, 19(1), 8-8.
<https://doi.org/10.1186/s12889-018-6274-z>

Bailis, D. S., Ashley Fleming, J., & Segall, A. (2005). Self-determination and functional persuasion to encourage physical activity. *Psychology & Health*, 20(6), 691-708. <https://doi.org/10.1080/14768320500051359>

Bandura, A. (1997). *Self-efficacy : the exercise of control*. New York : W.H. Freeman.

Bandura, A. (2001). Social Cognitive Theory of Mass Communication. *Media psychology*, 3(3), 265-299. https://doi.org/10.1207/S1532785XMEP0303_03

- Bandura, A. (2004). Health Promotion by Social Cognitive Means. *Health education & behavior*, 31(2), 143-164. <https://doi.org/10.1177/1090198104263660>
- Barnes, R., Giles-Corti, B., Bauman, A., Rosenberg, M., Bull, F., & Leavy, J. (2013). Does Neighbourhood Walkability Moderate the Effects of Mass Media Communication Strategies to Promote Regular Physical Activity? *Annals of Behavioral Medicine*, 45(Supplement 1), 86-94. <https://doi.org/10.1007/s12160-012-9429-7>
- Barnish, M. S., & Turner, S. (2017). The value of pragmatic and observational studies in health care and public health. *Pragmatic and observational research*, 8, 49-55. <https://doi.org/10.2147/POR.S137701>
- Bassett, R. L. M. S., & Martin Ginis, K. A. P. D. (2011). Risky business: The effects of an individualized health information intervention on health risk perceptions and leisure time physical activity among people with spinal cord injury. *Disability and health journal*, 4(3), 165-176. <https://doi.org/10.1016/j.dhjo.2010.12.001>
- Bassett-Gunter, R., Stone, R., Jarvis, J., & Latimer-Cheung, A. (2017). Motivating parent support for physical activity: the role of framed persuasive messages. *Health Education Research*, 32(5), 412-422. <https://doi.org/10.1093/her/cyx059>
- Bassett-Gunter, R. L., Latimer-Cheung, A. E., Martin Ginis, K. A., & Castelhana, M. (2014). I Spy With My Little Eye: Cognitive Processing of Framed Physical Activity Messages. *Journal of Health Communication*, 19(6), 1-16. <https://doi.org/10.1080/10810730.2013.837553>
- Bassett-Gunter, R. L., Martin Ginis, K. A., & Latimer-Cheung, A. E. (2013). Do You Want the Good News or the Bad News? Gain- Versus Loss-Framed Messages Following Health Risk Information: The Effects on Leisure Time Physical Activity Beliefs and Cognitions. *Health Psychology*, 32(12), 1188-1198. <https://doi.org/10.1037/a0030126>
- Bassett-Gunter, R. L., Ruscitti, R. J., Latimer-Cheung, A. E., & Fraser-Thomas, J. L. (2017). Targeted physical activity messages for parents of children with disabilities: A qualitative investigation of parents' informational needs and preferences. *Research in Developmental Disabilities*, 64, 37-46. <https://doi.org/10.1016/j.ridd.2017.02.016>
- Bates, L. C., Zieff, G., Stanford, K., Moore, J. B., Kerr, Z. Y., Hanson, E. D., . . . Stoner, L. (2020). COVID-19 Impact on Behaviors across the 24-Hour Day in Children and Adolescents: Physical Activity, Sedentary Behavior, and Sleep. *Children (Basel)*, 7(9), 138. <https://doi.org/10.3390/children7090138>
- Bauman, A., & Chau, J. (2009). The role of media in promoting physical activity. *Journal of Physical Activity and Health*, 6(2), S196-S210.
- Bauman, A. E., Bellew, B., Owen, N., & Vita, P. (2001). Impact of an Australian mass media campaign targeting physical activity in 1998. *American Journal of Preventive Medicine*, 21(1), 41-47. [https://doi.org/10.1016/S0749-3797\(01\)00313-0](https://doi.org/10.1016/S0749-3797(01)00313-0)

- Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., & Martin, B. W. (2012). Correlates of physical activity: why are some people physically active and others not? *The Lancet*, 380(9838), 258-271. [https://doi.org/10.1016/S0140-6736\(12\)60735-1](https://doi.org/10.1016/S0140-6736(12)60735-1)
- Beaudoin, C. E., Fernandez, C., Wall, J. L., & Farley, T. A. (2007). Promoting Healthy Eating and Physical Activity: Short-Term Effects of a Mass Media Campaign. *American Journal of Preventive Medicine*, 32(3), 217-223. <https://doi.org/10.1016/j.amepre.2006.11.002>
- Becker, M. H. (1974). *The health belief model and personal health behavior / editor Marshall H. Becker*. C.B. Slack.
- Beenackers, M., Kamphuis, C., Giskes, K., Brug, H., Kunst, A., Burdorf, A., & Lenthe, F. (2012). Socioeconomic inequalities in occupational, leisure-time, and transport related physical activity among European adults: A systematic review. *The international journal of behavioral nutrition and physical activity*, 9(1), 116-116. <https://doi.org/10.1186/1479-5868-9-116>
- Bellows, L., Spaeth, A., Lee, V., & Anderson, J. (2013). Exploring the Use of Storybooks to Reach Mothers of Preschoolers With Nutrition and Physical Activity Messages. *Journal of Nutrition Education and Behavior*, 45(4), 362-367. <https://doi.org/10.1016/j.jneb.2012.10.011>
- Beretta, R. (1996). A critical review of the Delphi technique. *Nursing Research*, 1(3), 79-89. <https://doi.org/10.7748/nr.3.4.79.s8>
- Bergeron, C. D., Tanner, A. H., Friedman, D. B., Zheng, Y., Schrock, C. S., Bornstein, D. B., . . . Swift, N. (2019). Physical Activity Communication: A Scoping Review of the Literature. *Health Promotion Practice*, 20(3), 344-353. <https://doi.org/10.1177/1524839919834272>
- Bernhardt, J. M. (2004). Communication at the core of effective public health. *American journal of public health (1971)*, 94(12), 2051-2053. <https://doi.org/10.2105/AJPH.94.12.2051>
- Berry, T. (2006). Who's Even Interested in the Exercise Message? Attentional Bias for Exercise and Sedentary-Lifestyle Related Words. *Journal of Sport & Exercise Psychology*, 28(1). <https://doi.org/10.1123/jsep.28.1.4>
- Berry, T. (2017). Rethinking how physical activity messages are thought about: Implications for successful promotion. *WellSpring*, 28(3), 1-4.
- Berry, T. R. (2016). Changes in implicit and explicit exercise-related attitudes after reading targeted exercise-related information. *Psychology of Sport and Exercise*, 22, 273-278. <https://doi.org/10.1016/j.psychsport.2015.09.001>
- Berry, T. R., & Carson, V. (2010). Ease of imagination, message framing, and physical activity messages. *British Journal of Health Psychology*, 15(1), 197-211.
- Berry, T. R., Jones, K. E., Courneya, K. S., McGannon, K. R., Norris, C. M., Rodgers, W. M., & Spence, J. C. (2018). Believability of messages about

- preventing breast cancer and heart disease through physical activity. *BMC psychology*, 6(1), 2. <https://doi.org/https://dx.doi.org/10.1186/s40359-018-0213-8>
- Berry, T. R., Jones, K. E., McLeod, N. C., & Spence, J. C. (2011). The Relationship Between Implicit and Explicit Believability of Exercise-Related Messages and Intentions. *Health Psychology*, 30(6), 746-752. <https://doi.org/10.1037/a0025082>
- Berry, T. R., & Latimer-Cheung, A. E. (2013). Overcoming Challenges to Build Strong Physical Activity Promotion Messages. *American Journal of Lifestyle Medicine*, 7(6), 371-378. <https://doi.org/10.1177/1559827613499289>
- Berry, T. R., Spence, J. C., Plotnikoff, R. C., & Bauman, A. (2011). Physical Activity Information Seeking and Advertising Recall. *Health Communication*, 26(3), 246-254. <https://doi.org/10.1080/10410236.2010.549810>
- Berry, T. R., Witcher, C., Holt, N. L., & Plotnikoff, R. C. (2010). A Qualitative Examination of Perceptions of Physical Activity Guidelines and Preferences for Format. *Health Promotion Practice*, 11(6), 908-916. <https://doi.org/10.1177/1524839908325066>
- Bevington, F., Piercy, K. L., Olscamp, K., Hilfiker, S. W., Fisher, D. G., & Barnett, E. Y. (2020). The Move Your Way Campaign: Encouraging Contemplators and Families to Meet the Recommendations From the Physical Activity Guidelines for Americans. *Journal of physical activity & health*, 17(4), 397-403. <https://doi.org/10.1123/jpah.2019-0395>
- Biddle, S. J. H., Ciaccioni, S., Thomas, G., & Vergeer, I. (2019). Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. *Psychology of sport and exercise*, 42, 146-155. <https://doi.org/10.1016/j.psychsport.2018.08.011>
- Biddle, S. J. H., & Nigg, C. R. (2000). Theories of exercise behavior. *International Journal of Sport Psychology*, 31, 290-304.
- Bize, R., Johnson, J. A., & Plotnikoff, R. C. (2007). Physical activity level and health-related quality of life in the general adult population: A systematic review. *Preventive medicine*, 45(6), 401-415. <https://doi.org/10.1016/j.ypmed.2007.07.017>
- Black, D., Blue, C., Komoski, K., & Coster, D. (2000). Social Marketing: Developing a Tailored Message for a Physical Activity Program. *American Journal of Health Behavior*, 24(5), 323-337.
- Black, N., Murphy, M., Lamping, D., McKee, M., Sanderson, C., Askham, J., & Marteau, T. (1999). Consensus Development Methods: A Review of Best Practice in Creating Clinical Guidelines. *Journal of Health Services Research & Policy*, 4(4), 236-248. <https://doi.org/10.1177/135581969900400410>
- Blum, J. W., Beaudoin, C. M., & Caton-Lemos, L. (2004). Physical Activity Patterns and Maternal Well-Being in Postpartum Women. *Maternal and child health journal*, 8(3), 163-169. <https://doi.org/10.1023/B:MACI.0000037649.24025.2c>

- Booth, M., Bauman, A., Oldenburg, B., Owen, N., & Magnus, P. (1992). Effects of a National Mass-Media Campaign on Physical Activity Participation. *Health Promotion International*, 7(4), 241-247. <https://doi.org/10.1093/heapro/7.4.241>
- Borland, R., & Balmford, J. (2003). Understanding how mass media campaigns impact on smokers. *Tobacco control*, 12(suppl 2), ii45-ii52. https://doi.org/10.1136/tc.12.suppl_2.ii45
- Brand, C., Götschi, T., Dons, E., Gerike, R., Anaya-Boig, E., Avila-Palencia, I., . . . Nieuwenhuijsen, M. J. (2021). The climate change mitigation impacts of active travel: Evidence from a longitudinal panel study in seven European cities. *Global environmental change*, 67, 102224. <https://doi.org/10.1016/j.gloenvcha.2021.102224>
- Brand, R., & Ekkekakis, P. (2018). Affective–Reflective Theory of physical inactivity and exercise: Foundations and preliminary evidence. *German journal of exercise and sport research*, 48(1), 48-58. <https://doi.org/10.1007/s12662-017-0477-9>
- Braun, V., Clarke, V., Hayfield, N., & Terry, G. (2019). Thematic Analysis. In *Handbook of Research Methods in Health Social Sciences* (pp. 843-860). Singapore: Springer Singapore Pte. Limited.
- Brawley, L. R., & Latimer, A. E. (2007). Physical activity guides for Canadians: messaging strategies, realistic expectations for change, and evaluation. *Canadian journal of public health = Revue canadienne de sante publique*, 98 Suppl 2, S170.
- Brengman, M., Wauters, B., Macharis, C., & Mairesse, O. (2010). Functional Effectiveness of Threat Appeals in Exercise Promotion Messages. *Psicologica: International Journal of Methodology and Experimental Psychology*, 31(3), 577-604.
- Bronfenbrenner, U. (1996). *The ecology of human development experiments by nature and design / Urie Bronfenbrenner*. Harvard University Press.
- Brown, D. R., Soares, J., Epping, J. M., Lankford, T. J., Wallace, J. S., Hopkins, D., . . . Orleans, C. T. (2012). Stand-Alone Mass Media Campaigns to Increase Physical Activity: A Community Guide Updated Review: A Community Guide Updated Review. *American Journal of Preventive Medicine*, 43(5), 551-561. <https://doi.org/10.1016/j.amepre.2012.07.035>
- Brown, W., Bauman, A., Bull, F., & Burton, N. (2012). *Development of Evidence-based Physical Activity Recommendations for Adults (18-64 years)*. Retrieved from [https://www1.health.gov.au/internet/main/publishing.nsf/Content/F01F92328EDADA5BCA257BF0001E720D/\\$File/DEB-PAR-Adults-18-64years.pdf](https://www1.health.gov.au/internet/main/publishing.nsf/Content/F01F92328EDADA5BCA257BF0001E720D/$File/DEB-PAR-Adults-18-64years.pdf)
- Bull, F., Milton, K., Kahlmeier, S., Arlotti, A., Juričan, A. B., Belander, O., . . . Vlasveld, A. (2015). Turning the tide: national policy approaches to increasing physical activity in seven European countries. *British journal of*

sports medicine, 49(11), 749-756. <https://doi.org/10.1136/bjsports-2013-093200>

- Bull, F. C., Kreuter, M. W., & Scharff, D. P. (1999). Effects of tailored, personalized and general health messages on physical activity. *Patient Education and Counseling*, 36(2), 181-192. [https://doi.org/10.1016/S0738-3991\(98\)00134-7](https://doi.org/10.1016/S0738-3991(98)00134-7)
- Buller, D. B. (2006). Diffusion and Dissemination of Physical Activity Recommendations and Programs to World Populations. *American Journal of Preventive Medicine*, 31(4), 1-4. <https://doi.org/10.1016/j.amepre.2006.06.016>
- Bélanger-Gravel, A., Cutumisu, N., Gauvin, L., Lagarde, F., & Laferté, M. (2017). Correlates of Initial Recall of a Multimedia Communication Campaign to Promote Physical Activity among Tweens: the WIXX Campaign. *Health Communication*, 32(1), 103-110. <https://doi.org/10.1080/10410236.2015.1099508>
- Bélanger-Gravel, A., Cutumisu, N., Lagarde, F., Laferté, M., & Gauvin, L. (2017). Short-Term Impact of a Multimedia Communication Campaign on Children's Physical Activity Beliefs and Behavior. *Journal of Health Communication*, 22(1), 1-9. <https://doi.org/10.1080/10810730.2016.1245802>
- Bélanger-Gravel, A., Gauvin, L., Lagarde, F., & Laferté, M. (2014). Initial recall and understanding of a multimedia communication campaign to promote physical activity among tweens: A process evaluation study. *Preventive Medicine*, 69, 192-196. <https://doi.org/10.1016/j.yjmed.2014.10.018>
- Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of personality and social psychology*, 42(1), 116-131. <https://doi.org/10.1037/0022-3514.42.1.116>
- Carlsen, B., & Glenton, C. (2011). What about N? A methodological study of sample-size reporting in focus group studies.
- Carpenter, C. J. (2010). A Meta-Analysis of the Effectiveness of Health Belief Model Variables in Predicting Behavior. *Health communication*, 25(8), 661-669. <https://doi.org/10.1080/10410236.2010.521906>
- Carson, V., Lee, E.-Y., Hewitt, L., Jennings, C., Hunter, S., Kuzik, N., . . . Tremblay, M. S. (2017). Systematic review of the relationships between physical activity and health indicators in the early years (0-4 years). *BMC public health*, 17(Suppl 5), 854-854. <https://doi.org/10.1186/s12889-017-4860-0>
- Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical Activity, Exercise, and Physical Fitness: Definitions and Distinctions for Health-Related Research. *Public Health Reports (1974-)*, 100(2), 126-131.
- Cavill, N., & Bauman, A. (2004). Changing the way people think about health-enhancing physical activity: do mass media campaigns have a role? *Journal of Sports Sciences*, 22(8), 771-790. <https://doi.org/10.1080/02640410410001712467>

- Chastin, S. F. M., Schwarz, U., & Skelton, D. A. (2013). Development of a consensus taxonomy of sedentary behaviors (SIT): Report of Delphi round 1. *PloS one*, *8*(12), e82313-e82313. <https://doi.org/10.1371/journal.pone.0082313>
- Chatwin, J., Butler, D., Jones, J., James, L., Choucri, L., & McCarthy, R. (2021). Experiences of pregnant mothers using a social media based antenatal support service during the COVID-19 lockdown in the UK: Findings from a user survey. *BMJ open*, *11*(1), e040649-e040649. <https://doi.org/10.1136/bmjopen-2020-040649>
- Cheval, B., Sarrazin, P., Isoard-Gauthier, S., Radel, R., & Friese, M. (2015). Reflective and Impulsive Processes Explain (In)effectiveness of Messages Promoting Physical Activity: A Randomized Controlled Trial. *Health Psychology*, *34*(1), 10-19. <https://doi.org/10.1037/hea0000102>
- Choi, B. C. K., Pak, A. W. P., Choi, J. C. L., & Choi, E. C. L. (2007). Daily step goal of 10,000 steps: A literature review. *Clinical and investigative medicine*, *30*(3), E146-E151. <https://doi.org/10.25011/cim.v30i3.1083>
- Clarke, V., Braun, V., & Hayfield, N. (2015). Thematic analysis. In S. A. Jonathan (Ed.), *Qualitative Psychology: A Practical Guide to Research Methods* (3rd ed., pp. 222-248). SAGE Publications.
- Connell, L. E., Carey, R. N., de Bruin, M., Rothman, A. J., Johnston, M., Kelly, M. P., & Michie, S. (2019). Links Between Behavior Change Techniques and Mechanisms of Action: An Expert Consensus Study. *Annals of behavioral medicine : a publication of the Society of Behavioral Medicine*, *53*(8), 708. <https://doi.org/10.1093/abm/kay082>
- Conroy, D. E., Hojjatinia, S., Lagoa, C. M., Yang, C.-H., Lanza, S. T., & Smyth, J. M. (2019). Personalized models of physical activity responses to text message micro-interventions: A proof-of-concept application of control systems engineering methods. *Psychology of Sport & Exercise*, *41*, 172-180. <https://doi.org/10.1016/j.psychsport.2018.06.011>
- Courneya, K. S. (2004). Antecedent correlates and theories of exercise behaviour. In T. Morris & J. Summers (Eds.), *Sport psychology: Theories, applications and issues* (2nd ed., pp. 492-512). John Wiley and Sons.
- Cox, D., & Cox, A. D. (2001). Communicating the Consequences of Early Detection: The Role of Evidence and Framing. *Journal of marketing*, *65*(3), 91-103. <https://doi.org/10.1509/jmkq.65.3.91.18336>
- Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2008). Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ*, *337*(7676), 29-983. <https://doi.org/10.1136/bmj.a1655>
- Crisp, J., Pelletier, D., Duffield, C., Adams, A., & Nagy, S. (1997). The Delphi Method? *Nursing Research*, *46*(2), 116-118. <https://doi.org/10.1097/00006199-199703000-00010>

- Crosby, R., Salazar, L., & DiClemente, R. (2013). Value-expectancy theories. In R. DiClemente, L. Salazar, & R. Crosby (Eds.), *Health behavior theory for public health: Principles, foundations, and applications* (pp. 65-82). Jones and Barlett Learning.
- Cross, R., Davis, S., & O'Neil, I. (2017). *Health Communication: Theoretical and Critical Perspectives*. Polity Press.
- Crozier, A. J., & Taylor, K. L. (2019). An Exploratory Study Examining the Interactive Effect of Descriptive Norm and Image Appeal Messages on Adults' Physical Activity Intentions: A Test of Deviation Regulation Theory. *Journal of Health Communication, 24*(2), 195-202.
<https://doi.org/10.1080/10810730.2019.1593553>
- Cunningham, C., O' Sullivan, R., Caserotti, P., & Tully, M. A. (2020). Consequences of physical inactivity in older adults: A systematic review of reviews and meta-analyses. *Scandinavian journal of medicine & science in sports, 30*(5), 816-827. <https://doi.org/10.1111/sms.13616>
- Custer, R. L., Scarcella, J. A., & Stewart, B. R. (1999). The Modified Delphi Technique--A Rotational Modification. *Journal of Vocational and Technical Education, 15*(2), 50.
- Dacey, M., Baltzell, A., & Zaichkowsky, L. (2008). Older adults' intrinsic and extrinsic motivation toward physical activity. *American journal of health behavior, 32*(6), 570-582. <https://doi.org/10.5993/AJHB.32.6.2>
- Dalkey, N. (1969). An experimental study of group opinion: The Delphi method. *Futures, 1*(5), 408-426. [https://doi.org/10.1016/S0016-3287\(69\)80025-X](https://doi.org/10.1016/S0016-3287(69)80025-X)
- Daugbjerg, S. B., Kahlmeier, S., Racioppi, F., Eva, M.-D., Martin, B., Oja, P., & Bull, F. (2009). Promotion of physical activity in the european region: Content analysis of 27 national policy documents. *Journal of physical activity & health, 6*(6), 805-817. <https://doi.org/10.1123/jpah.6.6.805>
- Davis, R., Campbell, R., Hildon, Z., Hobbs, L., & Michie, S. (2015). Theories of behaviour and behaviour change across the social and behavioural sciences: a scoping review. *Health psychology review, 9*(3), 323-344.
<https://doi.org/10.1080/17437199.2014.941722>
- Day, J., & Bobeva, M. (2005). A generic toolkit for the successful management of delphi studies. *Electronic Journal of Business Research Methods, 3*(2), 103-116.
- Deci, E. L. (1985). *Intrinsic motivation and self determination in human behavior / Edward L. Deci and Richard M. Ryan*. Planum Press.
- Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological inquiry, 11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01
- Delaney, A. L., & Singleton, G. (2020). Information and Relationship Functions of Communication between Pregnant Women and Their Health Care Providers.

Communication studies, 71(5), 800-822.
<https://doi.org/10.1080/10510974.2020.1807376>

Delbecq, A. L. (1975). *Group techniques for program planning : a guide to nominal group and Delphi processes*. Glenview, Ill. : Scott, Foresman.

Demarest, S., van Oyen, H., Roskam, A.-J., Cox, B., Regidor, E., Mackenbach, J. P., & Kunst, A. E. (2014). Educational inequalities in leisure-time physical activity in 15 European countries. *European journal of public health*, 24(2), 199-204. <https://doi.org/10.1093/eurpub/ckt061>

Department of Health. (2004). *At Least Five a Week. Evidence on the Impact of Physical Activity and Its Relationship to Health. A report from the Chief Medical Officer*. Department of Health.
https://www.staffs.ac.uk/images/First%20steps%20SHE%20CMO%2520Report%2520Summary_tcm68-26370.pdf

Department of Health. (2011). *Start active, stay active: A report on physical activity from the four home countries' Chief Medical Officers*.

Department of Health & Social Care. (2019). *UK Chief Medical Officers' Physical Activity Guidelines*. U.K. Government Retrieved from
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/832868/uk-chief-medical-officers-physical-activity-guidelines.pdf

Deshpande, S., Berry, T. R., Faulkner, G. E. J., Latimer-Cheung, A. E., Rhodes, R. E., & Tremblay, M. S. (2015). Comparing the Influence of Dynamic and Static Versions of Media in Evaluating Physical-Activity-Promotion Ads. *Social Marketing Quarterly*, 21(3), 135-141.
<https://doi.org/10.1177/1524500415599376>

Develin, E., & Currie, J. (2000). The Strollers Pramwalking Program: a community intervention aimed at increasing the physical activity level of mothers with young children. *Health Promotion Journal of Australia*, 10(1), 57-59.

Diamond, I. R., Grant, R. C., Feldman, B. M., Pencharz, P. B., Ling, S. C., Moore, A. M., & Wales, P. W. (2014). Defining consensus: A systematic review recommends methodologic criteria for reporting of Delphi studies. *Journal of Clinical Epidemiology*, 67(4), 401-409.
<https://doi.org/10.1016/j.jclinepi.2013.12.002>

Ding, D., Mutrie, N., Bauman, A., Pratt, M., Hallal, P. R. C., & Powell, K. E. (2020). Physical activity guidelines 2020: comprehensive and inclusive recommendations to activate populations. *The Lancet (British edition)*, 396(10265), 1780-1782. [https://doi.org/10.1016/S0140-6736\(20\)32229-7](https://doi.org/10.1016/S0140-6736(20)32229-7)

Dipietro, L., Evenson, K. R., Bloodgood, B., Sprow, K., Troiano, R. P., Piercy, K. L., . . . Powell, K. E. (2019). Benefits of Physical Activity during Pregnancy and Postpartum: An Umbrella Review. *Medicine and science in sports and exercise*, 51(6), 1292-1302.
<https://doi.org/10.1249/MSS.0000000000001941>

- Dishman, R. K. (1988). *Exercise adherence : its impact on public health / Rod K. Dishman, editor*. Human Kinetics Books.
- Dixey, R., Cross, R., & Foster, S. (2013). The foundations of health promotion. In R. Dixey (Ed.), *Health Promotion: Global Principles and Practice*. (pp. 1-29). CABI.
- Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2013). A systematic review of the psychological and social benefits of participation in sport for children and adolescents: Informing development of a conceptual model of health through sport. *The international journal of behavioral nutrition and physical activity*, *10*(1), 98-98. <https://doi.org/10.1186/1479-5868-10-98>
- Ekkekakis, P. (2013). Redrawing the Model of the Exercising Human in Exercise Prescriptions.
- Ekkekakis, P., & Brand, R. (2019). Affective responses to and automatic affective valuations of physical activity: Fifty years of progress on the seminal question in exercise psychology. *Psychology of sport and exercise*, *42*, 130-137. <https://doi.org/10.1016/j.psychsport.2018.12.018>
- Elley, C. R., Kerse, N., Arroll, B., & Robinson, E. (2003). Effectiveness of counselling patients on physical activity in general practice: cluster randomised controlled trial. *BMJ*, *326*(7393), 793-796. <https://doi.org/10.1136/bmj.326.7393.793>
- Emma M, D., Jing Jing, L. I. U., Raj, B., Martin, W., Mark R.D, J., Gina, N., . . . Aziz, S. (2013). Behavior Change Interventions to Improve the Health of Racial and Ethnic Minority Populations: A Tool Kit of Adaptation Approaches. *The Milbank quarterly*, *91*(4), 811-851. <https://doi.org/10.1111/1468-0009.12034>
- Evenson, K. R., Aytur, S. A., & Borodulin, K. (2009). Physical Activity Beliefs, Barriers, And Enablers Among Postpartum Women: The Pin Postpartum Study: 2598 Board #243 May 29 8:00 AM - 9:30 AM. *Medicine and science in sports and exercise*, *41*(5), 399. <https://doi.org/10.1249/01.MSS.0000355763.05014.59>
- Faught, E., Walters, A. J., Latimer-Cheung, A. E., Faulkner, G., Jones, R., Duggan, M., . . . Tomastone, J. R. (2020). Optimal messaging of the Canadian 24-Hour Movement Guidelines for Adults aged 18–64 years and Adults aged 65 years and older. *Applied Physiology, Nutrition, and Metabolism*, *45*, S125-S150. <https://doi.org/https://doi.org/10.1139/apnm-2020-0494>
- Fawkner, S., Niven, A., Hanson, S., Williamson, C., & Hanson, C. (2020). Physical activity for children and young people aged 5-18 years during COVID-19. Stay safe; be active. <https://blogs.bmj.com/bjism/2020/04/13/physical-activity-for-children-and-young-people-aged-5-18-years-during-covid-19-stay-safe-be-active/>
- Filion, A. J., Darlington, G., Chaput, J. P., Ybarra, M., & Haines, J. (2015). Examining the influence of a text message-based sleep and physical activity

- intervention among young adult smokers in the United States. *BMC public health*, 15(671), 671. <https://doi.org/10.1186/s12889-015-2045-2>
- Finlay, S.-J., & Faulkner, G. (2005). Physical activity promotion through the mass media: Inception, production, transmission and consumption. *Preventive Medicine*, 40(2), 121-130. <https://doi.org/10.1016/j.ypmed.2004.04.018>
- Finney, L. J., & Iannotti, R. J. (2002). Message Framing and Mammography Screening: A Theory-Driven Intervention. *Behavioral medicine (Washington, D.C.)*, 28(1), 5-14. <https://doi.org/10.1080/08964280209596393>
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior : an introduction to theory and research / Martin Fishbein and Icek Ajzen*. Addison-Wesley Pub. Co.
- Fjeldsoe, B. S., Miller, Y. D., & Marshall, A. L. (2010). MobileMums: A Randomized Controlled Trial of an SMS-Based Physical Activity Intervention. *Annals of behavioral medicine*, 39(2), 101-111. <https://doi.org/10.1007/s12160-010-9170-z>
- Fjeldsoe, B. S., Miller, Y. D., & Marshall, A. L. (2013). Social cognitive mediators of the effect of the MobileMums intervention on physical activity. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association*, 32(7), 729-738. <https://doi.org/https://dx.doi.org/10.1037/a0027548>
- Forouzanfar, M. H., Alexander, L., Anderson, H. R., Bachman, V. F., Biryukov, S., Brauer, M., . . . Benzian, H. (2015). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, 386(10010), 2287-2323. [https://doi.org/10.1016/S0140-6736\(15\)00128-2](https://doi.org/10.1016/S0140-6736(15)00128-2)
- Foster, C., Brennan, G., Matthews, A., McAdam, C., Fitzsimons, C., & Mutrie, N. (2011). Recruiting participants to walking intervention studies: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, 8(1), 137. <https://doi.org/10.1186/1479-5868-8-137>
- French, J. (2017). *Social Marketing and Public Health: Theory and Practice*. Oxford: Oxford University Press USA - OSO.
- Friedenreich, C. M., Stone, C. R., Cheung, W. Y., & Hayes, S. C. (2020). Physical activity and mortality in cancer survivors: A systematic review and meta-analysis. *JNCI cancer spectrum*, 4(1), pkz080-pkz080. <https://doi.org/10.1093/jncics/pkz080>
- Friel, S., Pescud, M., Malbon, E., Lee, A., Carter, R., Greenfield, J., . . . Meertens, B. (2017). Using systems science to understand the determinants of inequities in healthy eating. *PLoS ONE*, 12(11), e0188872. <https://doi.org/10.1371/journal.pone.0188872>

- Gale, N. K., Heath, G., Cameron, E., Rashid, S., & Redwood, S. (2013). Using the framework method for the analysis of qualitative data in multi-disciplinary health research.(Report). *BMC Medical Research Methodology*, 13(1). <https://doi.org/10.1186/1471-2288-13-117>
- Gallagher, K., & Updegraff, J. (2012). Health Message Framing Effects on Attitudes, Intentions, and Behavior: A Meta-analytic Review. *Annals of Behavioral Medicine*, 43(1), 101-116. <https://doi.org/10.1007/s12160-011-9308-7>
- Gallagher, K. M., & Updegraff, J. A. (2011). When 'fit' leads to fit, and when 'fit' leads to fat: How message framing and intrinsic vs. extrinsic exercise outcomes interact in promoting physical activity. *Psychology & Health*, 26(7), 819-834.
- Gallagher, M., Hares, T., Spencer, J., Bradshaw, C., & Webb, I. (1993). The Nominal Group Technique: A Research Tool for General Practice? *Family Practice*, 10(1), 76-81. <https://doi.org/10.1093/famp/10.1.76>
- Gaston, A., & Gammage, K. (2010). Health versus appearance messages, self-monitoring and pregnant women's intentions to exercise postpartum. *Journal of Reproductive and Infant Psychology*, 28(4), 345-358. <https://doi.org/10.1080/02646830903487367>
- Gaston, A., & Gammage, K. (2011). The effectiveness of a health-based message on pregnant women's intentions to exercise postpartum. *Journal of Reproductive and Infant Psychology*, 29(2), 162-169. <https://doi.org/10.1080/02646838.2010.541230>
- Gaziano, C. (1982). The Knowledge Gap: An Analytical Review of Media Effects. *Communication Research*, 10(4), 447-486.
- Gilbert, G., Williamson, C., Richards, J., Collyer, T. A., & Kelly, P. (2021). Do Framed Mental Health Messages on Social Media Influence University Students' Motivation for Physical Activity? *International Journal of Environmental Research and Public Health*, 18(16), 8671, 1-11. <https://doi.org/https://doi.org/10.3390/ijerph18168671>
- Giles-Corti, B., & Donovan, R. J. (2002). The relative influence of individual, social and physical environment determinants of physical activity. *Social science & medicine* (1982), 54(12), 1793-1812. [https://doi.org/10.1016/S0277-9536\(01\)00150-2](https://doi.org/10.1016/S0277-9536(01)00150-2) (Social Science & Medicine)
- Gill, J. M. (2022). Physical Activity and Mortality. In D. J. Stensel, A. E. Hardman, & J. M. Gill (Eds.), *Physical Activity and Health: The Evidence Explained* (Third ed.). Routledge.
- Gilson, N., Brown, W. J., Faulkner, G., McKenna, J., Murphy, M. S., Pringle, A., . . . Stathi, A. (2009). The International Universities Walking Project: development of a framework for workplace intervention using the Delphi technique. *Journal of Physical Activity & Health*, 6(4), 520-528. <https://doi.org/10.1123/jpah.6.4.520>

- Glaser, B. G., & Strauss, A. L. (1999). *The Discovery of Grounded Theory: Strategies for Qualitative Research* (1 ed.). Routledge.
<https://doi.org/10.4324/9780203793206>
- Glowacki, K., Duncan, M. J., Gainforth, H., & Faulkner, G. (2017). Barriers and facilitators to physical activity and exercise among adults with depression: A scoping review. *Mental health and physical activity*, 13, 108-119.
<https://doi.org/10.1016/j.mhpa.2017.10.001>
- Goodman, C. M. (1987). The Delphi technique: a critique. *Journal of Advanced Nursing*, 12(6), 729-734. <https://doi.org/10.1111/j.1365-2648.1987.tb01376.x>
- Graham, D. J., & Graham, J. F. (2008). Improving media campaigns promoting physical activity: the underutilized role of gender. *International Journal of Nonprofit and Voluntary Sector Marketing*, 13(3), 205-213.
<https://doi.org/10.1002/nvsm.323>
- Green, B., Jones, M., Hughes, D., & Williams, A. (1999). Applying the Delphi technique in a study of GPs' information requirements. *Health & Social Care in the Community*, 7(3), 198-205. <https://doi.org/10.1046/j.1365-2524.1999.00176.x>
- Green, J. (2015). *Health promotion : planning and strategies* (Third edition.. ed.). Los Angeles : SAGE.
- Green, L. W. (1999). *Health promotion planning : an educational and ecological approach* (Third edition.. ed.). Mountain View, Ca. : Mayfield.
- Grier, S., & Bryant, C. A. (2005). SOCIAL MARKETING IN PUBLIC HEALTH. In (Vol. 26, pp. 319-339).
- Groshong, L., Stanis, S. A. W., Kaczynski, A. T., Hipp, J. A., & Besenyi, G. M. (2017). Exploring Attitudes, Perceived Norms, and Personal Agency: Insights Into Theory-Based Messages to Encourage Park-Based Physical Activity in Low-Income Urban Neighborhoods. *Journal of physical activity & health*, 14(2), 108. <https://doi.org/10.1123/jpah.2016-0069>
- Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, 6(10), e1077-e1086. [https://doi.org/10.1016/S2214-109X\(18\)30357-7](https://doi.org/10.1016/S2214-109X(18)30357-7)
- Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. *The lancet child & adolescent health*, 4(1), 23-35. [https://doi.org/10.1016/S2352-4642\(19\)30323-2](https://doi.org/10.1016/S2352-4642(19)30323-2)
- Hagger, M. S., & Weed, M. (2019). DEBATE: Do interventions based on behavioral theory work in the real world?(Report). *The International Journal of Behavioral Nutrition and Physical Activity*, 16(1).
<https://doi.org/10.1186/s12966-019-0795-4>

- Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., & Ekelund, U. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. *The Lancet*, 380(9838), 247-257. [https://doi.org/10.1016/S0140-6736\(12\)60646-1](https://doi.org/10.1016/S0140-6736(12)60646-1)
- Hanson, C., Hanson, S., Fawkner, S., Tomaz, S., Niven, A., Williamson, C., . . . Neubeck, L. (2020, January 7th). Physical activity during COVID-19; a series of blogs and infographics. <https://blogs.bmj.com/bjbm/2020/05/19/physical-activity-during-covid-19-a-series-of-blogs-and-infographics/>
- Hanson, C., Kelly, P., Pearsons, A., Williamson, C., McHale, S., & Neubeck, L. (2020). Stay calm, be active: simple ways to boost your physical activity during COVID-19. https://blogs.bmj.com/bjbm/2020/03/30/stay-calm-be-active-simple-ways-to-boost-your-physical-activity-during-covid-19/?int_source=trendmd&int_medium=cpc&int_campaign=usage-042019
- Hanson, C., Oliver, E., Dodd-Reynolds, C., Pearsons, A., & Kelly, P. (2020). A modified Delphi study to gain consensus for a taxonomy to report and classify physical activity referral schemes (PARS). *The international journal of behavioral nutrition and physical activity*, 17(1), 158-158. <https://doi.org/10.1186/s12966-020-01050-2>
- Hargie, O. (2016). *Skilled Interpersonal Communication : Research, Theory and Practice* (6th edition ed.). Taylor & Francis Group.
- Harrison, A. L., Taylor, N. F., Frawley, H. C., & Shields, N. (2019). Women with gestational diabetes mellitus want clear and practical messages from credible sources about physical activity during pregnancy: a qualitative study. *Journal of Physiotherapy*, 65(1), 37-42. <https://doi.org/10.1016/j.jphys.2018.11.007>
- Hartley, P. (1999). *Interpersonal communication / Peter Hartley* (Second edition. ed.). Routledge.
- Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., . . . Bauman, A. (2007). Physical Activity and Public Health: Updated Recommendation for Adults from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise*, 39(8), 1423-1434.
- Hasson, F., & Keeney, S. (2011). Enhancing rigour in the Delphi technique research. *Technological Forecasting & Social Change*, 78(9), 1695-1704. <https://doi.org/10.1016/j.techfore.2011.04.005>
- Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*, 32(4), 1008-1015. <https://doi.org/10.1046/j.1365-2648.2000.t01-1-01567.x>
- Hastings, G. (2007). *The Potential of Social Marketing: Why Should the Devil Have All the Best Tunes?* (Vol. 13). Elsevier. <https://doi.org/10.1080/15245000701343934>

- Hastings, G. (2018). *Social marketing* (Third edition.. ed.). Abingdon, Oxon ; New York, NY : Routledge.
- Hatchell, A. C., Bassett-Gunter, R. L., Clarke, M., Kimura, S., & Latimer-Cheung, A. E. (2013). Messages for Men: The Efficacy of EPPM-Based Messages Targeting Men's Physical Activity. *Health Psychology, 32*(1), 24-32. <https://doi.org/10.1037/a0030108>
- Haughton McNeill, L., Wyrwich, K. W., Brownson, R. C., Clark, E. M., & Kreuter, M. W. (2006). Individual, social environmental, and physical environmental influences on physical activity among black and white Adults: A Structural Equation Analysis. *Annals of behavioral medicine, 31*(1), 36-44. https://doi.org/10.1207/s15324796abm3101_7
- Hawe, P., Shiell, A., & Riley, T. (2009). Theorising Interventions as Events in Systems. *American Journal of Community Psychology, 43*(3-4), 267-276. <https://doi.org/10.1007/s10464-009-9229-9>
- Heath, G. W. P., Parra, D. C. M. P. H., Sarmiento, O. L. M. D., Andersen, L. B. P., Owen, N. P., Goenka, S. P., . . . Brownson, R. C. P. (2012). Evidence-based intervention in physical activity: lessons from around the world. *The Lancet (British edition), 380*(9838), 272-281. [https://doi.org/10.1016/S0140-6736\(12\)60816-2](https://doi.org/10.1016/S0140-6736(12)60816-2)
- Hendry, M., Williams, N. H., Markland, D., Wilkinson, C., & Maddison, P. (2006). Why should we exercise when our knees hurt? A qualitative study of primary care patients with osteoarthritis of the knee. *Family practice, 23*(5), 558-567. <https://doi.org/10.1093/fampra/cml022>
- Herbert, G., Butler, L., Kennedy, O., & Lobb, A. (2010). Young UK adults and the 5 A DAY campaign: perceived benefits and barriers of eating more fruits and vegetables: Young adults and the 5 A DAY campaign. *International journal of consumer studies, 34*(6), 657-664. <https://doi.org/10.1111/j.1470-6431.2010.00872.x>
- Hevel, D. J., Amorose, A. J., Lagally, K. M., Rinaldi-Miles, A., & Pierce, S. (2019). Testing the effects of messaging on physical activity motivation in active and non-active adults. *Psychology of Sport & Exercise, 43*, 333-342.
- Hill, C., Abraham, C., & Wright, D. B. (2007). Can theory-based messages in combination with cognitive prompts promote exercise in classroom settings? *Social Science & Medicine, 65*(5), 1049-1058. <https://doi.org/10.1016/j.socscimed.2007.04.024>
- Hirschey, R., Lipkus, I., Jones, L., Mantyh, C., Sloane, R., & Demark-Wahnefried, W. (2016). Message framing and physical activity promotion in colorectal cancer survivors.(Report). *Oncology nursing forum, 43*(6), 697. <https://doi.org/10.1188/16.ONF.43-06AP>
- Howle, T. C., Dimmock, J. A., Ntoumanis, N., Chatzisarantis, N. L. D., Sparks, C., & Jackson, B. (2017). The Impact of Agentic and Communal Exercise Messages on Individuals' Exercise Class Attitudes, Self-Efficacy Beliefs, and

- Intention to Attend. *Journal of sport & exercise psychology*, 39(6), 397.
<https://doi.org/10.1123/jsep.2017-0084>
- Huberty, J. L., Buman, M. P., Leiferman, J. A., Bushar, J., Hekler, E. B., & Adams, M. A. (2017). Dose and timing of text messages for increasing physical activity among pregnant women: a randomized controlled trial. *Translational Behavioral Medicine*, 7(2), 212-223. <https://doi.org/10.1007/s13142-016-0445-1>
- Hubley, J. (1993). *Communicating health : an action guide to health education and health promotion*. London : Macmillan.
- Huhman, M., Kelly, R., & Edgar, T. (2017). Social Marketing as a Framework for Youth Physical Activity Initiatives: a 10-Year Retrospective on the Legacy of CDC's VERB Campaign. *Current Obesity Reports*, 6(2), 101-107.
<https://doi.org/10.1007/s13679-017-0252-0>
- Huhman, M., Potter, L. D., Wong, F. L., Banspach, S. W., Duke, J. C., & Heitzler, C. D. (2005). Effects of a mass media campaign to increase physical activity among children: year-1 results of the VERB campaign.(Author Abstract). *Pediatrics*, 116(2), 487. <https://doi.org/10.1542/peds.2005-0043>
- Hunter, R. F., Boeri, M., Tully, M. A., Donnelly, P., & Kee, F. (2015). Addressing inequalities in physical activity participation: Implications for public health policy and practice. *Preventive medicine*, 72, 64-69.
<https://doi.org/10.1016/j.ypmed.2014.12.040>
- Institute of Medicine. (2003). *The future of the public's health in the 21st century*. National Academies Press.
- International Society for Physical Activity and Health. (2010). *The Toronto Charter for Physical Activity: A Global Call to Action*.
<https://www.globalpa.org.uk/pdf/torontocharter-eng-20may2010.pdf>
- International Society for Physical Activity and Health. (2011). *NCD Prevention: Investments that Work for Physical Activity*.
<https://www.globalpa.org.uk/pdf/investments-work.pdf>
- International Society for Physical Activity and Health. (2020). *ISPAH's Eight Investments That Work for Physical Activity*. <http://www.ispah.org/Resources>
- Jaarsma, E. A., Haslett, D., & Smith, B. (2019). Improving Communication of Information About Physical Activity Opportunities for People With Disabilities. *Adapted Physical Activity Quarterly*, 36(2), 185-201.
- Jamieson, M. (2013). *Ethnicity and Religion in Northumberland: Northumberland Knowledge Research Report*.
<https://www.northumberland.gov.uk/NorthumberlandCountyCouncil/media/Northumberland-Knowledge/NK%20people/Demographics/Ethnicity-and-Religion-March-2013.pdf>

- Janz, N., & Becker, M. (1984). The **health belief model**: A decade later. *Health Education Quarterly*, 11(1), 1-47.
<https://doi.org/https://doi.org/10.1177/109019818401100101>
- Jarvis, J., Gainforth, H., & Latimer-Cheung, A. (2014). Investigating the effect of message framing on parents' engagement with advertisements promoting child physical activity. *International Review on Public and Nonprofit Marketing*, 11(2), 115-127. <https://doi.org/10.1007/s12208-013-0110-z>
- Johnston, C., & Davis, W. E. (2019). Motivating exercise through social media: Is a picture always worth a thousand words? *Psychology of Sport & Exercise*, 41, 119-126. <https://doi.org/10.1016/j.psychsport.2018.12.012>
- Jones, L. W., Sinclair, R. C., & Courneya, K. S. (2003). The Effects of Source Credibility and Message Framing on Exercise Intentions, Behaviors, and Attitudes: An Integration of the Elaboration Likelihood Model and Prospect Theory1. *Journal of Applied Social Psychology*, 33(1), 179-196.
<https://doi.org/10.1111/j.1559-1816.2003.tb02078.x>
- Jünger, S., Payne, S. A., Brine, J., Radbruch, L., & Brearley, S. G. (2017). Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. In (Vol. 31, pp. 684-706). London, England.
- Kang, Y., O'Donnell, M. B., Strecher, V. J., & Falk, E. B. (2017). Dispositional Mindfulness Predicts Adaptive Affective Responses to Health Messages and Increased Exercise Motivation.(Report)(Author abstract). *Mindfulness*, 8(2), 387. <https://doi.org/10.1007/s12671-016-0608-7>
- Kaplan, A., Skogstad, A. L., & Girshick, M. A. (1950). The Prediction of Social and Technological Events. *The Public Opinion Quarterly*, 14(1), 93-110.
<https://doi.org/10.1086/266153>
- Keeney, S., Hasson, F., & McKenna, H. (2011). *The Delphi Technique in Nursing and Health Research*. <https://doi.org/10.1002/9781444392029>
- Keeney, S., Hasson, F., & McKenna, H. P. (2001). A critical review of the Delphi technique as a research methodology for nursing. *International Journal of Nursing Studies*, 38(2), 195-200. [https://doi.org/10.1016/S0020-7489\(00\)00044-4](https://doi.org/10.1016/S0020-7489(00)00044-4)
- Kelly, P., Williamson, C., Niven, A. G., Hunter, R., Mutrie, N., & Richards, J. (2018). Walking on sunshine: scoping review of the evidence for walking and mental health. In *Br. J. Sports Med.* (Vol. 52, pp. 800-+).
- Ketteridge, A., & Boshoff, K. (2008). Exploring the reasons why adolescents participate in physical activity and identifying strategies that facilitate their involvement in such activity. *Australian occupational therapy journal*, 55(4), 273-282. <https://doi.org/10.1111/j.1440-1630.2007.00704.x>
- Kieffer, E. C., Willis, S. K., Arellano, N., & Guzman, R. (2002). Perspectives of Pregnant and Postpartum Latino Women on Diabetes, Physical Activity, and

Health. *Health education & behavior*, 29(5), 542-556.
<https://doi.org/10.1177/109019802237023>

- Kim, A. C. H., Park, S. H., Kim, S., & Fontes-Comber, A. (2020). Psychological and social outcomes of sport participation for older adults: a systematic review. *Ageing and society*, 40(7), 1529-1549.
<https://doi.org/10.1017/S0144686X19000175>
- Kin-Kit, L., Sheung-Tak, C., & Fung, H. H. (2014). Effects of Message Framing on Self-Report and Accelerometer-Assessed Physical Activity Across Age and Gender Groups. *Journal of Sport & Exercise Psychology*, 36(1), 40-51.
- Kinnafick, F. E., Thogersen - Ntoumani, C., & Duda, J. L. (2016). The effect of need supportive text messages on motivation and physical activity behaviour. 39(4). <https://doi.org/10.1007/s10865-016-9722-1>
- Klepac Pogrmilovic, B., O'Sullivan, G., Milton, K., Biddle, S. J. H., Bauman, A., Bellew, W., . . . Pedisic, Z. (2019). The development of the Comprehensive Analysis of Policy on Physical Activity (CAPPA) framework. *The international journal of behavioral nutrition and physical activity*, 16(1), 60.
<https://doi.org/10.1186/s12966-019-0822-5>
- Knox, E. C. L., Webb, O. J., Esliger, D. W., Biddle, S. J. H., & Sherar, L. B. (2014). Using threshold messages to promote physical activity: implications for public perceptions of health effects. *The European Journal of Public Health*, 24(2), 195-199. <https://doi.org/10.1093/eurpub/ckt060>
- Kohl, H. W. P. D., Craig, C. L. M., Lambert, E. V. P., Inoue, S. P., Alkandari, J. R. P., Leetongin, G. M. D., & Kahlmeier, S. P. (2012). The pandemic of physical inactivity: global action for public health. *The Lancet (British edition)*, 380(9838), 294-305. [https://doi.org/10.1016/S0140-6736\(12\)60898-8](https://doi.org/10.1016/S0140-6736(12)60898-8)
- Kozak, A. T., Nguyen, C., Yanos, B. R., & Fought, A. (2013). Persuading Students to Exercise: What Is the Best Way to Frame Messages for Normal-Weight Versus Overweight/Obese University Students? *Journal of American College Health*, 61(5), 264-273.
- Kreuter, M., Strecher, V., & Glassman, B. (1999). One size does not fit all: The case for tailoring print materials. *Annals of Behavioral Medicine*, 21(4), 276-283.
<https://doi.org/10.1007/BF02895958>
- Kreuter, M. W., Lukwago, S. N., Bucholtz, D. C., Clark, E. M., & Sanders-Thompson, V. (2003). Achieving Cultural Appropriateness in Health Promotion Programs: Targeted and Tailored Approaches. *Health education & behavior*, 30(2), 133-146. <https://doi.org/10.1177/1090198102251021>
- Kreuter, M. W., & Wray, R. J. (2003). Tailored and Targeted Health Communication: Strategies for Enhancing Information Relevance. *American journal of health behavior*, 27(3), S227-S232. <https://doi.org/10.5993/ajhb.27.1.s3.6>
- Kwak, N. (1999). Revisiting the Knowledge Gap Hypothesis: Education, Motivation, and Media Use. *Communication research*, 26(4), 385-413.
<https://doi.org/10.1177/009365099026004002>

- Lankford, T., Wallace, J., Brown, D., Soares, J., Epping, J., & Fridinger, F. (2014). Analysis of Physical Activity Mass Media Campaign Design. *J. Phys. Act. Health*, 11(6), 1065-1069. <https://doi.org/10.1123/jpah.2012-0303>
- Larocca, V., Arbour-Nicitopoulos, K. P., Tomasone, J. R., Latimer-Cheung, A. E., & Bassett-Gunter, R. L. (2021). Developing and Disseminating Physical Activity Messages Targeting Parents: A Systematic Scoping Review. *International journal of environmental research and public health*, 18(13), 7046. <https://doi.org/10.3390/ijerph18137046>
- Laswell, H. (1948). The structure and function of communication in society. In D. McQuail & S. Windahl (Eds.), *Communication Models: For the Study of Mass Communication* (2nd ed.). Pearson Education Limited.
- Latimer, A. E., Brawley, L., & Bassett, R. (2010). A systematic review of three approaches for constructing physical activity messages: What messages work and what improvements are needed? In *Int. J. Behav. Nutr. Phys. Act.* (Vol. 7).
- Latimer, A. E., Rench, T. A., Rivers, S. E., Katulak, N. A., Materese, S. A., Cadmus, L., . . . Salovey, P. (2008). Promoting participation in physical activity using framed messages: An application of prospect theory. *British Journal of Health Psychology*, 13(4), 659-681.
- Latimer, A. E., Rivers, S. E., Rench, T. A., Katulak, N. A., Hicks, A., Hodorowski, J. K., . . . Salovey, P. (2008). A field experiment testing the utility of regulatory fit messages for promoting physical activity. *Journal of Experimental Social Psychology*, 44(3), 826-832. <https://doi.org/10.1016/j.jesp.2007.07.013>
- Latimer-Cheung, A. E., Rhodes, R., Kho, M. E., Tomasone, Jr., Gainforth, H. L., Kowalski, K., . . . Duggan, M. (2013). Evidence-informed recommendations for constructing and disseminating messages supplementing the new Canadian Physical Activity Guidelines. *BMC Public Health*, 13. <https://doi.org/10.1186/1471-2458-13-419>
- Lavis, J. N., Robertson, D., Woodside, J. M., McLeod, C. B., & Abelson, J. (2003). How Can Research Organizations More Effectively Transfer Research Knowledge to Decision Makers? *The Milbank quarterly*, 81(2), 221-248. <https://doi.org/10.1111/1468-0009.t01-1-00052>
- Leahy, J., Shugrue, M., Daigle, J., & Daniel, H. (2009). Local and Visitor Physical Activity through Media Messages: A Specialized Benefits-Based Management Application at Acadia National Park. *Journal of park and recreation administration*, 27(3), 59-77.
- Leavy, J., Bauman, A. E., Rosenberg, M., & Bull, F. C. (2014). Examining the Communication Effects of Health Campaigns: A Case Study Using Find Thirty Every Day® in Western Australia. *SAGE Open*, 4(2). <https://doi.org/10.1177/2158244014533557>
- Leavy, J., Rosenberg, M., Bull, F., Corti, B. G., Shilton, T., Maitland, C., . . . Bauman, A. (2011). Effects of Find Thirty every day: Cross sectional findings from a Western Australian population wide mass media campaign 2008–

2010. *Journal of Science and Medicine in Sport*, 14, e27-e27.
<https://doi.org/10.1016/j.jsams.2011.11.054>
- Leavy, J. E., Bauman, A. E., Rosenberg, M., & Bull, F. C. (2014). Examining the Communication Effects of Health Campaigns. *SAGE Open*, 4(2), 215824401453355. <https://doi.org/10.1177/2158244014533557>
- Leavy, J. E., Bull, F. C., Rosenberg, M., & Bauman, A. (2011). Physical activity mass media campaigns and their evaluation: a systematic review of the literature 2003-2010. *Health Educ Res*, 26(6), 1060-1085.
<https://doi.org/10.1093/her/cyr069>
- Leavy, J. E., Bull, F. C., Rosenberg, M., & Bauman, A. (2011). Physical activity mass media campaigns and their evaluation: a systematic review of the literature 2003–2010. *Health Education Research*, 26(6), 1060-1085.
<https://doi.org/10.1093/her/cyr069>
- Leavy, J. E., Rosenberg, M., Bauman, A. E., Bull, F. C., Giles-Corti, B., Shilton, T., . . . Barnes, R. (2013). Effects of Find Thirty every day(R): cross-sectional findings from a Western Australian population-wide mass media campaign, 2008-2010. *Health Educ Behav*, 40(4), 480-492.
<https://doi.org/10.1177/1090198112459515>
- Leavy, J. E., Rosenberg, M., Bull, F. C., & Bauman, A. E. (2014). Who do we reach? Campaign evaluation of Find Thirty every day(R) using awareness profiles in a Western Australian cohort. *J Health Commun*, 19(7), 853-869.
<https://doi.org/10.1080/10810730.2013.837560>
- Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Katzmarzyk, P. T. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet*, 380(9838), 219-229. <https://doi.org/10.5167/uzh-69553>
- Lee, Y. O., Curry, L. E., Fiacco, L., Henes, A., Farrelly, M. C., Nonnemaker, J. M., . . . Walker, M. W. (2019). Peer crowd segmentation for targeting public education campaigns: Hip hop youth and tobacco use. *Preventive medicine reports*, 14, 100843-100843. <https://doi.org/10.1016/j.pmedr.2019.100843>
- Lehne, G., & Bolte, G. (2017). Impact of universal interventions on social inequalities in physical activity among older adults: An equity-focused systematic review. *The international journal of behavioral nutrition and physical activity*, 14(1), 20-20. <https://doi.org/10.1186/s12966-017-0472-4>
- Leone, L. A., Campbell, M. K., Allicock, M., & Pignone, M. (2012). Colorectal Cancer Screening and Physical Activity Promotion Among Obese Women: An Online Evaluation of Targeted Messages. *Journal of Health Communication*, 17(10), 1-17. <https://doi.org/10.1080/10810730.2012.665422>
- Lesser, I. A., & Nienhuis, C. P. (2020). The Impact of COVID-19 on Physical Activity Behavior and Well-Being of Canadians. *International journal of environmental research and public health*, 17(11), 3899.
<https://doi.org/10.3390/ijerph17113899>

- Letts, L., Martin Ginis, K. A., Faulkner, G., Colquhoun, H., Levac, D., & Gorczynski, P. (2011). Preferred Methods and Messengers for Delivering Physical Activity Information to People With Spinal Cord Injury: A Focus Group Study. *Rehabilitation Psychology, 56*(2), 128-137. <https://doi.org/10.1037/a0023624>
- Levac, D., Colquhoun, H., & Brien, K. K. (2010). Scoping studies: Advancing the methodology. *Implementation Science, 5*(1), <xocs:firstpage xmlns:xocs=""/>. <https://doi.org/10.1186/1748-5908-5-69>
- Lewis, C. C., Klasnja, P., Powell, B. J., Lyon, A. R., Tuzzio, L., Jones, S., . . . Weiner, B. (2018). From Classification to Causality: Advancing Understanding of Mechanisms of Change in Implementation Science. *Frontiers in public health, 6*, 136-136. <https://doi.org/10.3389/fpubh.2018.00136>
- Li, K., Lorna, N., Sheung-Tak, C., Helene, H. F., Li, K.-K., Ng, L., . . . Fung, H. H. (2017). Reverse Message-Framing Effects on Accelerometer-Assessed Physical Activity Among Older Outpatients With Type 2 Diabetes. *Journal of Sport & Exercise Psychology, 39*(3), 222-227.
- Lim, S., Vos, T., Flaxman, A., Danaei, G., Shibuya, K., Adair-Rohani, H., . . . Kok, C. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. [https://doi.org/10.1016/S0140-6736\(12\)61766-8](https://doi.org/10.1016/S0140-6736(12)61766-8)
- Lithopoulos, A., Bassett-Gunter, R. L., Martin Ginis, K. A., & Latimer-Cheung, A. E. (2017). The Effects of Gain- versus Loss-Framed Messages Following Health Risk Information on Physical Activity in Individuals With Multiple Sclerosis. *Journal of Health Communication, 22*(6), 523-531. <https://doi.org/10.1080/10810730.2017.1318983>
- Luszczynska, A., & Schwarzer, R. (2005). Social cognitive theory. In M. Connor & P. Norman (Eds.), *Predicting Health Behavior*. Open University Press.
- Lynn, R. M., Layman, L. E., & Englehardt, P. S. (1998). Nursing Administration Research Priorities: A National Delphi Study. *The Journal of Nursing Administration, 28*(5), 7-11. <https://doi.org/10.1097/00005110-199805000-00002>
- Mailey, E. L., & Hsu, W.-W. (2019). Is a general or specific exercise recommendation more effective for promoting physical activity among postpartum mothers? *Journal of health psychology, 24*(7), 964-978. <https://doi.org/10.1177/1359105316687627>
- Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample Size in Qualitative Interview Studies: Guided by Information Power. *Qualitative health research, 26*(13), 1753-1760. <https://doi.org/10.1177/1049732315617444>
- Mandolesi, L., Polverino, A., Montuori, S., Foti, F., Ferraioli, G., Sorrentino, P., & Sorrentino, G. (2018). Effects of physical exercise on cognitive functioning and wellbeing: Biological and psychological benefits. *Frontiers in psychology, 9*, 509-509. <https://doi.org/10.3389/fpsyg.2018.00509>

- Marcus. (2010). Physical Activity Intervention Studies: What We Know and What We Need to Know: A Scientific Statement From the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity); Council on Cardiovascular Disease in the Young; and the Interdisciplinary Working Group on Quality of Care and Outcomes Research (vol 114, pg 2739, 2006). *Circulation*, 122(1), E8-E8. <https://doi.org/10.1161/CIR.0b013e3181e65c8d>
- Marcus, B., Owen, N., Forsyth, L., Cavill, N., & Fridinger, F. (1998). Physical activity interventions using mass media, print media, and information technology. *American Journal of Preventive Medicine*, 15(4), 362-378. [https://doi.org/10.1016/S0749-3797\(98\)00079-8](https://doi.org/10.1016/S0749-3797(98)00079-8)
- Marmo, J. (2013). Applying Social Cognitive Theory to Develop Targeted Messages: College Students and Physical Activity. *Western Journal of Communication*, 77(4), 444-465. <https://doi.org/10.1080/10570314.2012.681101>
- Marshall, A. L., Owen, N., & Bauman, A. E. (2004). Mediated approaches for influencing physical activity: update of the evidence on mass media, print, telephone and website delivery of interventions. *Journal of Science and Medicine in Sport*, 7(1), 74-80. [https://doi.org/10.1016/S1440-2440\(04\)80281-0](https://doi.org/10.1016/S1440-2440(04)80281-0)
- Martin Ginis, K. A., van der Ploeg, H. P., Foster, C., Lai, B., McBride, C. B., Ng, K., . . . Heath, G. W. (2021). Participation of people living with disabilities in physical activity: a global perspective. *The Lancet (British edition)*, 398(10298), 443-455. [https://doi.org/10.1016/S0140-6736\(21\)01164-8](https://doi.org/10.1016/S0140-6736(21)01164-8)
- Martinez, J. L., Duncan, L. R., Rivers, S. E., Latimer, A. E., & Salovey, P. (2013). Examining the use of message tailoring to promote physical activity among medically underserved adults. *Journal of Health Psychology*, 18(4), 470-476. <https://doi.org/10.1177/1359105312445798>
- Maslow, A. H. (1943). A theory of human motivation. *Psychological review*, 50(4), 370-396. <https://doi.org/10.1037/h0054346>
- McCall, L. A., & Ginis, K. A. M. (2004). The Effects of Message Framing on Exercise Adherence and Health Beliefs Among Patients in a Cardiac Rehabilitation Program. *Journal of Applied Biobehavioral Research*, 9(2), 122-135. <https://doi.org/10.1111/j.1751-9861.2004.tb00096.x>
- McCormack, G. R., Friedenreich, C. M., Giles-Corti, B., Doyle-Baker, P. K., & Shiell, A. (2013). Do Motivation-Related Cognitions Explain the Relationship Between Perceptions of Urban Form and Neighborhood Walking? *Journal of Physical Activity & Health*, 10(7), 961-973.
- McCoy, P., Leggett, S., Bhuiyan, A., Brown, D., Frye, P., & Williams, B. (2017). Text Messaging: An Intervention to Increase Physical Activity among African American Participants in a Faith-Based, Competitive Weight Loss Program. *Int. J. Environ. Res. Public Health*, 14(4). <https://doi.org/10.3390/ijerph14040326>

- McGuire, W. (1969). Attitudes and attitude change. In R. Rice & W. Paisley (Eds.), *Public Communication Campaigns*. Sage.
- McKenna, H. P. (1994). The Delphi technique: a worthwhile research approach for nursing? *Journal of Advanced Nursing*, 19(6), 1221-1225.
<https://doi.org/10.1111/j.1365-2648.1994.tb01207.x>
- McLeroy, K., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education & Behavior*, 15, 351-377.
- McQuail, D., & Windahl, S. (1993). *Communication Models: for the Study of Mass Communication* (2nd ed.). Pearson Education Limited.
- Mehtala, M., Saakslanti, A., Inkinen, M. E., & Poskiparta, M. (2014). A socio-ecological approach to physical activity interventions in childcare: a systematic review. *Int. J. Behav. Nutr. Phys. Act.*, 11(1).
<https://doi.org/10.1186/1479-5868-11-22>
- Mendez, R. D. R., Rodrigues, R. C. M., Spana, T. M., Cornélio, M. E., Gallani, M. C. B. J., & Pérez-Nebra, A. R. (2012). Validation of persuasive messages for the promotion of physical activity among people with coronary heart disease. *Revista Latino-Americana de Enfermagem*, 20(6), 1015-1023.
<https://doi.org/10.1590/S0104-11692012000600002>
- Metcalf, J., & Mischel, W. (1999). A Hot/Cool-System Analysis of Delay of Gratification: Dynamics of Willpower. *Psychological review*, 106(1), 3-19.
<https://doi.org/10.1037/0033-295X.106.1.3>
- Michalovic, E., Hall, S., Duncan, L. R., Bassett-Gunter, R., & Sweet, S. N. (2018). Understanding the Effects of Message Framing on Physical Activity Action Planning: the Role of Risk Perception and Elaboration. *International journal of behavioral medicine*, 25(6), 626-636.
<https://doi.org/https://dx.doi.org/10.1007/s12529-018-9746-8>
- Michie, S., & Abraham, C. (2004). Interventions to change health behaviours: evidence-based or evidence-inspired? *Psychology & health*, 19(1), 29-49.
<https://doi.org/10.1080/0887044031000141199>
- Michie, S., & Prestwich, A. (2010). Are Interventions Theory-Based? Development of a Theory Coding Scheme. *Health Psychology*, 29(1), 1-8.
<https://doi.org/10.1037/a0016939>
- Michie, S., Stralen, v. M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science*, 6.
- Milio, N. (2001). Glossary: healthy public policy. *Journal of epidemiology and community health* (1979), 55(9), 622-623.
<https://doi.org/10.1136/jech.55.9.622>
- Milton, K., Bauman, A. E., Faulkner, G., Hastings, G., Bellew, W., Williamson, C., & Kelly, P. (2020). Maximising the impact of global and national physical activity guidelines: the critical role of communication strategies. *British*

journal of sports medicine, 54(24), 1463-1467.
<https://doi.org/10.1136/bjsports-2020-102324>

- Miyachi, M., Tripette, J., Kawakami, R., & Murakami, H. (2015). "+10 min of Physical Activity per Day": Japan Is Looking for Efficient but Feasible Recommendations for Its Population. *J. Nutr. Sci. Vitaminol.*, 61, S7-S9.
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*, 339(jul21 1), b2535-b2535. <https://doi.org/10.1136/bmj.b2535>
- Morgan, D. L. (1997). *Focus groups as qualitative research* (Second edition.. ed.). Thousand Oaks, Calif. ; London : Sage.
- Morris, J. N., Heady, J. A., Raffle, P. A. B., Roberts, C. G., & Parks, J. W. (1953). CORONARY HEART- DISEASE AND PHYSICAL ACTIVITY OF WORK. *The Lancet*, 262(6795), 1053-1057. [https://doi.org/10.1016/S0140-6736\(53\)90665-5](https://doi.org/10.1016/S0140-6736(53)90665-5)
- Morton, S. (2015). Progressing research impact assessment: A 'contributions' approach. *Research Evaluation*, 24(4), 405-419. <https://doi.org/10.1093/reseval/rvv016>
- Murray, A. D., Archibald, D., Murray, I. R., Hawkes, R. A., Foster, C., Barker, K., . . . Mutrie, N. (2018). 2018 International Consensus Statement on Golf and Health to guide action by people, policymakers and the golf industry. *British Journal of Sports Medicine*, 52(22), 1426. <https://doi.org/10.1136/bjsports-2018-099509>
- Murtagh, E. M., Archibald, K., Doherty, A., Mutrie, N., Breslin, G., Lambe, B., . . . Murphy, M. (2014). 150 minutes per week or 30 minutes on 5 days? The effect of brief advice about physical activity recommendations on moderate-to-vigorous activity of inactive adults. In U. o. Limerick (Ed.).
- Mutrie, N., Campbell, A. M., Whyte, F., McConnachie, A., Emslie, C., Lee, L., . . . Ritchie, D. (2007). Benefits of supervised group exercise programme for women being treated for early stage breast cancer: pragmatic randomised controlled trial. *BMJ*, 334(7592), 517-520. <https://doi.org/10.1136/bmj.39094.648553.AE>
- Napolitano, A. M., & Marcus, H. B. (2002). Targeting and Tailoring Physical Activity Information Using Print and Information Technologies. *Exercise and sport sciences reviews*, 30(3), 122-128. <https://doi.org/10.1097/00003677-200207000-00006>
- Nau, T., Lee, K., Smith, B. J., Bellew, W., Reece, L., Gelius, P., . . . Bauman, A. (2019). Toward Whole-of-System Action to Promote Physical Activity: A Cross-Sectoral Analysis of Physical Activity Policy in Australia. *Journal of physical activity & health*, 16(11), 1029-1038. <https://doi.org/10.1123/jpah.2019-0122>
- Negron, R., Martin, A., Almog, M., Balbierz, A., & Howell, E. A. (2012). Social Support During the Postpartum Period: Mothers' Views on Needs,

- Expectations, and Mobilization of Support. *Maternal and child health journal*, 17(4), 616-623. <https://doi.org/10.1007/s10995-012-1037-4>
- Neubeck, L., McHale, S., Williamson, C., Kelly, P., Pearsons, A., Hanson, S., & Hanson, C. (2020). For the 'at-risk' or vulnerable COVID-19 group: staying or becoming active during social distancing In: *British Journal of Sports Medicine*.
- Nicholson, L. (2012a). *Development of key themes for physical activity promotion for adults - Summary report*.
- Nicholson, L. (2012b). *Development of key themes for physical activity promotion for the early years, children and young people*.
- Nicoloro-SantaBarbara, J., Rosenthal, L., Auerbach, M. V., Kocis, C., Busso, C., & Lobel, M. (2017). Patient-provider communication, maternal anxiety, and self-care in pregnancy. *Social science & medicine (1982)*, 190, 133-140. <https://doi.org/10.1016/j.socscimed.2017.08.011>
- Noar, S. M., Benac, C. N., & Harris, M. S. (2007). Does Tailoring Matter? Meta-Analytic Review of Tailored Print Health Behavior Change Interventions. *Psychological Bulletin*, 133(4), 673-693. <https://doi.org/10.1037/0033-2909.133.4.673>
- Nobles, J., Thomas, C., Gross, Z. B., Hamilton, M., Trinder-Widdess, Z., Speed, C., . . . Redwood, S. (2020). "Let's Talk about Physical Activity": Understanding the Preferences of Under-Served Communities When Messaging Physical Activity Guidelines to the Public. *International Journal of Environmental Research and Public Health*, 17(2782), 2782. <https://doi.org/10.3390/ijerph17082782>
- Nobles, J. D., Radley, D., & Mytton, O. T. (2021). The Action Scales Model: A conceptual tool to identify key points for action within complex adaptive systems. *Perspectives in public health*, 17579139211006747-17579139211006747. <https://doi.org/10.1177/17579139211006747>
- Nocon, M., Müller-Riemenschneider, F., Nitzschke, K., & Willich, S. N. (2010). Review Article: Increasing physical activity with point-of-choice prompts - a systematic review. *Scandinavian Journal of Public Health*, 38(6), 633-638. <https://doi.org/10.1177/1403494810375865>
- Notthoff, N., & Carstensen, L. L. (2014). Positive Messaging Promotes Walking in Older Adults. *Psychology and Aging*, 29(2), 329-341. <https://doi.org/10.1037/a0036748>
- Notthoff, N., Klomp, P., Doerwald, F., & Scheibe, S. (2016). Positive messages enhance older adults' motivation and recognition memory for physical activity programmes. *Social, Behavioural and Health Perspectives*, 13(3), 251-257. <https://doi.org/10.1007/s10433-016-0368-1>
- Nowak, G. J., Gellin, B. G., Macdonald, N. E., & Butler, R. (2015). Addressing vaccine hesitancy: The potential value of commercial and social marketing

principles and practices. *Vaccine*.
<https://doi.org/10.1016/j.vaccine.2015.04.039>

- Nutbeam, D., & Bauman, A. (2014). *Evaluation in a nutshell : a practical guide to the evaluation of health promotion programs* (2nd edition / Adrian Bauman, Don Nutbeam.. ed.). North Ryde, NSW : McGraw Hill Education, Medical.
- Oja, P., & Titze, S. (2011). Physical activity recommendations for public health: development and policy context. *The EPMA journal*, 2(3), 253-259.
<https://doi.org/10.1007/s13167-011-0090-1>
- Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: an example, design considerations and applications. *Information & Management*, 42(1), 15-29. <https://doi.org/10.1016/j.im.2003.11.002>
- Oliver, K., Kothari, A., & Mays, N. (2019). The dark side of coproduction: do the costs outweigh the benefits for health research? *Health research policy and systems*, 17(1), 33-33. <https://doi.org/10.1186/s12961-019-0432-3>
- Op Den Akker, H., Cabrita, M., Op Den Akker, R., Jones, V. M., & Hermens, H. J. (2015). Tailored motivational message generation: A model and practical framework for real-time physical activity coaching. *Journal of Biomedical Informatics*, 55, 104-115. <https://doi.org/10.1016/j.jbi.2015.03.005>
- Owen, N., Bauman, A., Booth, M., Oldenburg, B., & Magnus, P. (1995). Serial Mass-Media Campaigns to Promote Physical Activity: Reinforcing or Redundant? *American Journal of Public Health*, 85(2), 244.
<https://doi.org/10.2105/AJPH.85.2.244>
- Owen, N., Glanz, K., Sallis, J. F., & Kelder, S. H. (2006). Evidence-Based Approaches to Dissemination and Diffusion of Physical Activity Interventions. *American journal of preventive medicine*, 31(4), 35-44.
<https://doi.org/10.1016/j.amepre.2006.06.008>
- Pal, S., Cheng, C., & Ho, S. (2011). The effect of two different health messages on physical activity levels and health in sedentary overweight, middle-aged women. *BMC Public Health*, 11, 204-204. <https://doi.org/10.1186/1471-2458-11-204>
- Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., . . . King, A. C. (1995). Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA: Journal of the American Medical Association*, 273(5), 402-407.
- Pena-Y-Lillo, M., & Lee, C.-J. (2019). A Communication Inequalities Approach to Disparities in Physical Activities: The Case of the VERB Campaign. *Journal of Health Communication*, 24(2), 111-120.
<https://doi.org/10.1080/10810730.2019.1583699>
- Peters, D. (2014). The application of systems thinking in health: why use systems thinking? *Health Research Policy and Systems*, 12(1), 51.
<https://doi.org/10.1186/1478-4505-12-51>

- Peterson, M., Abraham, A., & Waterfield, A. (2005). Marketing Physical Activity: Lessons Learned From a Statewide Media Campaign. *Health Promotion Practice*, 6(4), 437-446. <https://doi.org/10.1177/1524839904266797>
- Peterson, M., Chandlee, M., & Abraham, A. (2008). Cost-Effectiveness Analysis of a Statewide Media Campaign to Promote Adolescent Physical Activity. *Health Promotion Practice*, 9(4), 426-433. <https://doi.org/10.1177/1524839907313722>
- Pfadenhauer, L. M., Gerhardus, A., Mozygemba, K., Lysdahl, K. B., Booth, A., Hofmann, B., . . . Rehfuess, E. (2017). Making sense of complexity in context and implementation: The Context and Implementation of Complex Interventions (CICI) framework. *Implementation science : IS*, 12(1), 21-21. <https://doi.org/10.1186/s13012-017-0552-5>
- Piggin, J., Mansfield, L., & Weed, M. (2017). *Routledge Handbook of Physical Activity Policy and Practice / editors, Louise Mansfield, Mike Weed* (First edition. ed.). Taylor and Francis. <https://doi.org/10.4324/9781315672779>
- Pikora, T., Giles-Corti, B., Bull, F., Jamrozik, K., & Donovan, R. (2003). Developing a framework for assessment of the environmental determinants of walking and cycling. *Social Science & Medicine*, 56(8), 1693-1703. [https://doi.org/10.1016/S0277-9536\(02\)00163-6](https://doi.org/10.1016/S0277-9536(02)00163-6)
- Pope, J. P., & Pelletier, L. G. (2021). What Messages Do Adults Prefer? Understanding Adults' Perceptions of Intrinsic and Extrinsic Physical Activity Messages. *Canadian journal of behavioural science*, 53(4), 522-529. <https://doi.org/10.1037/cbs0000189>
- Pozzo, M. L., Brusati, V., & Cetin, I. (2010). Clinical relationship and psychological experience of hospitalization in "high-risk" pregnancy. *European journal of obstetrics & gynecology and reproductive biology*, 149(2), 136-142. <https://doi.org/10.1016/j.ejogrb.2009.12.009>
- Pratt, M., Perez, L. G., Goenka, S., Brownson, R. C., Bauman, A., Sarmiento, O. L., & Hallal, P. C. (2014). Can Population Levels of Physical Activity Be Increased? Global Evidence and Experience. *Progress in cardiovascular diseases*, 57(4), 356-367. <https://doi.org/10.1016/j.pcad.2014.09.002>
- Priebe, C. S., & Spink, K. S. (2012). Using Messages Promoting Descriptive Norms to Increase Physical Activity. *Health Communication*, 27(3), 284-291. <https://doi.org/10.1080/10410236.2011.585448>
- Priebe, C. S., & Spink, K. S. (2015). Less sitting and more moving in the office: Using descriptive norm messages to decrease sedentary behavior and increase light physical activity at work. *Psychology of Sport and Exercise*, 19, 76-84. <https://doi.org/10.1016/j.psychsport.2015.02.008>
- Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behaviour change. *American Journal of Health Promotion*, 12(1), 38-48.
- Public Health Agency of Canada. (2020). *Canadian 24-hour Movement Guidelines for Adults ages 18-64 years: An Integration of Physical Activity, Sedentary*

Behaviour and Sleep. <https://csepguidelines.ca/wp-content/uploads/2020/10/24HMovementGuidelines-Adults18-64-2020-ENG.pdf>

- Quick, B. L., & Considine, J. R. (2008). Examining the Use of Forceful Language When Designing Exercise Persuasive Messages for Adults: A Test of Conceptualizing Reactance Arousal as a Two-Step Process. *Health Communication, 23*(5), 483-491. <https://doi.org/10.1080/10410230802342150>
- Quintiliani, L. M., Campbell, M. K., Bowling, J. M., Steck, S., Haines, P. S., & DeVellis, B. M. (2010). Results of a Randomized Trial Testing Messages Tailored to Participant-Selected Topics Among Female College Students: Physical Activity Outcomes. *Journal of Physical Activity & Health, 7*(4), 517-526.
- Reese, J. M., Joseph, R. P., Cherrington, A., Allison, J., Kim, Y.-I., Spear, B., . . . Durant, N. H. (2017). Development of Participant-Informed Text Messages to Promote Physical Activity Among African American Women Attending College: A Qualitative Mixed-Methods Inquiry. *Journal of Transcultural Nursing, 28*(3), 236-242. <https://doi.org/10.1177/1043659616644959>
- Rhee, Y., Nyquist, H., Garden-Robinson, J., & Brunt, A. (2009). Promoting Healthy Eating and Exercise through Online Messages. *Journal of the American Dietetic Association, 109*(9), A53. <https://doi.org/10.1016/j.jada.2009.06.161>
- Rhodes, R., & Courneya, K. (2000). Effects of a Health-Based versus Appearance-Based Persuasive Message on Attitudes Towards Exercise: Testing the Moderating Role of Self-Monitoring. *Journal of Social Behavior and Personality, 15*(3), 321.
- Rhodes, R. E. (2017). The evolving understanding of physical activity behavior: A multi-process action control approach. In A. J. Elliot (Ed.), *Advances in motivation science* (4 ed., pp. 171-205). Elsevier Academic Press.
- Rhodes, R. E., Brown, S. G., & McIntyre, C. A. (2006). Integrating the Perceived Neighborhood Environment and the Theory of Planned Behavior When Predicting Walking in a Canadian Adult Sample. *American journal of health promotion, 21*(2), 110-118. <https://doi.org/10.4278/0890-1171-21.2.110>
- Rhodes, R. E., McEwan, D., & Rebar, A. L. (2019). Theories of physical activity behaviour change: A history and synthesis of approaches. *Psychology of sport and exercise, 42*, 100-109. <https://doi.org/10.1016/j.psychsport.2018.11.010>
- Rhodes, R. E., & Nigg, C. R. (2011). Advancing physical activity theory: A review and future directions. *Exercise and sport sciences reviews, 39*(3), 113-119. <https://doi.org/10.1097/JES.0b013e31821b94c8>
- Ritchie, J., & Lewis, J. (2003). *Qualitative research practice : a guide for social science students and researchers / edited by Jane Ritchie and Jane Lewis*. Sage Publications.

- Robert, J. D. (1995). Steps in Planning and Developing Health Communication Campaigns: A Comment on CDC's Framework for Health Communication. *Public health reports (1974)*, 110(2), 215-217.
- Robertson, J. M., Gibson, G., Pemble, C., Harrison, R., Strachan, K., & Thorburn, S. (2020). "It is part of belonging": Walking groups to promote social health amongst people living with dementia. *Social inclusion*, 8(3), 113-122. <https://doi.org/10.17645/si.v8i3.2784>
- Robin, N., Toussaint, L., Coudeville, G. R., Ruart, S., Hue, O., & Sinnapah, S. (2018). Text Messages Promoting Mental Imagery Increase Self-Reported Physical Activity in Older Adults: A Randomized Controlled Study. *Journal of aging and physical activity*, 26(3), 462-470. <https://doi.org/https://dx.doi.org/10.1123/japa.2017-0069>
- Rodham, K. (2010). *Health Psychology*. Palgrave Macmillan.
- Rodriguez-Ayllon, M., Cadenas-Sánchez, C., Estévez-López, F., Muñoz, N. E., Mora-Gonzalez, J., Migueles, J. H., . . . Esteban-Cornejo, I. (2019). Role of Physical Activity and Sedentary Behavior in the Mental Health of Preschoolers, Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports medicine (Auckland)*, 49(9), 1383-1410. <https://doi.org/10.1007/s40279-019-01099-5>
- Rogers, E. M. (2003). *Diffusion of innovations / Everett M. Rogers* (5th ed.). Free Press.
- Rothman, A., & Updegraff, J. (2010). Specifying When and How Gain- and Loss-Framed Messages Motivate Healthy Behavior: An Integrated Approach. In G. Keren (Ed.), *Perspectives on Framing*. Psychology Press.
- Rothman, A., & Updegraff, J. (2010). Specifying When and How Gain- and Loss-Framed Messages Motivate Healthy Behavior: An Integrated Approach. In G. Keren (Ed.), *Perspectives on Framing*. Psychology Press.
- Rothman, A. J. (2004). "Is there nothing more practical than a good theory?": Why innovations and advances in health behavior change will arise if interventions are used to test and refine theory. *The international journal of behavioral nutrition and physical activity*, 1(1), 11-11. <https://doi.org/10.1186/1479-5868-1-11>
- Rothman, A. J., & Salovey, P. (1997). Shaping Perceptions to Motivate Healthy Behavior: The Role of Message Framing. *Psychological Bulletin*, 121(1), 3-19. <https://doi.org/10.1037/0033-2909.121.1.3>
- Rutter, H., Cavill, N., Bauman, A., & Bull, F. (2019). Systems approaches to global and national physical activity plans. *Bulletin of the World Health Organization*, 97(2), 162-165. <https://doi.org/10.2471/BLT.18.220533>
- Rutter, H., Savona, N., Glonti, K., Bibby, J., Cummins, S., Finegood, D. T., . . . White, M. (2017). The need for a complex systems model of evidence for public health. *The Lancet*, 390(10112), 2602-2604. [https://doi.org/10.1016/S0140-6736\(17\)31267-9](https://doi.org/10.1016/S0140-6736(17)31267-9)

- Ryan, R. M., & Deci, E. L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *The American psychologist*, 55(1), 68-78. <https://doi.org/10.1037/0003-066X.55.1.68> (Positive Psychology)
- Ryan, R. M., Williams, G. C., Patrick, H., & Deci, E. L. (2009). Self-determination theory and physical activity: The dynamics of motivation in development and wellness. *Hellenic Journal of Psychology*, 6(2), 107-124.
- Saito, Y., Oguma, Y., Tanaka, A., Kamada, M., Inoue, S., Inaji, J., . . . Takebayashi, T. (2018). Community-wide physical activity intervention based on the Japanese physical activity guidelines for adults: A non-randomized controlled trial. *Preventive medicine*, 107, 61-68. <https://doi.org/https://dx.doi.org/10.1016/j.ypped.2017.11.008>
- Salazar, L., Crosby, R., Noar, S., Walker, J., & DiClemente, R. (2013). Models based on perceived threat and fear appeals. In R. DiClemente, L. Salazar, & R. Crosby (Eds.), *Health Behaviour Theory for Public Health: Principles, Foundations, and Applications*. (pp. 83-104). Jones and Barlett Learning.
- Saligheh, M., McNamara, B., & Rooney, R. (2016). Perceived barriers and enablers of physical activity in postpartum women: A qualitative approach. *BMC pregnancy and childbirth*, 16(1), 131-131. <https://doi.org/10.1186/s12884-016-0908-x>
- Sallis, J. F., Bauman, A., & Pratt, M. (1998). Environmental and policy interventions to promote physical activity. In (Vol. 15, pp. 379-397).
- Sallis, J. F., & Owen, N. (2015). Ecological Models in Health Behavior. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior : theory, research, and practice / Karen Glanz, Barbara K. Rimer, K. Viswanath, editors* (Fifth edition. ed.). Jossey-Bass.
- Salovey, P., & Williams-Piehota, P. (2004). Field Experiments in Social Psychology: Message Framing and the Promotion of Health Protective Behaviors. In (Vol. 47, pp. 488-505).
- Scarapicchia, T. M. F., Sabiston, C. M. F., Brownrigg, M., Blackburn-Evans, A., Cressy, J., Robb, J., & Faulkner, G. E. J. (2015). MoveU? Assessing a Social Marketing Campaign to Promote Physical Activity. *Journal of American College Health*, 00-00. <https://doi.org/10.1080/07448481.2015.1025074>
- Schmid, K. L., Rivers, S. E., Latimer, A. E., & Salovey, P. (2008). Targeting or Tailoring? Maximizing Resources to Create Effective Health Communications. *Marketing health services*, 28(1), 32-37.
- Schramm, W. (1949). How communication works. In W. Schramm & D. Roberts (Eds.), *The Process and Effects of Mass Communication*. (Revised ed.). University of Illinois Press.

- Schuch, F. B., Stubbs, B., Meyer, J., Heissel, A., Zech, P., Vancampfort, D., . . . Hiles, S. A. (2019). Physical activity protects from incident anxiety: A meta-analysis of prospective cohort studies. *Depression and Anxiety*, 1-13.
- Schuch, F. B., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P. B., Silva, E. S., . . . Stubbs, B. (2018). Physical Activity and Incident Depression: A Meta-Analysis of Prospective Cohort Studies. *American Journal of Psychiatry*, 175(7), 631-648. <https://doi.org/10.1176/appi.ajp.2018.17111194>
- Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials. *PLoS medicine*, 7(3), 1-7. <https://doi.org/10.1371/journal.pmed.1000251>
- Scottish Government. (2012). *Scottish Health Survey: Main Report*. Retrieved from <http://www.gov.scot/Resource/0043/00434590.pdf>
- Scottish Government. (2021). *Scotland in lockdown: urgent action to bring virus under control*. Retrieved 31st May from <https://www.gov.scot/news/scotland-in-lockdown/>
- Sebastião, E., Chodzko-Zajko, W., & Schwingel, A. (2015). The need to modify physical activity messages to better speak to older African American women: a pilot study.(Report). *BMC Public Health*, 15(1). <https://doi.org/10.1186/s12889-015-2317-x>
- Segar, M., Taber, J. M., Patrick, H., Thai, C. L., & Oh, A. (2017). Rethinking physical activity communication: using focus groups to understand women's goals, values, and beliefs to improve public health. *BMC Public Health*, 17. <https://doi.org/10.1186/s12889-017-4361-1>
- Segar, M. L., & Richardson, C. R. (2014). Prescribing Pleasure and Meaning. Cultivating Walking Motivation and Maintenance. *American journal of preventive medicine*, 47(6), 838-841. <https://doi.org/10.1016/j.amepre.2014.07.001>
- Seth, M. N. (2012). An Audience–Channel–Message–Evaluation (ACME) Framework for Health Communication Campaigns. *Health promotion practice*, 13(4), 481-488. <https://doi.org/10.1177/1524839910386901>
- Shannon, C. E., & Weaver, W. (1963). *The mathematical theory of communication / by Claude E. Shannon and Warren Weaver*. University of Illinois Press.
- Sheeran, P., Gollwitzer, P. M., & Bargh, J. A. (2013). Nonconscious processes and health. *Health psychology*, 32(5), 460-473. <https://doi.org/10.1037/a0029203>
- Silva, K. S., Garcia, L. M. T., Rabacow, F. M., de Rezende, L. F. M., & de Sá, T. H. (2017). Physical activity as part of daily living: Moving beyond quantitative recommendations. *Preventive Medicine*, 96, 160-162. <https://doi.org/10.1016/j.ypmed.2016.11.004>
- Sirriyeh, R., Lawton, R., & Ward, J. (2010). Physical activity and adolescents: An exploratory randomized controlled trial investigating the influence of affective

- and instrumental text messages. *British Journal of Health Psychology*, 15(4), 825-840. <https://doi.org/10.1348/135910710X486889>
- Sjörs, C., Bonn, S. E., Trolle Lagerros, Y., Sjölander, A., & Bälter, K. (2014). Perceived reasons, incentives, and barriers to physical activity in Swedish elderly men. *Interactive journal of medical research*, 3(4), e15-e15. <https://doi.org/10.2196/ijmr.3191>
- Skapinsky, K. F., Persky, S., Lewis, M., Goergen, A., Ashida, S., de Heer, H. D., . . . Koehly, L. M. (2018). Heart disease risk information, encouragement, and physical activity among Mexican-origin couples: Self- or spouse-driven change? *Translational behavioral medicine*, 8(1), 95-104. <https://doi.org/https://dx.doi.org/10.1093/tbm/ibx012>
- Slade, S. C., Dionne, C. E., Underwood, M., & Buchbinder, R. (2014). Standardised method for reporting exercise programmes: protocol for a modified Delphi study. *BMJ Open*, 55(2). <https://doi.org/10.1136/bmjopen-2014-006682>
- Sloman, S. A. (1996). The Empirical Case for Two Systems of Reasoning. *Psychological bulletin*, 119(1), 3-22. <https://doi.org/10.1037/0033-2909.119.1.3>
- Smith, B., Mallick, K., Monforte, J., & Foster, C. (2021). Disability, the communication of physical activity and sedentary behaviour, and ableism: a call for inclusive messages. *British journal of sports medicine*, bjsports-2020-103780. <https://doi.org/10.1136/bjsports-2020-103780>
- Smith, B., & McGannon, K. R. (2018). Developing rigor in qualitative research: problems and opportunities within sport and exercise psychology. *International Review of Sport and Exercise Psychology*, 11(1), 101-121. <https://doi.org/https://doi.org/10.1080/1750984X.2017.1317357>
- Smith, B., Netherway, J., Jachyra, P., Bone, L., & Foster, C. (Forthcoming). Infographic to Communicate Physical Activity Guidelines for Disabled Children and Young People. *British Journal of Sports Medicine*.
- Smith, B., & Wightman, L. (2019). Promoting physical activity to disabled people: messengers, messages, guidelines and communication formats. *Disability and rehabilitation*, 1. <https://doi.org/10.1080/09638288.2019.1679896>
- Smith, B., Williams, O., Bone, L., & Collective, t. M. S. W. C.-p. (2022). Co-production: A resource to guide co-producing research in the sport, exercise, and health sciences. *Qualitative research in sport, exercise and health, ahead-of-print*, 1-29. <https://doi.org/10.1080/2159676X.2022.2052946>
- Smith, B. J., & Bonfiglioli, C. M. F. (2015). Physical activity in the mass media: an audience perspective. *Health Education Research*, 30(2), 359-369. <https://doi.org/10.1093/her/cyv008>
- Smith, E. R., & de Coster, J. M. (2000). Dual-process models in social and cognitive psychology: Conceptual integration and links to underlying memory systems. *Personality and social psychology review*, 4(2), 108-131. https://doi.org/10.1207/S15327957PSPR0402_01

- Spence, J. C., Brawley, L. R., Craig, C. L., Plotnikoff, R. C., Tremblay, M. S., Bauman, A., . . . Clark, M. I. (2009). ParticipACTION: awareness of the participACTION campaign among Canadian adults--examining the knowledge gap hypothesis and a hierarchy-of-effects model. *The international journal of behavioral nutrition and physical activity*, 6(1), 85. <https://doi.org/10.1186/1479-5868-6-85>
- Spence, J. C., Faulkner, G., Lee, E.-Y., Berry, T., Cameron, C., Deshpande, S., . . . Tremblay, M. S. (2018). Awareness of ParticipACTION among Canadian adults: a seven-year cross-sectional follow-up. *Health promotion and chronic disease prevention in Canada*, 38(4), 179-186. <https://doi.org/10.24095/hpcdp.38.4.04>
- Sport England. (2015). *Go where women are: Insight on engaging women and girls in sport and exercise*. https://sportengland-production-files.s3.eu-west-2.amazonaws.com/s3fs-public/insight_go-where-women-are.pdf?eYAoAledAKaO0lnqZqC6_DFYjF7_rfAl
- Sport England. (2019a). *This Girl Can*. Retrieved 4th July 2019 from <https://www.sportengland.org/our-work/women/this-girl-can/>
- Sport England. (2019b). *This Girl Can: Campaign Summary*. https://sportengland-production-files.s3.eu-west-2.amazonaws.com/s3fs-public/2020-01/Campaign-Summary.pdf?Yu_jmNiqPxjL8lJJC0EqvKXjJ_GOFpfx
- Stamatakis, E., Ding, D., Ekelund, U., & Bauman, A. E. (2021). Sliding down the risk factor rankings: reasons for and consequences of the dramatic downgrading of physical activity in the Global Burden of Disease 2019. *British journal of sports medicine*, 55(21), 1222-1223. <https://doi.org/10.1136/bjsports-2021-104064>
- Stampini, V., Monzani, A., Caristia, S., Ferrante, G., Gerbino, M., De Pedrini, A., . . . Surico, D. (2021). The perception of Italian pregnant women and new mothers about their psychological wellbeing, lifestyle, delivery, and neonatal management experience during the COVID-19 pandemic lockdown: a web-based survey. *BMC pregnancy and childbirth*, 21(1), 1-473. <https://doi.org/10.1186/s12884-021-03904-4>
- Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and social psychology review*, 8(3), 220-247. https://doi.org/10.1207/s15327957pspr0803_1
- Strain, T., Brage, S., Sharp, S. J., Richards, J., Tainio, M., Ding, D., . . . Kelly, P. (2020). Use of the prevented fraction for the population to determine deaths averted by existing prevalence of physical activity: a descriptive study. *The Lancet global health*, 8(7), e920-e930. [https://doi.org/10.1016/S2214-109X\(20\)30211-4](https://doi.org/10.1016/S2214-109X(20)30211-4)
- Strain, T., Fitzsimons, C., Kelly, P., & Mutrie, N. (2016). The forgotten guidelines: cross-sectional analysis of participation in muscle strengthening and balance & co-ordination activities by adults and older adults in Scotland. *Strain , T , Fitzsimons , C , Kelly , P & Mutrie , N 2016 , ' The forgotten guidelines: cross-sectional analysis of participation in muscle strengthening and balance*

& co-ordination activities by adults and older adults in Scotland ' *BMC Public Health* . , 10.1186/s12889-016-3774-6. <https://doi.org/10.1186/s12889-016-3774-6>

- Strain, T., Wijndaele, K., Dempsey, P. C., Sharp, S. J., Pearce, M., Jeon, J., & Lindsay, T. (2020). Wearable-device-measured physical activity and future health risk. *Nature medicine*, 26(9), 1385-1391. <https://doi.org/10.1038/s41591-020-1012-3>
- Strath, J. S., Kaminsky, A. L., Ainsworth, E. B., Ekelund, S. U., Freedson, A. P., Gary, R. R., . . . Swartz, M. A. (2013). Guide to the Assessment of Physical Activity: Clinical and Research Applications: A Scientific Statement From the American Heart Association. *Circulation*, 128(20), 2259-2279. <https://doi.org/10.1161/01.cir.0000435708.67487.da>
- Stratigos, A., Nikolaou, V., Kedicoglou, S., Antoniou, C., Stefanaki, I., Haidemenos, G., & Katsambas, A. D. (2007). Melanoma/skin cancer screening in a Mediterranean country: results of the Euromelanoma Screening Day Campaign in Greece. *Journal of the European Academy of Dermatology and Venereology*, 21(1), 56-62. <https://doi.org/10.1111/j.1468-3083.2006.01865.x>
- Suggs, S., Blake, H., Bardus, M., & Lloyd, S. (2013). Effects of text messaging in addition to emails on physical activity among university and college employees in the UK. *Journal of Health Services Research & Policy*, 18(1_suppl), 56-64. <https://doi.org/10.1177/1355819613478001>
- Sumsion, T. (1998). The Delphi Technique: An Adaptive Research Tool. *British Journal of Occupational Therapy*, 61(4), 153-156. <https://doi.org/10.1177/030802269806100403>
- Sweet, S. N., Brawley, L. R., Hatchell, A., Gainforth, H. L., & Latimer-Cheung, A. E. (2014). Can Persuasive Messages Encourage Individuals to Create Action Plans for Physical Activity? *Journal of Sport & Exercise Psychology*, 36(4), 413-423.
- Swinburn, B. A., Kraak, V. I., Allender, S., Atkins, V. J., Baker, P. I., Bogard, J. R., . . . Dietz, W. H. (2019). The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. *The Lancet (British edition)*, 393(10173), 791-846. [https://doi.org/10.1016/S0140-6736\(18\)32822-8](https://doi.org/10.1016/S0140-6736(18)32822-8)
- Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *The international journal of behavioral nutrition and physical activity*, 9(1), 78-78. <https://doi.org/10.1186/1479-5868-9-78>
- Teychenne, M., White, R. L., Richards, J., Schuch, F. B., Rosenbaum, S., & Bennie, J. A. (2020). Do we need physical activity guidelines for mental health: What does the evidence tell us? *Mental health and physical activity*, 18, 100315. <https://doi.org/10.1016/j.mhpa.2019.100315>
- Thai, C. L., Taber, J. M., Oh, A., Segar, M., Blake, K., & Patrick, H. (2019). "Keep it Realistic": Reactions to and Recommendations for Physical Activity

Promotion Messages From Focus Groups of Women. *American Journal of Health Promotion*, 33(6), 903-911.

- Tomaz, S., Fawcner, S., Niven, A., Hanson, S., Williamson, C., Kelly, P., & Hanson, C. (2020, January 7th). Physical activity for children under 5 years during COVID-19: Play your way and keep moving while at home. <https://blogs.bmj.com/bjism/2020/04/29/physical-activity-for-children-under-5-years-during-covid-19-play-your-way-and-keep-moving-while-at-home/>
- Tracy, N., Lee, K., Smith, B. J., Bellew, W., Reece, L., Gelius, P., . . . Bauman, A. (2019). Toward Whole-of-System Action to Promote Physical Activity: A Cross-Sectoral Analysis of Physical Activity Policy in Australia. *Journal of physical activity & health*, 16(11), 1029-1038. <https://doi.org/10.1123/jpah.2019-0122>
- Tracy, S. J. (2010). Qualitative Quality: Eight “Big-Tent” Criteria for Excellent Qualitative Research. *Qualitative inquiry*, 16(10), 837-851. <https://doi.org/10.1177/1077800410383121>
- Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., . . . Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of Internal Medicine*, 169(7), 467. <https://doi.org/10.7326/M18-0850>
- Trost, S. G., Owen, N., Bauman, A. E., Sallis, J. F., & Brown, W. (2002). Correlates of adults' participation in physical activity: Review and update. *Medicine and science in sports and exercise*, 34(12), 1996-2001. <https://doi.org/10.1097/00005768-200212000-00020>
- Tversky, A., & Kahneman, D. (1981). The Framing of Decisions and the Psychology of Choice. *Science*, 211(4481), 453-458. <https://doi.org/10.1126/science.7455683>
- United Nations General Assembly. (1948). Resolution 217A. Universal Declaration of Human Rights. In. New York, NY: United Nations.
- US Department of Health and Human Services. (2008). *2008 Physical Activity Guidelines for Americans*. U. S. Department of Health and Human Services. <http://www.health.gov/paguidelines>
- US Department of Health and Human Services. (2010). *Healthy People 2010 Final Review*. Retrieved from https://www.cdc.gov/nchs/data/hpdata2010/hp2010_final_review.pdf
- US Department of Health and Human Services. (2018). *Physical Activity Guidelines for Americans, 2nd Edition*. Washington, DC. USA. Retrieved from https://health.gov/paguidelines/second-edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf
- Valente, A., Castellani, T., Larsen, M., & Aro, A. R. (2015). Models and visions of science–policy interaction: Remarks from a Delphi study in Italy. *Science and Public Policy*, 42(2), 228-241. <https://doi.org/10.1093/scipol/scu039>

- van 't Riet, J., Ruiter, R. A. C., Werrij, M. Q., & de Vries, H. (2010). Investigating message-framing effects in the context of a tailored intervention promoting physical activity. *Health Education Research*, 25(2), 343-354. <https://doi.org/10.1093/her/cyp061>
- van Bavel, R., Esposito, G., & Baranowski, T. (2014). Is anybody doing it? An experimental study of the effect of normative messages on intention to do physical activity.(Survey). *BMC Public Health*, 14(1). <https://doi.org/10.1186/1471-2458-14-778>
- van Sluijs, E. M. F., Ekelund, U., Crochemore-Silva, I., Guthold, R., Ha, A., Lubans, D., . . . Katzmarzyk, P. T. (2021). Physical activity behaviours in adolescence: current evidence and opportunities for intervention. *The Lancet (British edition)*, 398(10298), 429-442. [https://doi.org/10.1016/S0140-6736\(21\)01259-9](https://doi.org/10.1016/S0140-6736(21)01259-9)
- Varela, A. R., Pratt, M., Powell, K., Lee, I. M., Bauman, A., Heath, G., . . . Hallal, P. C. (2017). Worldwide surveillance, policy, and research on physical activity and health: The global observatory for physical activity. *Journal of physical activity & health*, 14(9), 701-709. <https://doi.org/10.1123/jpah.2016-0626>
- Wahid, A., Manek, N., Nichols, M., Kelly, P., Foster, C., Webster, P., . . . Scarborough, P. (2016). Quantifying the Association Between Physical Activity and Cardiovascular Disease and Diabetes: A Systematic Review and Meta-Analysis. *Journal of the American Heart Association*, 5(9), n/a. <https://doi.org/10.1161/JAHA.115.002495>
- Webb, T. L., & Sheeran, P. (2006). Does Changing Behavioral Intentions Engender Behavior Change? A Meta-Analysis of the Experimental Evidence. *Psychological bulletin*, 132(2), 249-268. <https://doi.org/10.1037/0033-2909.132.2.249>
- White, R. L. P., Babic, M. J. B., Parker, P. D. P., Lubans, D. R. P., Astell-Burt, T. P., & Lonsdale, C. P. (2017). Domain-Specific Physical Activity and Mental Health: A Meta-analysis. *American journal of preventive medicine*, 52(5), 653-666. <https://doi.org/10.1016/j.amepre.2016.12.008>
- Wiers, R. W., Bartholow, B. D., van den Wildenberg, E., Thush, C., Engels, R. C. M. E., Sher, K. J., . . . Stacy, A. W. (2007). Automatic and controlled processes and the development of addictive behaviors in adolescents: A review and a model. *Pharmacology, biochemistry and behavior*, 86(2), 263-283. <https://doi.org/10.1016/j.pbb.2006.09.021>
- William, L. R. (1993). Health Communication Takes on New Dimensions at CDC. *Public health reports (1974)*, 108(2), 179-183.
- Williams, D. M., Anderson, E. S., & Winett, R. A. (2005). A review of the outcome expectancy construct in physical activity research. *Annals of behavioral medicine*, 29(1), 70-79. https://doi.org/10.1207/s15324796abm2901_10
- Williams, J., Saken, M., Gough, S., & Hing, W. (2019). The effects of message framing characteristics on physical activity education: A systematic review.

Cogent medicine, 6(1), 1666619.
<https://doi.org/10.1080/2331205X.2019.1666619>

- Williams, T. L., Lozano-Sufrategui, L., & Tomasone, J. R. (2021). Stories of physical activity and disability: exploring sport and exercise students' narrative imagination through story completion. *Qualitative research in sport, exercise and health, ahead-of-print*(ahead-of-print), 1-19.
<https://doi.org/10.1080/2159676X.2021.2001031>
- Williamson, C., Baker, G., Mutrie, N., Niven, A., & Kelly, P. (2019). *A conceptual framework for physical activity messaging*. University of Edinburgh.
https://www.researchgate.net/publication/336956859_A_conceptual_framework_for_physical_activity_messaging
- Williamson, C., Baker, G., Mutrie, N., Niven, N., & Kelly, P. (2020). Get the message? A scoping review of physical activity messaging. *International Journal of Behavioral Nutrition and Physical Activity*, 17(51).
<https://doi.org/https://doi.org/10.1186/s12966-020-00954-3>
- Williamson, C., Baker, G., Tomasone, J. R., Bauman, A., Mutrie, N., Niven, A., . . . Kelly, P. (2021). The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC): International consensus statement and user guide. *The international journal of behavioral nutrition and physical activity*, 18(1), 1.
<https://doi.org/10.1186/s12966-021-01230-8>
- Williamson, C., Baker, G., Tomasone, J. R., Bauman, A., Richards, J., Niven, A., . . . Kelly, P. (2021). A modified Delphi study to enhance and gain international consensus on the Physical Activity Messaging Framework (PAMF) and Checklist (PAMC). *International Journal of Behavioral Nutrition and Physical Activity*, 18(108), 1-13. <https://doi.org/https://doi.org/10.1186/s12966-021-01182-z>
- Williamson, C., Kelly, P., & Baker, G. (2020, January 7th). How can we better promote physical activity to the public through messaging?
<https://blogs.bmj.com/bjism/2020/11/10/how-can-we-better-promote-physical-activity-to-the-public-through-messaging/>
- Wong, F., Huhman, M., Heitzler, C., Asbury, L., Bretthauer-Mueller, R., McCarthy, S., & Londe, P. (2004). VERB - a social marketing campaign to increase physical activity among youth. *Preventing chronic disease*, 1(3), A10.
- Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., . . . Roberts, I. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. *The Lancet*, 374(9705), 1930-1943. [https://doi.org/10.1016/S0140-6736\(09\)61714-1](https://doi.org/10.1016/S0140-6736(09)61714-1)
- World Health Organization. (2004). *Global Strategy on Diet, Physical Activity and Health*.
https://www.who.int/dietphysicalactivity/strategy/eb11344/strategy_english_web.pdf
- World Health Organization. (2007). *A guide for population-based approaches to increasing levels of physical activity : implementation of the WHO global*

- strategy on diet, physical activity and health.* . W. H. Organization.
<https://apps.who.int/iris/handle/10665/43612>
- World Health Organization. (2010). *Global Recommendations on Physical Activity for Health*. <https://www.who.int/publications/i/item/9789241599979>
- World Health Organization (WHO). (2013). *Global NCD Target: Reduce Premature Deaths from NCDs*. W. H. Organization. <https://www.who.int/beat-ncds/take-action/policy-brief-reduce-premature-deaths.pdf?ua=1>
- World Health Organization. (2018). *Global action plan on physical activity 2018-2030: more active people for a healthier world*.
<https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf?ua=1>
- World Health Organization. (2019). *Global action plan on physical activity 2018-2030: more active people for a healthier world*.
<https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf?ua=1>
- World Health Organization. (2020). *WHO guidelines on physical activity and sedentary behaviour*. Licence: CC BY-NC-SA 3.0 IGO.
<https://apps.who.int/iris/bitstream/handle/10665/336656/9789240015128-eng.pdf?sequence=1&isAllowed=y>
- Wu, X. Y., Han, L. H., Zhang, J. H., Luo, S., Hu, J. W., & Sun, K. (2017). The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: A systematic review. *PloS one*, 12(11), e0187668-e0187668.
<https://doi.org/10.1371/journal.pone.0187668>
- Xia, Y., & Deshpande, S. (2016). Effectiveness of Social Marketing Interventions to Promote Physical Activity Among Adults: A Systematic Review. *Journal of Physical Activity & Health*, 13(11), 1263-1274.
<https://doi.org/10.1123/jpah.2015-0189>
- Xia, Y., Deshpande, S., & Bonates, T. (2016). Effectiveness of Social Marketing Interventions to Promote Physical Activity Among Adults: A Systematic Review. *J. Phys. Act. Health*, 13(11), 1263-1274.
<https://doi.org/10.1123/jpah.2015-0189>
- Yan, A. (2015). MHealth text messaging for physical activity promotion in college youth: a participatory approach. *Ann. Behav. Med.*, 49(s1), S201-S201.
- Yan, A., Stevens, P., Wang, Y., Weinhardt, L., Holt, C., O'Connor, C., . . . Luelloff, S. (2015). MHealth text messaging for physical activity promotion in college youth: a participatory approach. *Ann. Behav. Med.*, 49(s1), S201-S201.
- Yap, T. & Davis, S. (2008). Physical activity: the science of health promotion through tailored messages. *Rehabilitation nursing*, 33(2), 55-62.

- Young, B., Lewis, S., Katikireddi, S. V., Bauld, L., Stead, M., Angus, K., . . . Langley, T. (2018). Effectiveness of Mass Media Campaigns to Reduce Alcohol Consumption and Harm: A Systematic Review.
- Yun, L., Ori, E. M., Younghan, L., Sivak, A., & Berry, T. R. (2017). A Systematic Review of Community-wide Media Physical Activity Campaigns: An Update From 2010. *Journal of Physical Activity & Health*, 14(7), 552-570.
- Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *The American psychologist*, 35(2), 151-175. <https://doi.org/10.1037/0003-066X.35.2.151>
- Zambon, F., Hyder, A., Ma, S., & Peden, M. (2012). Increasing seat belt use in the Russian context: tailored social marketing campaign and concerted strengthened enforcement. *Injury Prevention*, 18(Suppl 1), A245. <https://doi.org/10.1136/injuryprev-2012-040590w.69>

Appendices

1. List of publications and presentations

Peer reviewed publications:

Williamson C, Baker G, Tomasone J R. et al. (2021). The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC): International consensus statement and user guide. *International Journal of Behavioral Nutrition and Physical Activity*, 18(164). <https://doi.org/10.1186/s12966-021-01230-8>

Williamson C, Kelly P, Tomasone J R, Bauman A, Mutrie A, Niven A, Richards J, & Baker, G. (2021). A modified Delphi study to enhance and gain international consensus on the Physical Activity Messaging Framework (PAMF) and Checklist (PAMC). *International Journal of Behavioral Nutrition and Physical Activity*, 18(108). <https://doi.org/10.1186/s12966-021-01182-z>

Williamson C, Baker G, Mutrie N, Niven A, & Kelly P. (2020). Get the message? A scoping review of physical activity messaging. *International Journal of Behavioral Nutrition and Physical Activity*, 17(5).
doi:10.1186/s12966-020-00954-3

Milton K, AE Bauman, Faulkner G, Hastings G, Bellew W, **Williamson C** & Kelly P. (2020). Maximising the impact of global and national physical activity guidelines: the critical role of communication strategies. *British Journal of Sports Medicine*, 54(24), 1463-1467.

Gilbert G, **C Williamson**, Richards J, Collyer TA, & Kelly P. (2021).

Do mental health messages on social media influence university students' motivation for physical activity? International Journal of Environmental Research and Public Health. Accepted for publication 13th August 2021.

Presentations:

Williamson C, Tomasone J, Ochoa V, Bauman A (2021, February):

“How can guidelines be used to create physical activity behaviour change?”: 2021 ISPAH and WHO webinar series: WHO guidelines on physical activity and sedentary behaviour

Williamson C, Foster C, Nobles J, Kelly P (2021, January): “Physical

activity guidelines: getting the message right”. Keynote session, I-PARC conference.

Williamson C, Tomasone J, Tomaz S, Kelly P, Nobles J, Foster C

(2020, October): “National physical activity guidelines: Closing the gap between development and implementation”. ISPAH virtual congress symposium.

Williamson C, & Nobles J (2019, November): “Let’s talk about

physical activity! Communicating physical activity messages to the public”. Workshop, SPARC conference, Edinburgh, Scotland.

Blogs:

Williamson, C., Kelly, P., & Baker, G. (2020, January 7th). How can we better promote physical activity to the public through messaging?
<https://blogs.bmj.com/bjism/2020/11/10/how-can-we-better-promote-physical-activity-to-the-public-through-messaging/>

Fawkner, S., Niven, A., Hanson, S., **Williamson, C.**, & Hanson, C. (2020). Physical activity for children and young people aged 5-18 years during COVID-19. Stay safe; be active.
<https://blogs.bmj.com/bjism/2020/04/13/physical-activity-for-children-and-young-people-aged-5-18-years-during-covid-19-stay-safe-be-active/>

Tomaz, S., Fawkner, S., Niven, A., Hanson, S., **Williamson, C.**, Kelly, P., & Hanson, C. (2020, January 7th). Physical activity for children under 5 years during COVID-19: Play your way and keep moving while at home.
<https://blogs.bmj.com/bjism/2020/04/29/physical-activity-for-children-under-5-years-during-covid-19-play-your-way-and-keep-moving-while-at-home/>

Hanson, C., Kelly, P., Pearsons, A., **Williamson, C.**, McHale, S., & Neubeck, L. (2020). Stay calm, be active: simple ways to boost your physical activity during COVID-19. https://blogs.bmj.com/bjism/2020/03/30/stay-calm-be-active-simple-ways-to-boost-your-physical-activity-during-covid-19/?int_source=trendmd&int_medium=cpc&int_campaign=usage-042019

Hanson, C., Hanson, S., Fawkner, S., Tomaz, S., Niven, A., **Williamson, C.**, . . . Neubeck, L. (2020, January 7th). Physical activity during COVID-19; a series of blogs and infographics.

<https://blogs.bmj.com/bjism/2020/05/19/physical-activity-during-covid-19-a-series-of-blogs-and-infographics/>

Neubeck, L., McHale, S., **Williamson, C.**, Kelly, P., Pearsons, A., Hanson, S., & Hanson, C. For the 'at-risk' or vulnerable COVID-19 group: staying or becoming active during social distancing In: British Journal of Sports Medicine. <https://blogs.bmj.com/bjism/2020/04/08/for-the-at-risk-or-vulnerable-covid-19-group-staying-or-becoming-active-during-social-distancing/>

2. Infographic of PA recommendations for various groups

Physical Activity Messaging Recommendations

For different groups

For: Children & Young People

- Engaging modes e.g. videos
- Highlight social and affective benefits
- Informal delivery e.g. via phone app
- E.g. "physical activity is cool and fun!"
- Highlight social and mental benefits

For: Pregnant Women

- Clear and practical advice
- Credible source e.g. health care professional
- E.g. provide safe examples

For: All groups

Evidence supports use of **positive messages** highlighting the **short-term benefits** of physical activity

- Avoid threat-based language
- E.g. "physical activity makes you happy"
- Informal delivery e.g. peers, the media

For: Adults

- Highlight social and mental benefits
- Informal delivery e.g. peers, the media

For: Disabled People

- Highlight affective benefits
- Credible source e.g. social workers
- E.g. "move in a way that feels good"
- Use inclusive images

For: Older Adults

- Highlight social and mental benefits
- E.g. "PA is an opportunity to connect with others"
- Credible source e.g. health care professional

These recommendations are based on a scoping review of physical activity messaging which synthesised evidence from 123 studies on physical activity messaging. Williamson, C., Baker, G., Mutrie, N. *et al.* Get the message? A scoping review of physical activity messaging. *Int J Behav Nutr Phys Act* 17, 51 (2020). <https://doi.org/10.1186/s12966-020-00954-3>

Chloë Williamson: @Chlobobs_ Paul Kelly: @narrowboat_paul Graham Baker: @DrGrahamBaker Ailsa Niven: @AilsaNiven Nanette Mutrie: @nanettemutrie

This infographic was created by Chloë Williamson

3. Study 2 ethics approval



THE UNIVERSITY of EDINBURGH
Moray House School
of Education

Research & Knowledge Exchange Office
Moray House School of Education and Sport
The University of Edinburgh
Old Moray House
Holyrood Road
Edinburgh EH8 8AQ

D/D +44 (0)131 651 4846
S/B +44 (0)131 650 1000

www.ed.ac.uk

Ref: 2749

Chloe Williamson
SPEHS
Moray House School of Education and Sport

Date: 31st May 2020

Dear Chloe,

Title: The Physical Activity Messaging (PAM) Framework and Checklist: A modified Delphi study

The School of Education and Sport Ethics Sub-Committee has now considered your request for ethical approval for the studies detailed in your application.

This is to confirm that the Sub-Committee is happy to approve the application and that the research meets the School Ethics Level 2 criterion. This is defined as "applies to non-intervention research where you have the consent of the participants and data subjects. This may include, for example, analysis of archived data, classroom observation, or questionnaires on topics that are not generally considered 'sensitive'. This research can involve children or young people, if the likelihood of risk to them is minimal".

A standard condition of this ethical approval is that you are required to notify the Committee of any significant proposed deviation from the original protocol. The Committee also needs to be notified if there are any unexpected results or events once the research is underway that raise questions about the safety of the research.

Should you receive any formal complaints relating to the study you should notify your MHSE Ethics Committee immediately by email to MHSEthics@ed.ac.uk

Yours sincerely,

On behalf of:
Dr Martin Toye
Convener, School Ethics Sub-Committee

4. Study 3 ethics approval



THE UNIVERSITY of EDINBURGH
Moray House School of
Education and Sport

Research, Knowledge Exchange and Impact Office
Moray House School of Education and Sport
The University of Edinburgh
Old Moray House
Holyrood Road
Edinburgh EH8 8AQ

D/D +44 (0)131 651 4846
S/B +44 (0)131 650 1000

www.ed.ac.uk

Ref: CWIL12052021

Chloe Williamson
Moray House School of Education and Sport

Date: 19th May 2021

Dear Chloe,

Title: Applying the Physical Activity Messaging Framework to investigate messaging preferences in post-partum women

The School of Education and Sport Ethics Sub-Committee has now considered your request for ethical approval for the studies detailed in the above application.

This is to confirm that the Sub-Committee is happy to approve your application and that the research meets the School Ethics Approval criterion for this particular project. A standard condition of this ethical approval is that should any amendment, or deviation from the original protocol outlined in your application need to be made to carry out or continue your research, please notify the Ethics Sub-Committee at MHSES-Ethics@ed.ac.uk

The Committee also needs to be notified if there are any unexpected results or events once the research is underway that raise questions about the safety of the research.

Should you receive any formal complaints relating to the study you should notify the MHSE Ethics Committee immediately by email to MHSEthics@ed.ac.uk

Yours sincerely,

On behalf of:
Dr Fiona O'Hanlon
Convener, School Ethics Sub-Committee

5. Study 3 advertisement

Are you a new mum?

We would love to hear from you!

At the University of Edinburgh, we are trying to understand how we can be better at communicating information about physical activity with new mums.



We are looking for new mums who are willing to take part in a short online or telephone interview to help us with this research.

If you've given birth during the COVID-19 pandemic and live in North Tyneside or Northumberland then you are eligible to take part.



We would be so grateful if you could spare some of your time to share your valuable insights with us and help to improve how we communicate with new mums about physical activity.



THE UNIVERSITY
of EDINBURGH

Please contact Chloë Williamson
(the lead researcher) at
if you
are interested in taking part or if
you have any questions.
Thank you!

Study 3 PIS and Consent

Start of Block: Default Question Block

Q1 RESEARCH STUDY:

Understanding physical activity messaging preferences in new mothers

You are being invited to take part in research investigating physical activity messaging in new mothers. Chloë Williamson (PhD student) at the University of Edinburgh is leading this research. Before you decide whether to take part it is important you understand why the research is being conducted and what it will involve. Please take time to read the following information carefully.

What is the purpose of the study?

The aim of this study is to explore the physical activity messaging preferences of new mothers using a newly developed framework. This work will help us to understand what should be included in messages targeted at new mothers with the aim of improving physical activity levels.

Why have I been INVITED to take part?

You have been invited to take part in this study as you are a new mother (given birth within the past 12 months). Your insights are extremely valuable and will help us to improve physical activity messaging targeted at new mothers.

Do I have to take part?

No – it is entirely up to you. If you do decide to take part, you are still free to withdraw at any time and without giving a reason.

Please note that your data may be used in the production of formal research outputs (e.g., journal articles, conference papers, theses and reports) prior to your withdrawal and so you are advised to contact the research team at the earliest opportunity should you wish to withdraw from the study.

What will happen if I decide to take part?

If you do decide to take part, please keep this Information Sheet. You will be asked to complete an Informed Consent Form online to show that you understand your rights in relation to the research, and that you are happy to participate.

You will be invited to take part in a short interview where you will be asked a number of questions regarding your preferences to physical activity messaging. The interview will take place online or via telephone at a time that is convenient to you. Depending on your preferences, this interview will

be conducted via telephone or via a suitable online platform such as Zoom or Microsoft Teams. Ideally, we would like to audio record your responses (and will require your consent for this). The interview should take around 45 minutes to complete.

What are the POSSIBLE benefits of taking part?

There are no direct benefits, but by sharing your experiences with us, you will be helping Chloë Williamson and the University of Edinburgh to better understand physical activity messaging preferences in new mothers, and therefore helping to improve messaging practice going forward.

Are there any risks or disadvantages associated with taking part?

There are no significant risks associated with participation.

Will my taking part be kept Confidential?

All the information we collect during the course of the research will be kept confidential and there are strict laws which safeguard your privacy at every stage.

How will we use information about you?

We will need to use information from you for this research project. This information will include your name, age, ethnicity, number of children, number of months since birth, and area of residence. We will keep all information about you safe and secure.

Your data will be referred to by a unique participant number rather than by name. If you consent to being audio recorded, all recordings will be destroyed once they have been transcribed. Your data will only be viewed by the research team. The findings of the study may be shared with relevant stakeholders, such as local service providers in the Northumbria Healthcare Trust area, but raw data (your information) will not be shared with anybody. All electronic data will be stored on a password-protected computer file. Your consent information will be kept separately from your responses in order to minimise risk. Once we have finished the study, we will keep some of the data so we can check the results. We will write our reports in a way that no-one can work out that you took part in the study. Your information will not be disclosed with any other organisation. What are your choices about how your information is used? You can stop being part of the study at any time, without giving a reason, but we will keep information about you that we already have if data analysis has already commenced. **Where can you find out more about how your information is used?** You can find out more about how we use your information at <https://www.ed.ac.uk/records-management/privacy-notice-research> by asking one of the research team or by sending an email to chloe.williamson@ed.ac.uk.

What will happen with the results of this study?

The results of this study may be summarised in published articles, reports and presentations. You will not be identifiable from any published results. Quotes or key findings will always be made anonymous in any formal outputs

unless we have your prior and explicit written permission to attribute them to you by name. With your consent, your anonymised information may also be kept for future research. A summary of the findings from the study will be made available to participants who indicate they would like to receive this. This summary will be sent to participants by email. You can indicate your interest to receive a summary of findings in the consent form.

WHO IS ORGANISING AND FUNDING THE RESEARCH?

This study has been organised by Chloë Williamson, PhD Student, The Physical Activity for Health Research Centre. The study is being conducted as part of Chloë Williamson's PhD, which is funded by the University of Edinburgh's Principal's Career Development Scholarship.

WHO HAS REVIEWED THE STUDY?

The study proposal has been reviewed by Moray House School of Education and Sport Ethics Committee.

WHO CAN I CONTACT?

If you have any further questions about the study, please contact the lead researcher, Chloë Williamson,

If you would like to discuss this study with someone independent of the study please contact Dr Fiona O'Hanlon, Moray House School of Education and Sport Ethics Lead,

If you wish to make a complaint about the study, please contact: Research
Governance Team (cahss.res.ethics@ed.ac.uk)

Page

Break

Q3 Please indicate that you provide consent to take part in the

"Understanding physical activity messaging preferences in new mothers"

study by agreeing with the statements below. If you do not agree with these

statements, simply close the survey.

Agree (1)

I confirm that I have read and understood the Participant Information Sheet for the above study (provided on the previous page) (1)

I have been given the opportunity to consider the information provided, ask questions about my participation and have had these questions answered to my satisfaction. (2)

I understand that my participation is voluntary and that i can ask to withdraw at any time without giving reason. (3)

If I withdraw from the study, I understand that I can request for any information I have provided to be destroyed up until data analysis has commenced. (4)

I understand that my anonymised data will be stored for a minimum of 1 year and may be used in future ethically approved research. (5)

I agree to my interview being audio recorded. (6)

I agree to my audio/video recorded interview to be transcribed. (7)

I agree to take part in the above study. (8)



Q18 Please answer the following demographic questions. We are asking these questions so we are able to accurately describe the group of participants in the study. All of your responses will remain anonymous and will not be shared with anybody.

Q9 Please provide your name in the box below:

—

Q13 Please provide your age in years in the box below:

—

Page

Break

Q14 Please select your ethnicity:

- White (1)
- Mixed or multiple ethnic groups (8)
- Asian or Asian British (9)
- Black, African, Caribbean or BlackBritish (10)
- Other ethnic group (11)

Display This Question:

If Please select your ethnicity: = White

Q19 White

- English, Welsh, Scottish, Northern Irish or British (1)
- Irish (2)
- Gypsy or Irish Traveller (3)
- Any other White background (4)

Display This Question:

If Please select your ethnicity: = Mixed or multiple ethnic groups

Q20 Mixed or multiple ethnic groups

- White and Black Carribean (1)
- White and Black African (2)
- White and Asian (3)
- Any other mixed or multiple ethnic background (4)

Display This Question:

If Please select your ethnicity: = Asian or Asian British

Q21 Asian or Asian British

- Indian (1)
- Pakistani (2)
- Bangladeshi (3)
- Chinese (4)
- Any other Asian background (5)

Display This Question:

If Please select your ethnicity: = Black, African, Caribbean or BlackBritish

Q22 Black, African, Caribbean or Black British

- African (1)
- Caribbean (2)
- Any other Black, African or Caribbean background (3)

Display This Question:

If Please select your ethnicity: = Other ethnic group

Q23 Other ethnic group

- Arab (1)
- Any other ethnic group (2)

Page

Break

Q17 Please select your area of residence:

North Tyneside (1)

Northumberland (2)

Q15 How many children do you have?

—

Q16 How many months has it been since you gave birth to your most recent child?

—

Page

Break

Q10 Please provide your email address in the box below:

—

Q11 Please provide a contact telephone number that can be used to carry out the interview in the box below:

—

Q4 Would you like to be sent a summary of the study findings?

Yes please (1)

No thank you (2)

Page

Break

Q5 Please let us know of any potential interview dates and times that would work well for you using the box below.

End of Block: Default Question Block

7. Study 3 full interview schedule

Interview schedule

Introduction

- How are you? How has your day been?
- Introduce myself
- Ask participant to introduce themselves
- Explain interview format, length (30-45 mins) and what is required of participant. No right or wrong answer. If at any point something is unclear please ask me to repeat question/try to explain another way.
- Explain what PA messaging is
 - PA messaging is where we use educational or persuasive messages to try to encourage the public to become more physically active
 - This Girl Can, poster telling you to take stairs, leaflet about PA, CMO infographic, leaflet about PA
- Check if any outstanding questions and consent form (via Qualtrics)
- Ask if any questions/need toilet/go get drink etc
- **Start recording**

Note to self: Reminder of study aims/objectives:

- Demonstrate how the developed framework and checklist can be used to inform message development:
 - Use the framework and checklist to create an interview guide (formative research)
 - Identify areas for future development of the framework and checklist
- Provide targeted physical activity messaging recommendations for a population subgroup:
 - Explore **awareness** of PA guidelines and **perceptions** of physical activity
 - Explore **preferences** for physical activity message **content, format, and delivery**
 - Explore potential physical activity message **pathways** for this population subgroup

Demographic questions

If not already collected via survey:

- Age in years
- Ethnicity
 - **White**
 - English, Welsh, Scottish, Northern Irish or British
 - Irish
 - Gypsy or Irish Traveller
 - Any other White background
 - **Mixed or Multiple ethnic groups**
 - White and Black Caribbean

- White and Black African
 - White and Asian
 - Any other Mixed or Multiple ethnic background
- **Asian or Asian British**
 - Indian
 - Pakistani
 - Bangladeshi
 - Chinese
 - Any other Asian background
- **Black, African, Caribbean or Black British**
 - African
 - Caribbean
 - Any other Black, African or Caribbean background
- **Other ethnic group**
 - Arab
 - Any other ethnic group
- Area of residence: North Tyneside or Northumberland
- Number of children
- Number of months since birth of most recent child

Physical activity perceptions and guideline awareness

Here I'm going to ask a few questions about your perceptions and awareness around physical activity.

- Could you please tell me what physical activity means to you?
 - Examples of PA that they take part in or know that others take part in? / Examples of activities that you think "count" as PA?
- How would you describe your physical activity levels?
- How has becoming a new mum affected your physical activity levels?
 - Any effects exacerbated/caused by COVID-19 pandemic?
- What do you know about the physical activity guidelines for health (UK CMO)?

Message pathway

The next set of questions relate to the message pathway. Here I'm trying to understand a bit more about how a PA message may bring about a change in behaviour and what that process might look like. In other words, what are the steps between you seeing or hearing a message and actually changing your behaviour.

- Thinking now about physical activity messaging: How do you think a physical activity message may aid in changing your physical activity behaviour?
 - Educate? Increase awareness? Persuade? Inspire? Motivate? Set goals?
- Can you think of any examples of physical activity messages you've seen before?
 - (If participant was able to think of any examples) Thinking of any examples of PA messages you've seen before – has a PA message ever had an effect on you?
 - changed how you feel/think about PA?

- changed your motivation or intention to be active?
- changed your behaviour?
- Are there any key barriers you face to being active?
 - Time
 - Lack of support
 - Access to facilities
 - Environment
 - University work
 - Tired
 - Motivation
 - Money
- Do you think that a message could potentially help with some of these barriers?
 - If a message shows you how to shorten the time spent exercising, would this help? Why?
 - Would it help if a message showed you that you didn't need big fancy equipment, gyms or you can use things in your own home? Why?
 - Do you think a message could improve your motivation? If so, how?
 - Would a message highlighting free physical activity opportunities be helpful? If so, how?

Message content

Here I'm going to ask some questions that will help me understand your preferences for the message content, or what actually goes in a message about PA.

- What type of information would you like to see in a physical activity message?
 - **What to do**
 - Examples: **10,000 steps, 150 minutes per week**, a mixture of aerobic and strength
 - **Why do it**
 - **Benefits of being active** or consequences of being inactive
 - Mental, physical or other
 - Short term/long term
 - **How/when/where to do it**
 - Examples: signposting local opportunities, instructions, ideas, links to further information
- What type of language or choice of words would you want to see in a PA message?
 - Casual? Professional? E.g., cardiovascular vs heart? Avoid "should" or "need to"?
 - Positive or negative?
- What type of tone should a message have?

- Threatening? Encouraging? Avoid condescending/shaming tones? Use reassuring tones? Can use smoking as example where threatening language works well?
- What would make a message more relatable or relevant to you?
 - Use of certain models? Use of certain language? Portrayal of certain settings?
- (Linking with previous responses to preferences in content) - Is there any type of information that you don't think you'd want to see?
- (If able to provide examples) Thinking of examples of PA messages you've seen before, can you tell me about anything you liked or didn't like about them?

Message format and delivery

This is the last section of the interview. Here I'm going to ask you about your preferences for how a PA message would be formatted and delivered to you.

- You mentioned you'd like to see (see above) type of information in a message. How do you think you'd prefer to receive this type of information?
 - Via text/words, through images video, through audio such as a voiceover or music?
- What media or mode would you like to see physical activity messages in?
 - E.g., social media post, leaflet, poster, radio advert.
 - Use of multiple modes?
- What length do you think the message should be?
 - E.g., no more than 100 words? No more than 30 seconds?
- Who would be your preferred source or messenger?
 - Health visitor, GP, government, celebrities, peers, brands, organisations, NHS etc
- In which setting(s) would you most like to receive messages about PA?
 - At home? At work? In GP surgery? On bus stops?
- How often would you like to see messages about PA? / How often would you need to see a message for it to have an effect?
 - E.g., once a week?
- What time of day would you prefer to see messages about PA?
 - E.g., before breakfast, at lunchtime?

Concluding interview

- Do you have any other thoughts about PA messaging you'd like to share?
- Thank participant for their time.
- Ask for contact details of any others they think may be interested in taking part.
- Offer to send copy of results once they are ready.

8. Study 3 framework analysis matrix

8.1. Coding matrix for predetermined category of message aims and pathway

Themes	Sub-themes	Codes						
		P1 Charlotte	P2 Sophie	P3 Jennifer	P4 Rachel	P5 Suzanne	P6 Jade	P7 Amy
Perceptions of physical activity (and PA messaging)	Perceptions about their own PA behaviour	Physical activity is important to them				Physical activity is important to them		
		Perceive themselves as a physically active person	Perceive themselves as a physically active person	Perceive themselves as a physically active person	Perceive themselves as a physically active person			Perceive themselves as a physically active person
	Perceptions about 'what counts' as physical activity		Understanding that physical activity is about trying to keep healthy and fit					

					Perception that physical activity is about raising heart rate		Perception that physical activity is about raising heart rate	
							Perception that PA involves moving your body with a purpose	
		Awareness that incidental PA 'counts'	Awareness that incidental PA 'counts'			Awareness that incidental PA 'counts'	Awareness that incidental PA 'counts'	Awareness that incidental PA 'counts'
				Perception that physical activity ranges from gentle to intense				
	Perception that they wouldn't respond to a point of decision prompt							Perception that they wouldn't respond to a point of decision prompt

	Perception that changing behaviour is difficult		Perception that changing behaviour is really hard (comparative to 'theory' in message)					
	Perception that previous communications have not been helpful	Had previously received leaflet with exercises but no information on benefits/risks						
						Found 6 week check unhelpful		
Experiences of mental health benefits of PA	Baby classes present an opportunity to socialise with other mums	Baby classes encourage getting out and having a chat with other mums						
	General positive mental health experiences	Experiences of mental health benefits of PA	Experiences of mental health benefits of PA			Experiences of mental health benefits of PA	Experiences of mental health benefits of PA	

The way in which new mums are physically active/types of PA	Walking is a key form of physical activity	Walking as a key form of physical activity	Walking as a key form of physical activity	Walking as a key form of physical activity	Walking as a key form of physical activity		Walking as a key form of physical activity	Walking as a key form of physical activity
							Walking doesn't come with barriers that other PA's do	
	Participation in a range of physical activities		Participate in a range of physical activities	Participate in a range of physical activities				Participate in a range of physical activities
Changes to physical activity behaviour since becoming a new mum	Physical activity decreased following birth of baby				Stopped exercising after birth for a period of time following medical advice			
		Believe their physical activity levels have dropped since they had their baby		Believe their physical activity levels have dropped since they had their baby		Believe their physical activity levels have dropped since they had their baby		

	Physical activity has become more difficult/physical abilities have changed		Being a new mum has made physical activity harder					Being a new mum has made physical activity harder
			Physical abilities have changed since having new baby			Physical abilities have changed since having new baby		
	Physical activity types have shifted since giving birth	The types of physical activity they engage in have changed since they had their baby			The types of physical activity they engage in have changed since they had their baby		The types of physical activity they engage in have changed since they had their baby	
					Physical activity now is opportunistic (where and when you can squeeze it in)			
		Physical activity needs to now include the baby				Physical activity needs to now include the baby	Physical activity needs to now include the baby	

		Enjoy spending time outdoors being active with baby					Enjoy spending time outdoors being active with baby	
		A change in priorities since having baby			A change in priorities since having baby			
Effects of COVID-19 pandemic on new mums	Effects of pandemic on physical activity behaviour	The pandemic took away PA opportunities	The pandemic took away PA opportunities	The pandemic took away PA opportunities	The pandemic took away PA opportunities	The pandemic took away PA opportunities	The pandemic took away PA opportunities	The pandemic took away PA opportunities
		Pandemic has changed frame of mind about gym environments		Pandemic has changed frame of mind about gym environments	Pandemic has changed frame of mind about gym environments			
		The pandemic positively impacted physical activity behaviour						
							Lack of motivation for online/virtual classes	

	Psychological effects of pandemic on new mums	Pandemic caused feelings of loneliness or isolation	Pandemic caused feelings of loneliness or isolation					
			Pandemic created positive experiences of being a new mum					
				Pandemic made mental health take priority over physical health				
			Pandemic created negative experiences of being a new mum			Pandemic created negative experiences of being a new mum		
	Pandemic caused concerns around children not socialising	Pandemic caused concerns around kids not socialising						
Barriers to physical activity in new mums	Personal barriers	Being busy/ lack of time as a barrier to physical activity as a new mum	Being busy/ lack of time as a barrier to physical activity as a new mum	Being busy/ lack of time as a barrier to physical activity as a new mum	Being busy/ lack of time as a barrier to physical activity as a new mum			Being busy/ lack of time as a barrier to physical activity as a new mum

					Free time is limited and there are other priorities			
					Lack of flexibility/ability to plan as barrier			
		Fatigue/Lack of energy as barrier to PA			Fatigue/Lack of energy as barrier to PA			
		Need to recover/Physical pain as a barrier to physical activity as a new mum	Need to recover/Physical pain as a barrier to physical activity as a new mum	Need to recover/Physical pain as a barrier to physical activity as a new mum				
				Difficult to schedule/plan PA when you are a new mum	Difficult to schedule/plan PA when you are a new mum	Difficult to schedule/plan PA when you are a new mum	Difficult to schedule/plan PA when you are a new mum	
				Reduced income (maternity pay) resulted in cost being barrier to PA	Reduced income (maternity pay) resulted in cost being barrier to PA	Reduced income (maternity pay) resulted in cost being barrier to PA		

		Struggle to self-motivate as barrier to PA						
							childcare as a barrier	
	Social barriers							Being embarrassed as barrier to physical activity
								Breastfeeding in public as a barrier
						Not knowing what you can and can't do as a new mum is a barrier		
	Environmental barriers					Distance from opportunities as a barrier		

			Weather as a barrier to physical activity			Weather as a barrier to physical activity		Weather as a barrier to physical activity
	Helping overcome barriers as a mechanism			Helping overcome barriers as a mechanism (e.g. cost and time)			Helping overcome barriers as a mechanism (e.g. cost and time)	
Awareness/perceptions of physical activity guidelines for health	Unable to recall current PA guideline (150 minutes)	Believe they don't know what the UK physical activity guidelines for health are	Believe they don't know what the UK physical activity guidelines for health are	Believe they don't know what the UK physical activity guidelines for health are	Believe they don't know what the UK physical activity guidelines for health are	Believe they don't know what the UK physical activity guidelines for health are		Believe they don't know what the UK physical activity guidelines for health are
	Aware of some elements of guidelines (current or previous versions)				Aware of existence of pregnancy-specific guidelines but not sure what they are			
		Awareness of older guidelines (30x5 or 30 mins a day etc)	Awareness of older guidelines (30x5 or 30 mins a day etc)			Awareness of older guidelines (30x5 or 30 mins a day etc)	Awareness of older guidelines (30x5 or 30 mins a day etc)	

			Believe guidelines encourage activity every day	Believe guidelines encourage activity every day		Believe guidelines encourage activity every day		
Having support from family and friends facilitates PA	Having support from family and friends facilitates PA						Having support from friends/family facilitates PA	
Persuasion as a pathway	Relatedness or connectivity to message	Relatability/connectivity as a mechanism	Relatability/connectivity as a mechanism					
	Encourage 'taking stock'			Encourage 'taking stock' as a mechanism	Encourage 'taking stock' as a mechanism			
	Prompts, nudges				Prompt/nudge as potential mechanism in active recipients			
	Inducing feelings of guilt		Hard hitting health messages can make them feel guilty (mechanism)		Hard hitting health messages can make them feel guilty (mechanism)			

		Making recipient feel guilty/like they're not doing enough is not a helpful pathway or mechanism				Making recipient feel guilty/like they're not doing enough is not a helpful pathway or mechanism		
	Changing mindset					Changing mindset as a potential mechanism		
						Like to see facts/information that puts the activity into perspective (hard to word this one)		
	Encouraging creation of habits/routine			Changing habits as a potential mechanism				
						Help create routine as mechanism		
	Providing a purpose	Giving someone a purpose/challenge/goal as a mechanism	Giving someone a purpose/challenge/goal as a mechanism			Giving someone a purpose/challenge/goal as a mechanism	Giving someone a purpose/challenge/goal as a mechanism	

Education as a pathway	Knowledge does not equal behaviour	Knowing how much you should exercise doesn't mean you'll do it (knowledge doesn't = behaviour)	Knowing how much you should exercise doesn't mean you'll do it (knowledge doesn't = behaviour)					
	Balance between education and patronisation			There's a delicate balance between educating people and patronising people				
	Understanding benefits of PA may be a pathway to behaviour change	Understanding benefits of PA as a mechanism	Understanding benefits of PA as a mechanism				Understanding benefits of PA as a mechanism	
				Perception that many don't realise that even a little PA can provide benefits				
Different types of PA may have different useful pathways		Time sensitive/recovery exercises my benefit from loss-framing				Time sensitive/recovery exercises my benefit from loss-framing		

8.2. Coding matrix for pre-determined category of message content

Themes	Sub-themes	Codes						
		P1 Charlotte	P2 Sophie	P3 Jennifer	P4 Rachel	P5 Suzanne	P6 Jade	P7 Amy
Impact of language and tone	Use of forceful language	Language like "should" "must" and "need" makes people feel negatively			Language like "should" "must" and "need" makes people feel negatively			Language like "should" "must" and "need" makes people feel negatively
		Awareness that people often know what they 'should' be doing and the fact they're not doing it has a negative mental effect on them						
					Forceful tone can have opposite of intended effect			Forceful tone can have opposite of intended effect

	Use of lay-friendly language				Lay friendly language encourages inclusivity			Lay friendly language encourages inclusivity
		Messages should avoid scientific jargon			Messages should avoid scientific jargon			
	Appearance-based language						Appearance based phrases like "yummy mummy" and "hot mamas" don't resonate	
	Importance of empathetic tones	Messages should be empathetic		Messages should be empathetic				Messages should be empathetic
	Different individuals respond differently to certain language	Certain language is hit or miss depending on where the participant is from/ language for one geographical location may not resonate with others						

	The use of reassuring language		An overly reassuring message may cause complacency					
			Balance between motivating and reassuring required					
		Desire for messages that are reassuring (positive reinforcement)		Desire for messages that are reassuring (positive reinforcement)	Desire for messages that are reassuring (positive reinforcement)	Desire for messages that are reassuring (positive reinforcement)		
Preferences for message framing	Dislike toward loss-framed messages						Negative messages feel "preachy"	
				Negative messages can feel condescending				
		Dislike being given a row/told off		Dislike being given a row/told off				Dislike being given a row/told off

	Preference for gain-framed or positive messages		Factually equivalent positively framed messages produce more positive feelings					
			Positively framed information motivates/encourages participation	Positively framed information motivates/encourages participation	Positively framed information motivates/encourages participation			
		Preference for positive messages	Preference for positive messages	Preference for positive messages	Preference for positive messages	Preference for positive messages	Preference for positive messages	Preference for positive messages
		Doing things they enjoy require less motivation						
Preferences for 'why do it' information	Physical health benefits					Interest in physical health benefits	Interest in physical health benefits	
	Mental health benefits	New mums can struggle with mental health issues		New mums can struggle with mental health issues		New mums can struggle with mental health issues		

					Acute benefits of PA important		Acute benefits of PA important	Acute benefits of PA important
					Appearance isn't as important as mental health			
			Interested in mental health benefits of PA	Interested in mental health benefits of PA	Interested in mental health benefits of PA			
		Being a new mum is isolating						
	Social health benefits	New mums want to connect with other new mums		New mums want to connect with other new mums		New mums want to connect with other new mums		
		Messages should promote getting outdoors and socialising				Messages should promote getting outdoors and socialising		

		Going out and getting fresh air is an important benefit of PA to new mums						
				Perception that mental and social health go hand in hand				
		Social aspect of PA is important to new mums		Social aspect of PA is important to new mums		Social aspect of PA is important to new mums	Social aspect of PA is important to new mums	Social aspect of PA is important to new mums
		New mums offer each other social support and reassurance				New mums offer each other social support and reassurance	New mums offer each other social support and reassurance	New mums offer each other social support and reassurance
		New mums have a sense of 'togetherness'				New mums have a sense of 'togetherness'		
	Environmental benefits		Interested in the environmental benefits of PA					

	Other benefits	Getting back to the 'old you' as an appealing benefit of PA						
Preferences for 'what to do' information	Perception that information on what exercises a new mum should do is missing	Perception that information on what exercises a new mum should do is missing						
	Different PA appeals to different people	Perception that different physical activities will appeal to different people				Perception that different physical activities will appeal to different people		
		Gentle exercise opportunities may be more appealing to new mums						
		Getting out for a walk with others seems attainable				Getting out for a walk with others seems attainable		

	Perception that there should be greater focus on post-birth recovery exercises	Recovery exercises are not communicated as well as pregnancy pelvic floor exercises						
		Perception that communications post-birth focus much more on the baby than on the mum						
	Support for "every little helps" type messages		Perception that everybody is capable of doing a little bit more or making small changes	Perception that everybody is capable of doing a little bit more or making small changes				
					A 'do what you can' message is acceptable			
					Make small changes is a good message			
	Desire for clear guidance					Desire for clear guidance		

	Bite sized PA appealing			New mums appreciate ways to do things efficiently					
				Preference for PA in bite sized chunks					
							Breaking down goals into more manageable chunks is helpful		
	Prefer to make up to guidelines how they want						Prefer to make up the guidelines 'how they want'		
	Preferences for guideline format in messages				150 minutes preferable to 30x5 because it can be split up however you want (and 5 times is too much)				
				30x5 seems more feasible/easier to imagine than 150 mins		30x5 seems more feasible/easier to imagine than 150 mins			

							Goals need to be tangible and realistic	
							Marketing perspective - smaller number is more appealing (e.g. 2.5 over 150)	
						Preference for 2.5 hours over 150 minutes	Preference for 2.5 hours over 150 minutes	Preference for 2.5 hours over 150 minutes
		150 minutes seems unattainable/unrealistic to new mums		150 minutes seems unattainable/unrealistic to new mums		150 minutes seems unattainable/unrealistic to new mums		
				Preference for minutes over steps information as time is precious				
			Desire for descriptive/instructive information in messages					

	Usefulness of numerical element (e.g. 10k steps)				Numerical element (e.g. 10k steps or 5-a-day) can make a message memorable			
			Numerical element can give a goal			Numerical element can give a goal	Numerical element can give a goal	Numerical element can give a goal
Preferences for 'how, when, where to do it' information	Interest in opportunities that include baby	PA opportunities that include baby are appealing for practical reasons		PA opportunities that include baby are appealing for practical reasons	PA opportunities that include baby are appealing for practical reasons	PA opportunities that include baby are appealing for practical reasons	PA opportunities that include baby are appealing for practical reasons	
							PA opportunities that include baby are not widely advertised/know about	PA opportunities that include baby are not widely advertised/know about
				Keen to see ideas of ways they can integrate PA into busy life				

	Want for clear advice on how/where to be active		Desire for messages that give practical advice on how/where to be active	Desire for messages that give practical advice on how/where to be active	Desire for messages that give practical advice on how/where to be active	Desire for messages that give practical advice on how/where to be active	Desire for messages that give practical advice on how/where to be active	Desire for messages that give practical advice on how/where to be active
		Messages should signpost where new mums can get further advice/ask questions						Messages should signpost where new mums can get further advice/ask questions
Other message content preferences	Perception that mums already know what they 'should' be doing	Perception that they already know what they 'should' be doing	Perception that they already know what they 'should' be doing	Perception that they already know what they 'should' be doing				
	Messages should include focus on mum	Importance of having mum-focused messages						
		New mums need to know it's okay to do something for themselves		New mums need to know it's okay to do something for themselves				

	Mixed messages can be confusing						Mixed messages can be confusing	
	Mums want to know 'what counts'	Messages should let new mums know what 'counts'	Messages should let new mums know what 'counts'		Messages should let new mums know what 'counts'			
	Different types of information useful		Appreciation for messages that have a mixture of different types of information	Appreciation for messages that have a mixture of different types of information	Appreciation for messages that have a mixture of different types of information			
	Preference for plain and simple/to the point messages					Plain and simple message preference		
					Likes 'punchy' 'to the point' information			
	Message relatability	Messages capture attention more if they're relatable						

		Positive perception of testimonial style messages	Positive perception of testimonial style messages					
			Lived experiences may increase relatability of statistics					
		Messages should be relatable to new mums						
							Questions can increase relatability of messages	
Different people need different messages (importance of message targeting or tailoring)		Very active new mums may perceive PA opportunities targeted to this group to be too low intensity/too easy						
					Messaging may not be effective in inactive people			

							perception that some people do need educated on benefits of PA	
							awareness that different people have different PA needs/abilities	
		Acknowledgement that different messages resonate differently depending on the individual	Acknowledgement that different messages resonate differently depending on the individual	Acknowledgement that different messages resonate differently depending on the individual				
		Acceptance that abilities are different and that type of PA has changed since becoming a new mum						

8.3 Coding matrix for pre-determined category of message format and delivery

Themes	Sub-themes	Codes						
		P1 Charlotte	P2 Sophie	P3 Jennifer	P4 Rachel	P5 Suzanne	P6 Jade	P7 Amy
Preferences for media/mode/setting/platform	Use of social media in message delivery	Facebook groups are important platforms for mums where they can find information, reassurance, social support		Facebook groups are important platforms for mums where they can find information, reassurance, social support		Facebook groups are important platforms for mums where they can find information, reassurance, social support	Facebook groups are important platforms for mums where they can find information, reassurance, social support	
		Social media is an important delivery platform for new mums		Social media is an important delivery platform for new mums	Social media is an important delivery platform for new mums	Social media is an important delivery platform for new mums	Social media is an important delivery platform for new mums	Social media is an important delivery platform for new mums

							Don't have time to watch videos	
Physical media			Preference for physical media e.g. leaflet or poster					
						Non-electronic modes e.g. posters seem 'dated'/question their relevance		
						Perception that leaflets are easily forgotten		
Message setting	Home is most sensible delivery setting as mums are likely to be there			Home is most sensible delivery setting as mums are likely to be there	Home is most sensible delivery setting as mums are likely to be there	Home is most sensible delivery setting as mums are likely to be there		

		Perception that PA messages seen in GP surgery aren't inspiring or motivating						
			Prefer passive delivery					
Importance of use of modelling	Commercial gym messaging damaging	Commercial gym messaging with 'typical' fit models is damaging/uninspiring/unreliable	Commercial gym messaging with 'typical' fit models is damaging/uninspiring/unreliable					
	Importance of inclusive/representative models						Seeing a variety of women/shapes and sizes increases relatability	Seeing a variety of women/shapes and sizes increases relatability
		Desire for models in messages to be relatable to new mums	Desire for models in messages to be relatable to new mums	Desire for models in messages to be relatable to new mums	Desire for models in messages to be relatable to new mums	Desire for models in messages to be relatable to new mums	Desire for models in messages to be relatable to new mums	Desire for models in messages to be relatable to new mums

		Seeing unrealistic models doesn't feel good				Seeing unrealistic models doesn't feel good	Seeing unrealistic models doesn't feel good	
Preferences for messenger, provider or source	Healthcare professionals as messengers						Health care providers in general should act as conduits to information	
						Midwives as potential messengers		
			Positive perception of GPs as trustworthy messenger	Positive perception of GPs as trustworthy messenger	Positive perception of GPs as trustworthy messenger			
		Health visitors are potentially important messengers				Health visitors are potentially important messengers	Health visitors are potentially important messengers	Health visitors are potentially important messengers
	Celebrities/influencers as messengers		Negative perception of celebrities/influencers as messengers	Negative perception of celebrities/influencers as messengers	Negative perception of celebrities/influencers as messengers		Negative perception of celebrities/influencers as messengers	Negative perception of celebrities/influencers as messengers

		Down to earth or relatable influencers on social media could be good messengers				Down to earth or relatable influencers on social media could be good messengers		
			Appearance of messenger/model is less important than reputation/trustworthiness					
	Lack of trust in government		Negative perception/lack of trust in government	Negative perception/lack of trust in government		Negative perception/lack of trust in government		Negative perception/lack of trust in government
	NHS viewed as trustworthy source			NHS viewed as trustworthy messenger	NHS viewed as trustworthy messenger	NHS viewed as trustworthy messenger	NHS viewed as trustworthy messenger	NHS viewed as trustworthy messenger
	Reputable brands as messengers				Reputable organisations or brands as potential messengers	Reputable organisations or brands as potential messengers	Reputable organisations or brands as potential messengers	Reputable organisations or brands as potential messengers

	Other mums as messengers		Other mums are important messengers	Other mums are important messengers		Other mums are important messengers	Other mums are important messengers	
	Messenger needs to have genuine interest		Messenger needs to have genuine interest (e.g. members of community)					Messenger needs to have genuine interest (e.g. members of community)
Frequency, dose preferences	Time of day				Preference for evening delivery because that's when they're free to go online	Preference for evening delivery because that's when they're free to go online	Preference for evening delivery because that's when they're free to go online	
			Perception that afternoon is bad time for delivery ('hit a wall')					
			Preferences for messages being received at a time that allows mums to act on them	Preferences for messages being received at a time that allows mums to act on them	Preferences for messages being received at a time that allows mums to act on them	Preferences for messages being received at a time that allows mums to act on them	Preferences for messages being received at a time that allows mums to act on them	Preferences for messages being received at a time that allows mums to act on them

						act on them		
			Preference for early morning delivery as more alert/switched on					Preference for early morning delivery as more alert/switched on
	Frequency			Regular delivery (once a month) desirable		Regular delivery (once a month) desirable		
								Switching up messages every so often can stop them getting boring
			Perception that repeated exposure to same message would help it 'stick'		Perception that repeated exposure to same message would help it 'stick'		Perception that repeated exposure to same message would help it 'stick'	
				Too frequent delivery of messages may feel harassing	Too frequent delivery of messages may feel harassing	Too frequent delivery of messages may feel harassing	Too frequent delivery of messages may feel harassing	

	Length/duration				Too much information isn't required			
			Preference for short and sweet/to the point messages	Preference for short and sweet/to the point messages	Preference for short and sweet/to the point messages	Preference for short and sweet/to the point messages	Preference for short and sweet/to the point messages	Preference for short and sweet/to the point messages
		Length of message doesn't matter if it's engaging enough	Length of message doesn't matter if it's engaging enough					
Other format and delivery considerations	Accessibility considerations	If using videos then subtitles are useful		If using videos then subtitles are useful				
	Do not assume tone will be clear via text alone							Sometimes message tone can't be 'heard' via text
	Design considerations		Preference for good use of colours and text bubbles (visually appealing)		Preference for good use of colours and text bubbles (visually appealing)			

			Negative perception of 'bullet points'					
					Music can make message more memorable			
						Social media posts need to be attention grabbing		
			Visual elements can help capture attention		Visual elements can help capture attention		Visual elements can help capture attention	
	Importance of being able to revisit message or find out more				Appreciate being able to revisit message and find out more		Appreciate being able to revisit message and find out more	
					Appreciate being able to follow up if interested			

9. Study 3 PAMC

Physical Activity Messaging Checklist (PAMC)		
<p>This checklist has been designed to be used in conjunction with the Physical Activity Messaging Framework (PAMF).</p> <p>When aiming to create new messages: The user is encouraged to work sequentially through the checklist, with the decisions made in Section 1 informing subsequent sections and using the checklist as a reporting framework. This checklist is not a prescriptive set of instructions but rather a set of considerations for creating physical activity messages. The concepts in this checklist may also be used to guide formative research/evaluation with the target audience which in turn can be used to make decisions around message content and delivery.</p> <p>When aiming to evaluate or understand existing messages: The checklist may be used to plan a process, impact or outcome evaluation. It can help identify message aims to inform evaluation and indicators that could be measured. It can also help to understand existing messages by allowing the user to classify messages and identify potential effective message components.</p> <p>The 'tick those that apply' column is designed to aid you in keeping track of which concepts have been considered and how and what decisions were made, not to necessarily encourage use of all concepts. A message with more ticks is not by default better than a message with fewer ticks.</p>		
Reason for using checklist	Tick those that apply	Additional comments/description
I am using this checklist to create a new message	X	I am using the checklist to inform and document formative evaluation that will aid development of PA messaging recommendations
I am using this checklist to understand an existing message, or to inform process and/or impact/outcome evaluation of an existing message		
3. Who, When, What, How and Why?		
3.1. Who? (in which group(s)?)		
	Tick those that apply	Specify below
4.3.2. Target population identified	X	New mums residing in the Northumberland Healthcare Trust area
4.3.3. Target audience engaged with to inform message development	X	Members of target audience were interviewed to inform message development

4.4. When? (in which context?)		
	Tick those that apply	Specify below
4.4.2. Time of year and social/political context of message considered (e.g., during the Olympics or during the COVID-19 pandemic)	X	This study focused on developing messaging recommendations for new mums that had given birth during the COVID-19 pandemic.
4.5. What? (is the aim of the message?)		
	Tick those that apply	Specify below
4.5.2. Specific aim of message identified (e.g., to improve self-efficacy, motivation, awareness, perceptions, knowledge etc) and specific outcomes relating to the aim identified and clearly stated	X	Based on findings from formative evaluation, messages targeting new mums could aim to: <ul style="list-style-type: none"> - Improve knowledge of PA guidelines - Improve awareness of opportunities available to new mums - Improve PA behaviour and mental health of new mums
4.6. How? (is the message intended to work?)		
	Tick those that apply	Specify below
4.6.2. Potential pathway(s) by which message may bring about change in the outcome(s) of interest identified (e.g., targeting beliefs about capabilities)		Based on findings from formative evaluation, potential working pathways for PA messages to new mums are: <ul style="list-style-type: none"> - Education (on benefits) - Providing a purpose or goal - Reducing barriers (e.g., barrier to new mums is having reduced income on maternity pay, and so a PA message can address this by sign-posting free or inexpensive opportunities)
4.7. Why? (are the decisions around message creation being made?)		

	Tick those that apply	Specify below
4.7.2. Decisions based on psychological or sociological theory or social marketing principles		
4.7.3. Decisions based on formative evaluation or co-production with the target audience (note: the concepts in this Checklist can be used to inform areas of investigation in research with the target audience)	X	Formative evaluation with the target audience informed recommendations/decisions
4.7.4. Decisions based on existing literature and evidence involving the target audience		
5. Message Content (what is in the message?)		
5.1. Type of information		
	Tick those that apply	Additional comments/description
5.1.2. Message contains “what to do” information (quantity and type of activity). For example: “Aim for 10,000 steps a day!”	X	New mums find numerical element useful as it provides a goal, so this could be included. However, the 150-minute message is perceived as unattainable by new mums, and they preferred “2.5 hours”. Letting new mums know that they can make up these guidelines how they like and in smaller bouts is crucial.
5.1.3. Message contains “why you should do it” information (e.g., physical, mental, social health, environmental benefits or appearance-based information). For example: “Take the stairs – feel less stressed!”	X	New mums valued hearing information about the benefits of PA, especially social benefits (connecting with other mums) and acute mental health benefits (feeling relaxed, happier etc).
5.1.4. Message contains “how to do it” information (practical or supportive information). For example: “Did you know that we run a group walk for older adults every Thursday at 12pm?”	X	New mums showed a strong desire for clear information on how, where, and when to be physically active. Opportunities where they could take their babies were of particular interest.
5.2. Information framing, targeting, tailoring and personalisation		

	Tick those that apply	Additional comments/description
5.2.2. Message content is gain-framed (highlights benefits)	X	New mums prefer gain-framed messages
5.2.3. Message content is loss-framed (highlights consequences)		
5.2.4. Message content is generic (suitable for all)		
5.2.5. Message content is tailored to an <i>individual</i> (based on user-specific data such as personal step count goal)		
5.2.6. Message content is <i>targeted</i> at a group (e.g., Type 2 diabetics or inactive older adults)	X	These messaging recommendations are targeted a new mums, specifically in North Tyneside and Northumberland
5.2.7. Message content is <i>personalised</i> (contains personal information such as name or home address)		
5.3. Use of language		
	Tick those that apply	Additional comments/description
5.3.2. Appropriate language and choice of words considered (e.g., ethnically, culturally, contextually and age-appropriate)	X	New mums showed a preference for simple and jargon-free language. Some mums showed a dislike for language such as 'yummy mummy' or 'hot mama'. Messages should avoid language like "should" or "need".
5.3.3. Message conveyed using a particular tone (e.g., formal, encouraging or threatening)	X	Messages to new mums should be reassuring and empathetic. Messages should not use forceful tones.
6. Message Format and Delivery		
6.1. The way the information (content) is conveyed		
	Tick those that apply	Additional comments/description
6.1.2. Message uses text to convey information (e.g., "physical activity is fun")	X	
6.1.3. Message uses images or videos to convey information (e.g.,	X	Messages with visual elements may capture attention of new

images or footage of people having fun being physically active)		mums more effectively. In images and videos, it is important that models used are realistic and relatable to new mums.
6.1.4. Message uses music to convey information (e.g., the use of 'fun' music in the message)	X	Some new mums suggested that music may make messages memorable. If using audio ensure subtitles are used.
6.2. Message format		
	Tick those that apply	Additional comments/description
6.2.2. The media, mode or channel of the message has been considered/specified		
6.2.2.1. Radio advert		
6.2.2.2. TV advert		
6.2.2.3. Poster		If using posters, ensure they are regularly updated and visually appealing
6.2.2.4. Leaflet or pamphlet		
6.2.2.5. Social media post (specify platform e.g., Twitter, Facebook, Instagram, TikTok, Snapchat etc)	X	Social media is an important delivery platform for new mums due to its in-demand nature
6.2.2.6. Email		
6.2.2.7. SMS/text message		
6.2.2.8. Other		
6.2.3. The message is of a specified length or volume (e.g., 100 words or 20 seconds)	X	New mums showed a preference for short and sweet or 'to the point' messages, but it is important to note that they also valued the opportunity to follow up for further information (e.g., with a link)
6.3. Message delivery		
	Tick those that apply	Additional comments/description
3.3.1. The provider, messenger or source has been considered/specified		

3.6.1. <i>Health care professional (e.g., GP)</i>	X	New mums view the NHS, midwives, GPs and health visitors as trustworthy messengers
3.6.2. <i>Family or friends</i>	X	
3.6.3. <i>Peers</i>	X	
3.6.4. <i>The media</i>		
3.6.5. <i>The Government</i>		
3.6.6. <i>Celebrities</i>	X	Some mums believe down to earth and relatable 'influencers' could be effective messengers
3.6.7. <i>Other (specify in additional comments/description box)</i>	X	New mums also described reputable brands and organisations such as Pampers or the Lullaby Trust to be trustworthy messengers
3.7. The setting in which the message will be delivered has been considered and specified, e.g., at home, at school, at work, at the doctor's surgery, at bus stops etc.	X	New mums described at home as the most appropriate place to reach new mums
3.8. The frequency, time of day and dose of message delivery have been considered and specified, e.g., 3 messages a week, set at 9am, for 3 months.	X	New mums suggested fortnightly or monthly messages, and believed that too frequent delivery could be harassing.

10. Letter of support from UK Chief Medical Officers



Chloe Williamson
University of Edinburgh

Sent via email:

23 September 2021

Dear Chloe,

We would like to formally thank you for your time and commitment as a member of the Communications Expert Working Group. We appreciate your considerable work to date to develop effective communications of the 2019 physical activity guidelines. We thank you for your recent report and look forward to hearing how the recommendations progress over the next few months.

Best wishes,

UK Chief Medical Officers

Dr. Frank Atherton
Chief Medical Officer,
Wales

Dr. Michael McBride
Chief Medical Officer,
Northern Ireland

Dr. Gregor Smith
Chief Medical Officer,
Scotland

Prof. Chris Whitty
Chief Medical Officer,
England

11. Letter of support from Jennifer Tomasone, Queens University



SKHS Building
28 Division Street
Queen's University
Kingston, Ontario, Canada K7L 3N6
www.queensu.ca/skhs

Jennifer Tomasone, Ph.D.
Tel: 613-533-6000 x79193
Fax: 613-533-2009
E-Mail:

March 11, 2021

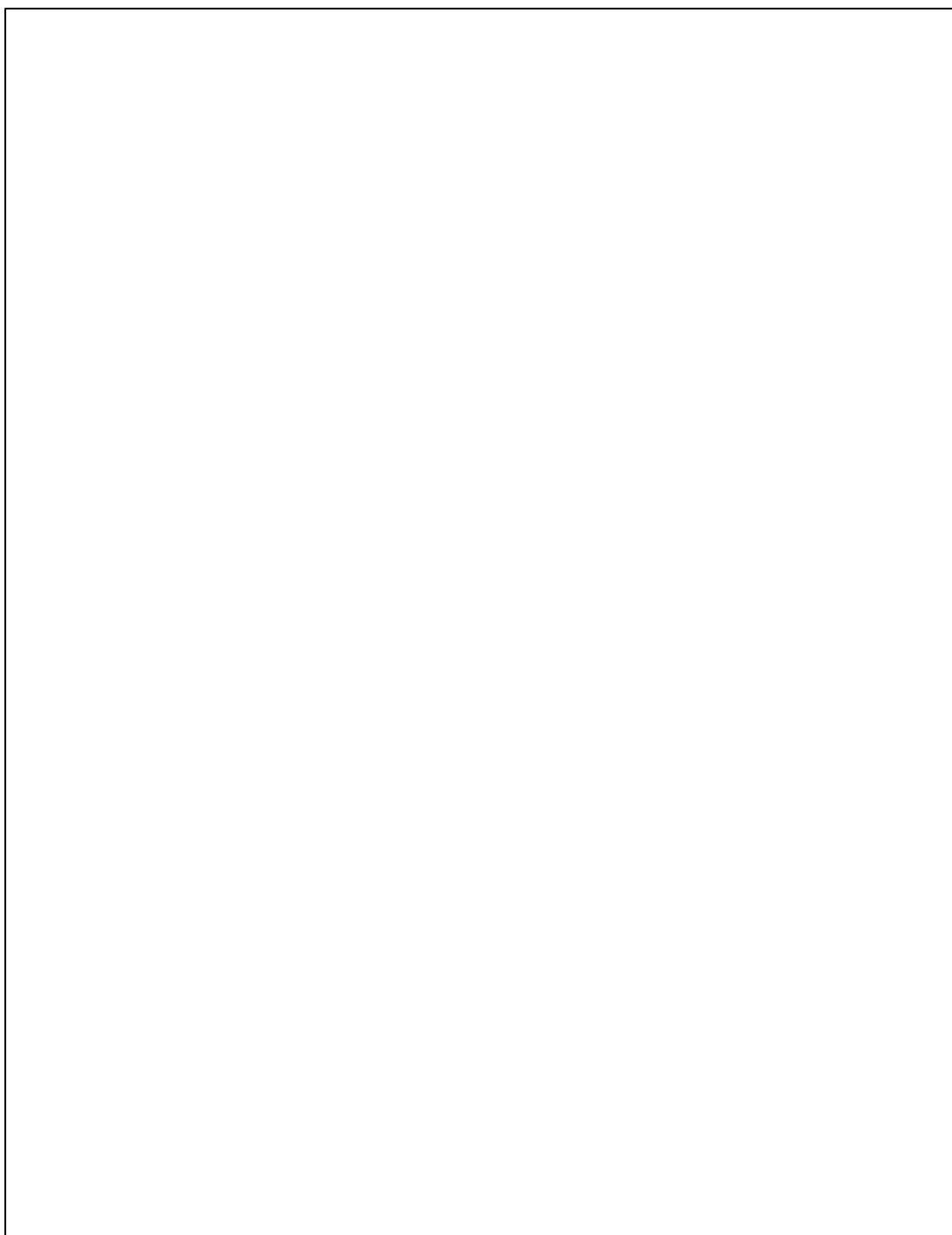
To Whom It May Concern,

Re: Chloë Williamson's Research Impact

It is with great pleasure that I write to discuss the impact that Chloë Williamson's PhD research has had on public health messaging in Canada. My name is Jennifer Tomasone, and I am the Knowledge Translation Lead for the Canadian 24-Hour Movement Guidelines for Adults 18-64 Years and 65+ Years. Our initiative is funded by the Public Health Agency of Canada and the Canadian Society for Exercise Physiology, and is supported by a variety of partners including ParticipACTION, Canada's leading physical activity promotion agency. In my role as the Knowledge Translation Lead, I oversaw the group that was responsible for the development and execution of the messaging of the nationwide mass media campaign that accompanied the guideline launch, which included the creation of public-facing materials to accompany the guidelines.

Ms. Williamson's Physical Activity Messaging Framework provided our group with structure and guidance for how we would proceed with developing co-created messages that were impactful, while also being evidence-informed, inclusive, and equitable. Specifically, our process was shaped by Chloë's framework, as follows:

- We engaged a multi-disciplinary group of stakeholders and end users in our message development process. The group contributed to shaping the formative research that we undertook, selecting a population of interest, interpreting our research findings, and provided rounds of feedback on our materials.
- One of our group's decision-making criteria for our process is ensuring equity in all efforts.
- We considered the context. Our guideline materials were being released during the pandemic, so all images and examples provided reflect the notion of being with immediate family members only. We chose not to make explicit mention of "COVID" so that the materials will resonate beyond the pandemic.
- We targeted the determinant of self-efficacy to meet the guidelines (i.e., based on psychological theory) and based our messages on previous literature as well as our formative research about preferences and needs of the target audience.
- We designed a variety of public-facing materials that provide the recommendations, the benefits of meeting the recommendations, and tips for "how to" do so.



12. Letter of support from Flora Jackson, Public Health Scotland



FAO: Chloe Williamson
Physical Activity for Health Research Centre
Moray House School of Education and Sport
The University of Edinburgh
Holyrood Road
Edinburgh EH8 8AQ

20 December 2021

To whom it may concern,

The Impact of Physical Activity Messaging Research on Work Undertaken by Public Health Scotland

As the Health Improvement Manager for Physical Activity at the national public health agency, Public Health Scotland, I would like to offer this letter as evidence of the impact that the research undertaken by Chloe Williamson has had on our work nationally.

Chloe has contributed to our work in an advisory capacity as well as through her initial review of literature, Delphi study and publications.

At the outbreak of the Covid-19 pandemic, Public Health Scotland developed a series of public facing communication messages to convey the importance of being and remaining active during the various stages of restrictions. These messages were drafted using the initial learning from Chloe's research and were underpinned by the emerging key principles developed, tested and further refined by Chloe in her published Physical Activity Messaging Framework (PAMF).

These messages were shared for onward dissemination by other national partners and Scotland's 14 territorial NHS Boards, as a bank of messages that they then tailored to their needs as part of local communications to the public. In addition, the messages were also used to shape the web content published on the NHS Scotland public facing website NHS Inform.

In August 2021, the UK CMOs tasked Public Health Scotland with the development of a Communications Strategy to enable the UK home nation public health agencies and devolved government administrations to disseminate the guidelines to professionals, practitioners and policymakers. The Physical Activity Messaging Framework (PAMF) and Checklist (PAMC) has been used by myself and colleagues to inform our approach, recognising that professionals and practitioners are a conduit to the public. Therefore the international consensus statement and user guide derived from Chloe's work, has been used to inform the development of the UK CMOs Physical Activity Guidelines Communications Strategy, by providing a framework through which professionals and practitioners can tailor messages for the public, using the checklist and user guide.

Yours sincerely

Flora Jackson
Health Improvement Manager (Physical Activity)

publichealthscotland.scot

Twitter  [@P_H_S_Official](https://twitter.com/P_H_S_Official)

Instagram  [@publichealthscotland](https://www.instagram.com/publichealthscotland)