Promoting physical activity in community settings: A critical exploration of intervention development, evaluation and implementation

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Published work and a critical commentary submitted in partial fulfilment of the requirements of the University of the West of England, Bristol for the degree of Doctor of Philosophy by publication (DPhil)

Section A: Commentary

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Supervisory team

Director of Studies: Dr Amy Slater

Second Supervisor 1: Dr Isabelle Bray

Second Supervisor 2: Dr Nicola Stock

Declaration of authorship and training

I confirm that all of the work presented in this doctoral thesis, including the selected publications and accompanying commentary (except where stated), is the original work of the author.

I confirm that none of the published body of work included within this portfolio of publications has been submitted for another academic award in this or any other institution.

I confirm that the necessary training requirements have been met (60-120 credits, of which at least 60 are at Level M).

Emma L Bird, 2020

Abstract

Evidence demonstrating the important and wide-ranging benefits of regular physical activity is well documented, however, one in four of the world's population is insufficiently active. Efforts to develop and implement effective interventions that facilitate and promote physical activity are therefore urgently required. Through submission of six academic works, published between 2013 and 2019, alongside a critical commentary, this thesis seeks to meet the UWE Bristol requirements for the Doctor of Philosophy by publication (DPhil) award in demonstrating a significant contribution to new knowledge in the area of community-based physical activity intervention development, evaluation and implementation.

While the publications submitted refer to research conducted in a range of settings, with different populations of interest and methodological approaches applied, they share a common focus: interventions that promote physical activity in community settings. In the critical commentary, each publication is critically examined, with reference to Medical Research Council guidance on developing and evaluating complex interventions. The critical commentary also provides additional insight into the importance of the research undertaken and its contribution to existing knowledge; it explores the methodological approaches utilised; it demonstrates the candidate's intellectual contribution to submitted works; and, it charts the candidate's development as a researcher and plans for future research.

Overall, the thesis makes the case for the development, evaluation and implementation of effective and replicable physical activity interventions for the real world, that explicitly consider the socio-ecological factors influencing

physical activity behaviours and that reduce inequalities in health. A number of recommendations are proposed to support public health researchers, practitioners and decision-makers in the future development, evaluation and implementation of interventions that promote physical activity in community settings.

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Abbreviations

APPHLE	Active People: Promoting Healthy Life Expectancy
BAME	Black and Minority Ethnic
BCT	Behaviour Change Technique
BGDP	Bristol Girls Dance Project
BSPHN	Behavioural Science and Public Health Network
CCA	Cost-Consequences Analysis
CEA	Cost-Effectiveness Analysis
CHU9D	Child Health Utility Instrument
CUA	Cost-Utility Analysis
DBS	Disclosure and Barring Service
EPSRC	Engineering and Physical Sciences Research Council
EQ-5D-Y	European Quality of Life-5 Dimensions Youth
eTPB	Extended Theory of Planned Behaviour
FPH	Faculty of Public Health
GRIP	Getting Research Into Practice
GUEST	GUidance for Exploratory STudies

HRQoL	Health-Related Quality of Life
iConnect	Impact of COnstructing Non-motorised Networks and Evaluating Changes in Travel
ICPAPH	International Congress of Physical Activity and Public Health
ISPAH	International Society for Physical Activity and Health
LGBT	Lesbian, Gay, Bisexual and Transgender
MEND	Mind, Exercise, Nutrition, Do it!
MRC	Medical Research Council
MVPA	Moderate-to-Vigorous Physical Activity
NICE	National Institute for Health and Care Excellence
NIHR	National Institute for Health Research
NIHR PHR	National Institute for Health Research Public Health Research
PBC	Perceived Behavioural Control
PHE	Public Health England
RCT	Randomised Controlled Trial
RE-AIM	Reach, Effectiveness, Adoption, Implementation, Maintenance
REF	Research Excellence Framework
SCPHN	Specialist Community Public Health Nursing
SSDC	South Somerset District Council
UWE Bristol	University of the West of England, Bristol
WHO	World Health Organization

Chapter 1: Introduction

This submission presents a body of peer-reviewed published academic work, alongside a critical commentary, that explores the development, evaluation and implementation of community-based interventions designed to promote physical activity. The submission highlights a concern about rising levels of physical inactivity and makes the case for the development, evaluation and implementation of effective and replicable physical activity interventions for the real world, that explicitly consider the socio-ecological factors influencing physical activity behaviours and that reduce inequalities in health.

The underpinning research of this submission draws upon five research projects and their outputs, and while these projects are diverse in setting, population of interest and methodological approach applied, they share a common focus: interventions that promote physical activity in community settings. In all, six works published between 2013 and 2019 are submitted (Table 1), each led by the author of this submission, alongside a critical commentary written in accordance with UWE Bristol regulations for the Doctor of Philosophy by publication (DPhil) award. The submission also includes an overview of wider research achievements to date.

Table 1. Citations of works submitted in support of DPhil by publication award

Publication number	Citation
1	**Bird, E.L.**, Ige, J.O., Pilkington, P., Pinto, A., Petrokofsky, C. and Burgess-Allen, J. (2018a) Built and natural environment planning principles for promoting health: An umbrella review. *BMC Public Health*. 18:930.
2	**Bird, E.L.**, Baker, G., Mutrie, N., Ogilvie, D., Sahlqvist, S. and Powell, J., on behalf of the iConnect Consortium. (2013a) Behavior change techniques used to promote walking and cycling: a systematic review. *Health Psychology*. 32 (8), pp. 829-838.
3	**Bird, E.L.**, Panter, J., Baker, G., Jones, T. and Ogilvie, D., on behalf of the iConnect Consortium. (2018b) Predicting walking and cycling behaviour change using an extended Theory of Planned Behaviour. *Journal of Transport and Health*. 10, pp. 11-27.
4	**Bird, E.L.** and Powell, J. (2019) Chapter 5 Economic Evaluation. In Jago *et al.,* Action 3:30: A cluster randomised feasibility study evaluation of a teaching assistant led, extracurricular physical activity intervention for 8 to 10 year olds. *Public Health Research* (in press).
5	**Bird, E.L.** and Powell, J. (2016) Chapter 4 Economic Evaluation. In Jago *et al.,* Bristol Girls Dance Project: cluster randomised controlled trial of an after-school dance programme to increase physical activity among 11- to 12-year-old girls. *Public Health Research*. 4 (6), pp. 47-53.
6	**Bird, E.L.,** Kok, M.S.Y. and Powell, J. (2019) General practice referral of 'at risk' populations to community leisure services: Applying the RE-AIM framework to evaluate the impact of a community-based physical activity programme for inactive adults with long-term conditions. *BMC Public Health* (in press).

Note. For validation, citations and journal esteem of works submitted see Appendix A. See Section B for copies of submitted works.

1.1 Requirements of the DPhil by publication award

The qualification descriptors for the DPhil by publication award at UWE Bristol are aligned with guidelines set out by the Quality Assurance Agency (QAA) for Higher Education (QAA, 2015). UWE Bristol Academic Regulations stipulate that students working towards any Doctoral-level award are required to demonstrate that they:

1) Have conducted enquiry leading to the creation and interpretation of new knowledge through original research or other advanced scholarship, shown by satisfying scholarly review by accomplished and recognised scholars in the field;
2) Can demonstrate a critical understanding of the current state of knowledge in that field of theory and/or practice;
3) Show the ability to conceptualise, design and implement a project for the generation of new knowledge at the forefront of the discipline or field of practice including the capacity to adjust the project design in the light of emergent issues and understandings;
4) Can demonstrate a critical understanding of the methodology of enquiry;
5) Have developed independent judgement of issues and ideas in the field of research and / or practice and are able to communicate and justify that judgement to appropriate audiences;
6) Can critically reflect on their work and evaluate its strengths and weaknesses including understanding validation procedures.

The presentation of published works represents only one aspect of the DPhil by publication submission process. A critical commentary is also required to provide

additional insight into the importance of the research undertaken and its contribution to existing knowledge; to explore the methodological approaches utilised; to demonstrate the candidate's intellectual contribution to submitted works; and, to chart the candidate's development as a researcher.

1.2 Aims and objectives

This DPhil by publication submission aims to demonstrate a contribution to new knowledge in the area of community-based physical activity intervention research, in order to support public health researchers, practitioners and decision-makers in future community-based physical activity intervention development, evaluation and implementation.

In addressing this aim, the objectives are:

- To collate evidence from a body of six first-authored, peer-reviewed academic works;
- To synthesise the evidence through a written critical commentary, demonstrating a significant contribution to knowledge in the area of community-based physical activity intervention development, evaluation and implementation;
- To critically examine the strengths and limitations associated with submitted works, and to make recommendations for future research and practice.

Chapter 2: An overview of research interests and career to date

My interest in community-based physical activity promotion stems from an early career experience, volunteering in South Bristol for the evidence-based childhood obesity prevention programme *Mind, Exercise, Nutrition, Do it!* (MEND). A central focus of the MEND programme is to promote physical activity in socio-economically deprived communities, and I was fortunate enough to see first-hand the positive impact physical activity can have on the physical and mental health of children and their families. I was aware of social and health inequalities from my undergraduate studies in Psychology at the University of Liverpool, but my experience with the MEND programme was the first time I came to appreciate the reality of how our health is affected by the environment in which we live, work and play.

Alongside this voluntary role, I completed Stage 1 training towards Practitioner Health Psychologist status through the MSc Health Psychology programme at UWE Bristol. When embarking on the Health Psychology programme, my knowledge and understanding of research was largely theoretical, and so I was pleased to receive encouragement from lecturers to undertake primary research for my master's dissertation. The study was a quasi-experimental school-based evaluation of an adapted Australian body image intervention for children aged 10-11 years called 'Happy Being Me', and the results were published in *Body Image* (Bird *et al.,* 2013b). This publication is not submitted as evidence toward this DPhil by publication as it is not focused on physical activity. However, it does

provide evidence for my long-standing interest in the development, evaluation and implementation of community-based interventions.

I graduated from the MSc Health Psychology programme with Distinction in 2010 and awarded the *Health Psychology Award* for obtaining the highest overall mark in my cohort. It was at this time that I joined UWE Bristol's *Centre for Public Health and Wellbeing* (then *Centre for Public Health Research*) as a Research Associate. I worked on the UK Engineering and Physical Sciences Research Council (EPSRC) funded *iConnect* study (Impact of COnstructing Non-motorised Networks and Evaluating Changes in Travel), which was a natural experimental study that aimed to measure and evaluate the impact of newly constructed walking and cycling infrastructure on physical activity, travel and carbon emissions. I was appointed to provide research support to various study work packages. Involvement in the *iConnect* study led directly to the publication of two journal papers included in this submission, which focused on the identification of evidence (Publication 2) and the examination of psychological theory (Publication 3) related to the development of interventions that promote walking and cycling behaviour change. These publications draw explicitly on my health psychology training. Involvement in the *iConnect* study facilitated membership with the *International Society for Physical Activity and Health* (ISPAH) and regular contributions at their bi-annual conference.

Alongside my *iConnect* role (2010-2014) I contributed to three other intervention development and evaluation-focused projects, which led to further publications. For example, in 2013, I was invited to work with colleagues at the University of Bristol on a cluster-randomised controlled trial of a school-based physical activity intervention, *Bristol Girls Dance Project* (BGDP), funded by the National Institute

for Health Research Public Health Research (NIHR PHR) funding stream. This study led to the publication of a peer-reviewed report, which incorporates a chapter I wrote and is included as evidence within this submission (Publication 5). Involvement in this project led to further collaboration with University of Bristol colleagues on a feasibility study of an after-school teaching assistant-led intervention, *Action 3:30*. The publication from this project is also included as evidence within this submission (Publication 4). My contribution to both of these works involved economic evaluation, an aspect of the intervention development and evaluation process that is under-researched.

While working on these research projects, I was invited to provide teaching support to *MSc Public Health* and *Specialist Community Public Health Nursing* (SCPHN) programmes at UWE Bristol. Initially this involved the facilitation of seminars and small workshops, but my remit gradually increased to include lecture delivery and then module leadership. It was in September 2014 that I was appointed as Senior Lecturer in Public Health at UWE Bristol. I currently lead three modules: *Health Promotion* (MSc Public Health); *Principles of Evidence Based Public Health* (SCPHN); and, *Public Health and Health Promotion for Professional Practice* (BSc Adult Nursing). I am also the Evidence Synthesis theme lead on the MSc Public Health dissertation module, and I contribute to teaching on *Quantitative Health Research* (MSc Public Health) and *Public Health and Health Promotion* (SCPHN) modules.

Engagement with, although not limited to, locally-based public health practitioners undertaking the MSc Public Health and SCPHN programmes led to the development of links between public health academia and practice. It facilitated my membership of the Bristol-based *APPHLE* (Active People: Promoting Healthy

Life Expectancy) Health Integration Team which encourages academics, commissioners and clinicians to work together and share best practice for the promotion of physical activity.

Since my appointment as Senior Lecturer, further opportunities to undertake community-based physical activity intervention development, evaluation and implementations have emerged. I have worked as a Principal Investigator and as a Co-Applicant on ten externally funded grants (see Appendix B). I have project-managed five research projects, acting as a co-applicant on two of these. Publications from these two projects are included as evidence in this submission as follows: 1) the *Healthy Places* project - an umbrella evidence review funded by Public Health England which identified evidence for associations between the built and natural environment and health impacts and outcomes (Publication 1); and, 2) the *CLICK* project – funded by Sport England – an implementation evaluation of General Practice referral of individuals with long-term conditions to community-based physical activity services in the rural UK district of South Somerset (Publication 6).

Overall, I feel fortunate to work in the role that I do. I thoroughly enjoy teaching and research, and the fact that these two aspects of the role overlap and complement each other. I am very much looking forward to continuing to develop my research career in the area of community-based physical activity development, evaluation and implementation in the years ahead.

Chapter 3: Background

3.1 Physical (in)activity as a public health issue

Evidence demonstrating the important and wide-ranging benefits of regular physical activity is well documented (2018 Physical Activity Guidelines Advisory Committee, 2018), and includes a reduced risk of non-communicable diseases, such as cardiovascular disease, type 2 diabetes mellitus and some cancers (Lee *et al.,* 2012), and improvements in mental wellbeing (Penedo and Dahn, 2005) and quality of life (Blair and Morris, 2009). Despite this, one in four of the world's population is thought to be insufficiently active, contributing to an estimated five million premature deaths (World Health Organization (WHO), 2018), and costing in excess of £41 billion to global health systems each year (Ding *et al.,* 2016).

Physical inactivity is recognised as the fourth leading risk factor for global mortality (WHO, 2009), leading prominent researchers to describe the issue as a "pandemic" (Kohl *et al.,* 2012, pp. 294). Growing recognition of this issue has resulted in the publication of numerous policy drivers and strategies that, broadly speaking, advocate for physical activity-focused policy creation (Global Advocacy Council for Physical Activity/ International Society for Physical Activity and Health, 2010; Global Advocacy Council for Physical Activity, 2012; United Nations, 2011; WHO, 2004). In 2013, the WHO responded to these policy drivers and pledged to reduce global physical inactivity prevalence by 10% by 2025 (WHO, 2013). However, findings from a recent pooled analysis of population-based survey data suggest that if current trends continue the target will not be met (Guthold *et al.,* 2018). Efforts to develop and implement effective interventions

that facilitate and promote physical activity are therefore urgently required.

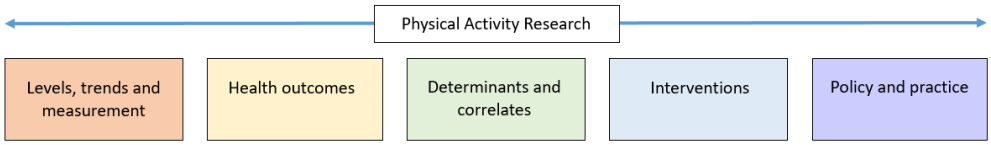
3.2 Physical activity interventions

Public health interventions are defined as "planned actions to prevent or reduce a particular health problem, or the determinants of the problem, in a defined population" (Wight *et al.,* 2016, pp. 520). Interventions range from those that are focused on promoting individual responsibility for health, known as 'downstream' interventions (*e.g.,* providing an inactive individual with information about the benefits of physical activity in an effort to encourage them to engage in physical activity), to 'midstream' interventions (*e.g.,* a workplace intervention designed to increase physical activity through increased access to facilities for physical activity), to 'upstream' interventions that are targeted at the policy level (*e.g.,* increasing the cost of car parking to promote physical activity or implementing new routes for walking and cycling) (Brownson, Seiler and Eyler, 2010).

In the seminal *2012 Lancet Physical Activity Series* (Bauman *et al.,* 2012; Hallal *et al.,* 2012; Kohl *et al.,* 2012), physical activity research was classified according to five categories (Figure 1): 1) Physical activity levels, trends and measurement; 2) Determinants and correlates of physical activity; 3) Health outcomes of physical activity; 4) Interventions in physical activity; and 5) Policy and practice in the field of physical activity. Physical activity research has grown exponentially since the 1950s, but it was only in the 1990s that studies of interventions with the primary objective of increasing physical activity began to appear in the literature. However, despite increased interest and acknowledgement of the need for developing interventions that promote physical activity, studies of such interventions remain the least common classification of published physical activity research (Varela *et*

al., 2018).

Figure 1. Physical activity research classification system

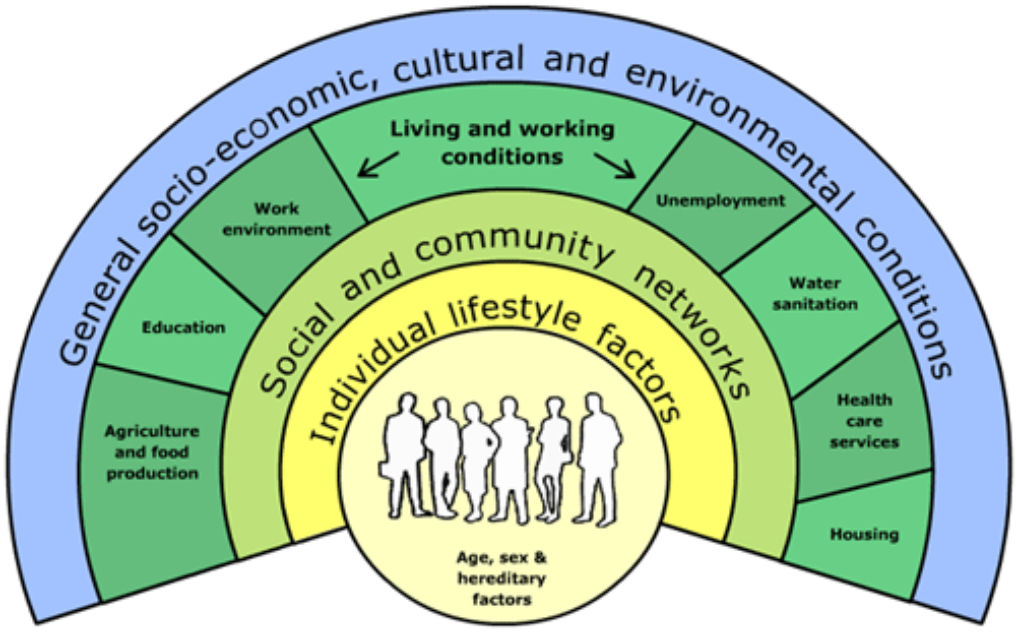


Source: Bauman *et al.,* 2012; Hallal *et al.,* 2012; Kohl *et al.,* 2012.

3.3 Physical activity and the socio-ecological model of health

Developing, evaluating and implementing effective physical activity interventions requires an understanding of the factors that influence physical activity behaviours (Bauman *et al.,* 2002; Bauman *et al.,* 2012). Many researchers have moved away from traditional approaches that focus on individual influences on behaviour, and towards more comprehensive frameworks that consider the contribution and interaction of the wider correlates and determinants of health present at individual-, social-, environmental-, and structural-levels, and how these are related to health inequalities (Dahlgren and Whitehead, 2006; Dahlgren and Whitehead, 1992; Giles-Corti *et al.,* 2016; Panter-Brick *et al.,* 2006). As shown in Figure 2, Dahlgren and Whitehead's widely cited socio-ecological model of health places individuals at the centre, surrounded by lifestyle factors, community influences, living and working conditions, and socio-economic, cultural and environmental factors, all of which are hypothesised to influence health and health inequality (Dahlgren and Whitehead, 1992).

Figure 2. Socio-ecological model of health



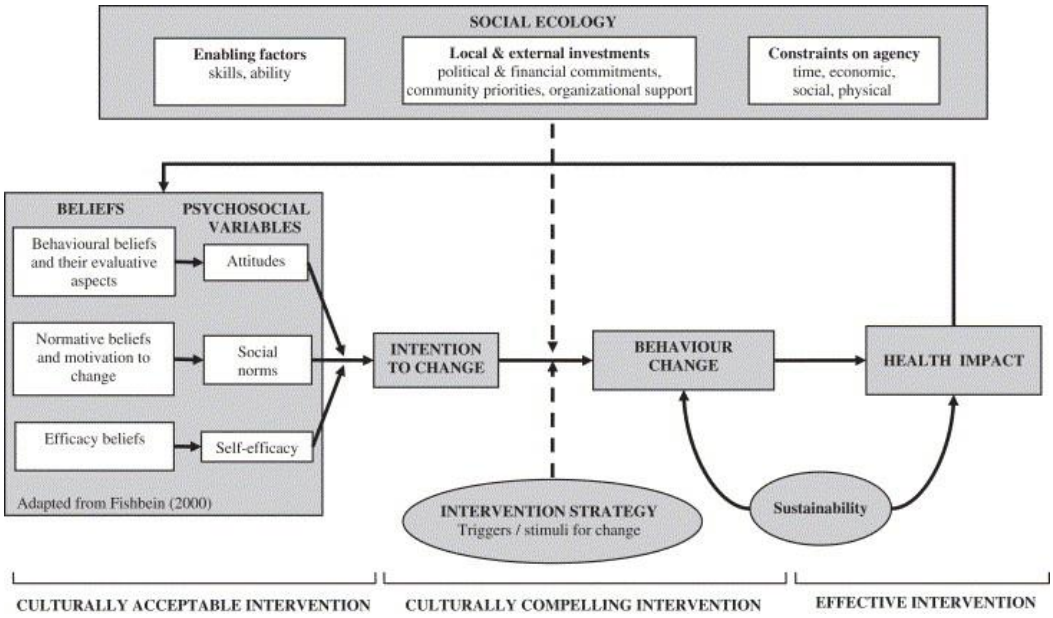
Source: Reproduced from *Policies and strategies to promote social equity in health. Background document to WHO – Strategy paper for Europe*, Dahlgren and Whitehead, 1992, with permission from WHO Europe ©.

Inequalities in physical activity behaviours stem from differences in the social and economic circumstances within which people live (Marmot, 2010; WHO, 2008). For example, in England alone, research has shown physical activity levels to be lower among the following groups: those living in socio-economically deprived areas; those living with a disability; those from Black, Asian and Minority Ethnic (BAME) groups; women and girls; and, those from lesbian, gay, bisexual and transgender (LGBT) communities (Public Health England, 2014a). Importantly, evidence also indicates that different forms of physical activity (*e.g.,* walking, swimming, dance, etc.) are influenced by a range of individual-, social-, and environmental-level determinants (Alfonzo, 2005; Krizek, Handy and Forsyth, 2009).

Building upon the work of Dahlgren and Whitehead (1992), Panter-Brick and colleagues propose a social ecology model, which not only identifies socio-ecological-level influences on health behaviours, but also presents a framework to aid the design, implementation, and evaluation of health behaviour change interventions (Panter-Brick *et al.,* 2006).

As shown in Figure 3, Panter-Brick and colleagues' model (2006) highlights individual-level influences on behaviour, such as attitudes and social norms, as well as socio-ecological factors, which include enabling factors (*e.g.,* skills, ability), local and external investments (for example, political and financial commitments), and potential constraints on agency (e.g., time, economy, social and physical factors). They argue that interventions designed to promote behaviour change need to be *culturally compelling* – to support people to move from intention to change behaviour, to actual behaviour change and subsequent health impact – through consideration of individual behaviours embedded within the "social and physical context, in micro- and macro-levels of community support, as well as levels of external support in terms of resources" (Panter-Brick *et al.,* 2006, pp. 2812). In moving beyond the identification of factors influencing health behaviours alone, Panter-Brick and colleagues' (2006) framework highlights opportunities for developing practical strategies for behaviour change and public health impact.

Figure 3. Social ecology model of behaviour change



Source: Reproduced from *Culturally compelling strategies for behaviour change: A social ecology model and case study in malaria prevention*, Panter-Brick *et al.,* 2006, 62, 2006, with permission from Social Science & Medicine.

In the context of physical activity, research has identified the need to better understand features of the environment that best promote physical activity and reduce health inequalities, in addition to exploring individual-level physical activity behaviours and their complexities (Bauman *et al.,* 2012; Sallis *et al.,* 2008). A recent review of strategies for promoting physical activity reiterated the need for interventions that address a range of socio-ecological influences, implemented at all levels of the socio-ecological model (Powell *et al.,* 2019). It is therefore concerning that in the UK, strategies for promoting physical activity and tackling health inequalities are primarily 'downstream' in nature, focused on individual responsibility for health, with limited consideration of wider influences on health and health behaviours (Kriznik *et al.,* 2018).

3.4 Community-based interventions

Interventions implemented in community settings are socio-ecologically driven, in that the environmental setting within which they are delivered is central to the development and implementation of that intervention. In a physical activity context, community-based interventions have been shown to be an effective and cost-effective approach for promoting physical activity (Garrett, Elley and Rose, 2011; Harding, Griffin and Wareham, 2006).

There are numerous and contesting definitions of 'community-based' in the context of community-based interventions (McLeroy *et al.,* 2003). One definition, that is the focus of works included in this DPhil by publication submission, refers to a particular community in a specific geographical setting (or with a shared interest) in which an intervention is delivered; interventions are then implemented at various levels within that setting (*e.g.,* with individuals, families, schools, city-wide) (McLeroy *et al.,* 2003; Merzel and D'Aflitti, 2003). The focus of such community-based interventions is chiefly on promoting behaviour change, as a means to reducing disease risk (Merzel and D'Aflitti, 2003; National Institute for Health and Care Excellence (NICE), 2007), although the effects may be felt at more than one level (*e.g.,* individual, community, population) (NICE, 2014).

Existing evidence on physical activity interventions has been criticised for an over-reliance on cross-sectional studies, which provide limited insight into the causal relationships between physical activity interventions and outcomes (Biddle, Mutrie and Gorely, 2015). Secondly, the evidence base for how best to promote population level physical activity through community- and population-level initiatives has been slow to develop (Foster *et al.,* 2018) and the evidence that does

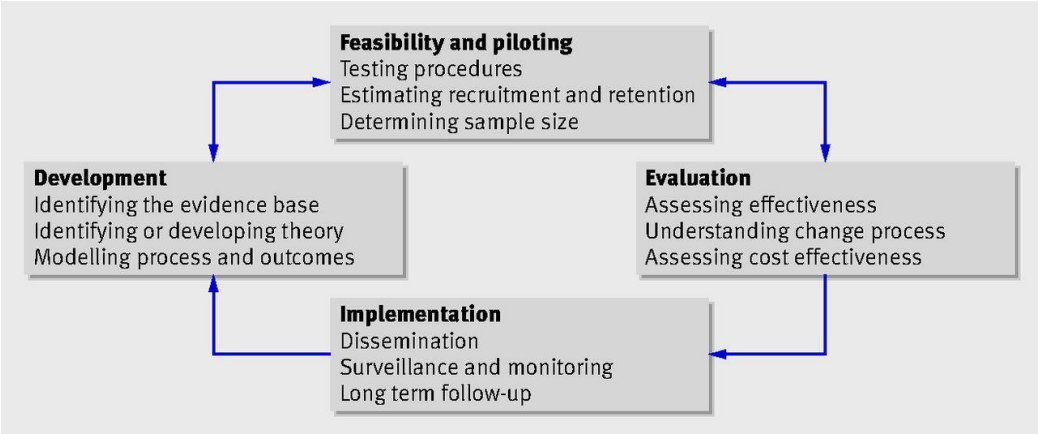
exist is limited (Hanson and Jones, 2017). For example, Hanson and Jones' evaluation of a community-based walking programme implemented across five UK cities identified that details of individual evaluations, such as the rationale, the target population, and participant demographics, were often poorly and inconsistently reported, making it difficult to replicate and scale-up evidence from interventions that show promise (Hanson and Jones, 2017). Understanding the impact of community-based interventions through the assessment of intervention development, evaluation and implementation is crucial if improvements to population health outcomes and a reduction in the burden on health and social care provision are to be achieved (Public Health England, 2014b; Reis *et al.,* 2016).

3.5 Intervention development and evaluation frameworks

Several frameworks exist (for example, Campbell *et al.,* 2000; Craig *et al.,* 2006; NICE, 2007; Michie *et al.,* 2011; Wight *et al.,* 2016) that are designed to aid the development and evaluation of public health interventions using a consistent approach. One of the most highly cited and influential frameworks was developed by the Medical Research Council (MRC). It was first published in 2000 (Campbell *et al.,* 2000), followed by the publication of a revised version in 2006 (Craig *et al.,* 2006) alongside an accompanying paper in the British Medical Journal (BMJ) (Craig *et al.,* 2008). The revised framework (Craig *et al.,* 2006; Craig *et al.,* 2008) is explicitly designed to support the development, feasibility testing, evaluation and implementation of complex interventions (Figure 3), and it has been widely applied in the field of physical activity research (Biddle *et al.,* 2015). In the 2006 guidance, complex interventions are defined as "interventions that contain several interacting components" (Craig *et al.,* 2006, pp. 7) and include varying dimensions of complexity in terms of outcomes, target populations, and intervention

characteristics. An appreciation of intervention complexity is important to better understand how an intervention can bring about change, and how variation in individual-level outcomes may be related to intervention design. It can also identify unintended intervention consequences, and be used to adapt an intervention to best serve the community within which it is being implemented.

Figure 3. Key elements of the development and evaluation process



Source: Reproduced from *Developing and evaluating complex interventions: the new Medical Research Council guidance*, Craig *et al.,* 2008, 337, 2008, with permission from BMJ Publishing Group Ltd.

The 2006 guidance acknowledges that the intervention development and evaluation process is not always linear, and advocates taking a flexible non-sequential approach (Craig *et al.,* 2006). The *Development* phase is concerned with the identification of the evidence base, the identification and development of theory, and the modelling of process and outcomes; the *Feasibility and Piloting* phase involves testing procedures, estimating recruitment and retention, and determining sample size; the *Evaluation* phase is concerned with assessing effectiveness, understanding change processes, and assessing cost effectiveness; and, the fourth phase refers to *Implementation*, which includes guidance on dissemination, surveillance and monitoring, and long-term follow-up.

3.5.1 Recent developments in public health intervention development and evaluation thinking

As the published works presented in this submission span seven years, it is important to recognise developments in intervention design and evaluation research during this time, and to reflect upon how, in light of the changes that have occurred, submitted works continue to contribute to the physical activity evidence base. Firstly, in 2019 the MRC funded a second revision of the MRC guidance on developing and evaluating complex evaluation, led by Professor Laurence Moore (Project reference: MR/N015843/1). In March 2019, there was a two-week open consultation on draft-revised guidance, and there are plans to publish the final revised guidance in 2020. The draft guidance circulated in March 2019 suggests that the four core phases of the 2006 guidance remain. However, additional attention is paid to the context (and the complexity of context) within which interventions are delivered and evaluated, as well as the complexity of the intervention itself. Draft guidance also highlights the importance of generating evaluation evidence that goes beyond academia and is of value to decision-makers. Six new factors, of which context is one, are proposed (Skivington *et al.,* 2019): 1) Consideration of context; 2) Involvement of stakeholders; 3) Development and iteration of programme theory; 4) Consideration of economics; 5) Ongoing intervention modification; and, 6) Consideration of uncertainty surrounding an intervention.

A second, relatively recent development for public health intervention development and evaluation has been the emergence of systems theory in helping to better understand complex public health issues. In 2017, Rutter and colleagues proposed a complex systems model of public health in which poor health and

health inequalities are conceptualised "as outcomes of a multitude of interdependent elements within a connected whole" (Rutter *et al.,* 2017, pp. 2602). In the physical activity context, systems thinking can be used to identify the political, social, cultural, economic and scientific factors influencing inactivity, and the relationships between these factors and changes over time (Rutter *et al.,* 2019).

A systems approach differs from traditional linear models of cause and effect (which make up much of the existing physical activity evidence base), with more emphasis on better understanding how a system responds and adapts to interventions within it (Rutter *et al.,* 2019). Individual-level interventions, which are not designed to consider the wider system, may be difficult to implement and sustain in the long term resulting in a limited overall impact on population health and wellbeing (Rutter *et al.,* 2017).

Co-production, defined as "working in equal partnership with communities in spaces where power is shared, making services more effective and efficient, and in the long-term more sustainable" (The King's Fund, 2016), is the final key development in intervention development and evaluation research that has received increased attention in recent years. The concept of co-production is integral to systems approaches for public health, in that co-production can be used to ensure that a comprehensive overview of a system's elements are identified and that any intervention is designed to work within the context of a chosen system through promoting programme acceptability and local community buy-in (Hawkins *et al.,* 2017).

3.6 Chapter summary

This chapter highlights a concern with rising levels of physical inactivity, and the need to develop, evaluate and implement socio-ecologically sensitive interventions that facilitate and promote physical activity in the community. In the chapters that follow my contribution to community-based physical activity intervention research is presented, with reference to intervention development, evaluation and implementation processes proposed by the MRC (Craig *et al.,* 2006).

Chapter 4: Research approach

4.1 Pragmatic paradigm

The philosophical movement of pragmatism began in the 1870s through the work of Charles Sanders Peirce, and was later developed by William James (1842-1910) and John Dewey (1859-1952). Pragmatism is often referred to as a philosophy for identifying "what works", as opposed to a search for objective "truth" or "reality" (Weaver, 2018; Murphy, 1990). It asserts that the nature of reality (ontology), the nature of knowledge (epistemology), and the approaches for research inquiry (methodology) are not fixed:

> *"Reality is actively created as individuals act in the world, and it is thus ever changing, based on human experience, and oriented toward solving practical problems. Truth is what works at the time…Methodology…is open to exploring the different kinds of methods employed in different branches of science."*
>
> Weaver, 2018, pp. 3.

Pragmatic research seeks to identify solutions to real-world problems, drawing upon quantitative, qualitative and mixed methods approaches that are best suited to answer the research question under investigation (Weaver, 2018; Murphy, 1990). In contrast with the post-positivist research paradigm, which is reductionist in nature, the pragmatic paradigm is well aligned with the socio-ecological approach to public health research (Dahlgren and Whitehead, 1992) in which the importance and complexity of the social, political and environmental context is acknowledged (Creswell and Creswell, 2018; Morgan, 2014).

In undertaking the research presented within this thesis, which sought to identify evidence to best support communities to become more physically active, my application of a pragmatic research approach, which attempts to identify "what works" in a real-world context, using methods most appropriate to answer a research question, was particularly apt. Pragmatic physical activity intervention research presents an opportunity to generate evidence that is contextually relevant, considers important issues of replicability and scalability, and is of value to stakeholders and decision-makers working in real-world community settings.

4.2 Research methods

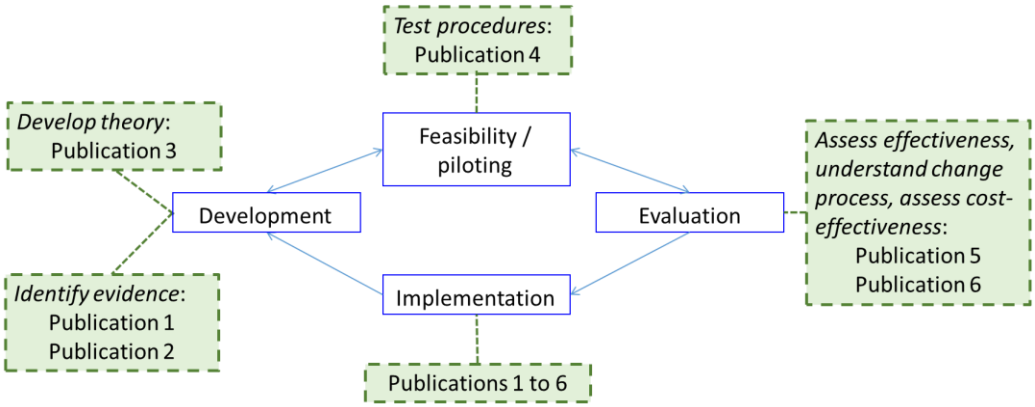
In line with the pragmatic research paradigm described above and the MRC framework for developing and evaluating complex interventions (Campbell *et al.,* 2000; Craig *et al.,* 2006) a range of robust methodological approaches were utilised to examine different aspects of the physical activity intervention development and evaluation process. For each submitted publication, the methodological approach applied was pragmatic in that it utilised the most appropriate methodology for answering the research question. Submitted works include two publications that employed evidence synthesis methods (Publications 1 and 2), three publications that involved quantitative inquiry (Publications 3, 4 and 5), and one publication that utilised mixed methods (Publication 6). Each of the publications submitted contain a critical examination of the methods utilised, so the critical commentary that follows in Chapter 5 takes a reflective approach to avoid unnecessary repetition.

This submission draws upon works published between 2013 and 2019. To synthesise research contributions, works submitted have been mapped against the

four key phases of the 2006 MRC framework (Craig *et al.,* 2006), and are critically considered against these phases in order to demonstrate a contribution to new knowledge.

MRC guidelines acknowledge that intervention research is not always conducted in a linear or chronological fashion, from development through to implementation (Craig *et al.,* 2006). This is the case for works submitted in this submission. In the critical commentary that follows in Chapter 5, the findings and implications of Publications 1 to 6 are presented in a logical way with reference to each of the four MRC framework phases (Figure 5): Publications 1 to 3 are used to demonstrate a contribution to understanding of the *development* of community-based physical activity interventions; the findings from Publication 4 are examined in relation to their implications for physical activity intervention *feasibility* testing; Publications 5 and 6 demonstrate a contribution to new knowledge in the area of physical activity intervention *evaluation*; and finally, the findings and implications of Publications 1 to 6 are explored in relation to community-based physical activity intervention *implementation*. Reflections on proposed revisions to the 2006 framework are also provided.

Figure 5. Published works mapped onto the Medical Research Council framework



Source: Adapted by permission from BMJ Publishing Group Limited *Developing and evaluating complex interventions: the new Medical Research Council guidance*, Craig *et al.,* 337, 2008.

4.3 Ethical considerations

Publications 1 and 2 utilised evidence synthesis methods; Publication 1 is an umbrella review (also known as a review of systematic reviews), while Publication 2 presents the findings from a traditional systematic review of quantitative evidence. Evidence synthesis is a form of secondary research that draws upon publicly available data, and as such, formal ethical approval was not required. However, in undertaking both reviews, guidance was consulted on the ethical issues associated with evidence synthesis preparation and reporting (Wager and Wiffen, 2011).

Publications 3 to 6 involved the collection and analysis of primary data, requiring careful consideration of ethical issues and potential risks. All data collected from these research projects were held and used in accordance with the Data Protection Act 1998. All participants were provided with a unique participant identifier to

ensure anonymity during data analysis, although participants were informed of circumstances where confidentiality would be breeched. For example, those responsible for data collection were trained to identify signs of participant distress and to signpost to support services where appropriate.

Research leading to Publications 4 and 5 was conducted in schools, a setting associated with increased ethical risks due to the engagement of children (Felzmann, 2009). In gaining ethical approval for these projects the team was required: to apply for Disclosure and Barring Service (DBS) checks and to obtain written permission from each school to conduct each study; to work with teachers in explaining the consent process to children (and to request written informed consent from parents); to seek notice of and discuss any specific emotional or learning needs (including language needs) among participants prior to data collection; and, to avoid unsupervised contact with children. I was not directly involved with data collection for these two projects, but I am familiar with ethical considerations when working with children in school settings from experience working on other research projects (*e.g.,* Bird *et al.,* 2013b; Bird *et al.,* 2017).

Ethical approval for Publication 3 was obtained from the University of Southampton Ethics Committee (Reference: CEE200809-15), and approval for Publications 4 and 5 was granted from the School for Policy Studies Ethics and Research Committee at the University of Bristol (Publication 4 reference: Bristol Girls Dance Project; Publication 5 reference: SPSREC16-17.B2). Publication 6 was granted ethical approval by the University of the West of England Faculty Research Ethics Committee (Reference: HAS/15/08/008).

4.4 Intellectual contributions to works submitted

Table 2 documents my contributions to each publication submitted; as lead author for each paper, I was involved at each stage, from study conceptualisation through to publication. In the interest of openness and transparency, co-authors of each publication were invited to provide a signed statement confirming the contribution stated below in Table 2. Signed statements from co-authors can be found in Appendix C.

Table 2. Author's intellectual contributions to works submitted

Publication 1: **Bird, E.L.** *et al.* (2018a) Built and natural environment planning principles for promoting health: An umbrella review. *BMC Public Health* 18:930. • Lead author • Identified and developed the topic • Contributed to the overall concept and design of the project • Conducted systematic literature review • Collaboratively drew conclusions and corresponding implications • Led all drafts of the work, including revisions • Disseminated the findings
Publication 2: **Bird, E.L.** *et al.* (2013a) Behavior change techniques used to promote walking and cycling: a systematic review. *Health Psychology*. 32 (8), pp. 829-838. • Lead author • Identified and developed the topic • Contributed to the overall concept and design of the project • Conducted systematic literature review • Conducted quantitative analysis • Collaboratively drew conclusions and corresponding implications • Led all drafts of the work, including revisions • Disseminated the findings

Publication 3: **Bird, E.L.** *et al.* (2018b) Predicting walking and cycling behaviour change using an extended Theory of Planned Behaviour. *Journal of Transport and Health*. 10, pp. 11-27.

- Lead author
- Identified and developed the topic
- Contributed to the overall concept and design of the project
- Conducted a literature search
- Conducted quantitative analysis
- Collaboratively drew conclusions and corresponding implications
- Led all drafts of the work, including revisions
- Disseminated the findings

Publication 4: **Bird, E.L.** and Powell, J. (2019) Chapter 5 Economic Evaluation. In Jago *et al*. Action 3:30: A cluster randomised feasibility study evaluation of a teaching assistant led, extracurricular physical activity intervention for 8 to 10 year olds. *Public Health Research* (in press).

- Lead author, under supervision of co-author Professor Jane Powell
- Contributed to the overall concept and design of the economic evaluation
- Conducted a literature search
- Conducted quantitative analysis
- Collaboratively drew conclusions and corresponding implications
- Led all drafts of Chapter 5 including revisions
- Disseminated the findings

Publication 5: **Bird, E.L.** and Powell, J. (2016) Chapter 4 Economic Evaluation. In Jago *et al*. Bristol Girls Dance Project: a cluster randomised controlled trial of an after-school dance programme to increase physical activity among 11- to 12-year-old girls. *Public Health Research*. 4 (6), pp. 47-53.

- Lead author, under supervision of co-author Professor Jane Powell
- Contributed to the overall concept and design of the economic evaluation
- Conducted a literature search
- Conducted quantitative analysis
- Collaboratively drew conclusions and corresponding implications
- Led all drafts of Chapter 4, including revisions
- Disseminated the findings

Publication 6: **Bird, E.L.** *et al*. (2019) General practice referral of 'at risk' populations to community leisure services: Applying the RE-AIM framework to evaluate the impact of a community-based physical activity programme for inactive adults with long-term conditions. *BMC Public Health* (in press).

- Lead author
- Identified and developed the topic

- Conducted a literature search
- Conceptualised and designed the study with supervision
- Collected quantitative and qualitative data
- Conducted quantitative and qualitative analysis
- Collaboratively drew conclusions and corresponding implications
- Led all drafts of the work, including revisions
- Disseminated the findings

Note. Stated contribution to each publication confirmed by co-authors. See Appendix C for further details.

Chapter 5: Critical commentary

5.1 Presentation of submitted works

This chapter explores each of the publications submitted, and summarises how, in submitting this evidence of scholarship, the UWE Bristol doctoral descriptors have been met.

5.1.1 Publication 1

> Bird, E.L., Ige, J.O., Pilkington, P., Pinto, A., Petrokofsky, C. and Burgess-Allen, J. (2018a) Built and natural environment planning principles for promoting health: an umbrella review. *BMC Public Health*. 18:930.

The first publication submitted presents the findings of an umbrella review designed to identify evidence for associations between features of the built environment and health-related impacts and outcomes, including physical activity. The review focused on five categories of the built and natural environment: Neighbourhood design; housing; healthier food environment; natural and sustainable environment; and, transport. The conceptual framework and the presentation of findings was inspired by a Canadian review produced by the British Columbia Centre for Disease Control (2014).

In acknowledging that a range of aspects of the built and natural environment are associated with health, the review identifies with a complex systems model of public health, where health is influenced by "a multitude of interdependent elements within a connected whole" (Rutter *et al.,* 2017, pp. 2602). Evidence pertaining to five review categories is presented separately; however, the publication does recognise interconnection between categories. For example, in

the case of physical activity, increased levels of cycling were found to be associated with supportive physical and food infrastructure, spatial planning, and integration with public transport. The findings of the review therefore make a useful contribution to developing the evidence base on systems-based approaches to intervention development, as they attempt to identify how to influence complex systems to achieve improved population health and wellbeing.

As numerous systematic reviews exist examining different aspects of the built environment and health (*e.g.,* Bambra *et al.,* 2010; Renalds, Smith and Hale*,* 2010) conducting yet another traditional systematic review seemed unlikely to lead to the creation of new knowledge and was also unlikely to hold much value in public health practice settings. Working alongside my UWE Bristol colleague Dr Paul Pilkington, we therefore conceptualised a plan to undertake an umbrella review (also known as a review of systematic reviews) and we were successful in our bid to Public Health England. I was a co-applicant on the bid and my role was to project manage the review, from review conceptualisation, to design and implementation. Importantly, this work was not conducted in an academic vacuum; we knew it was essential for future implementation to engage with relevant stakeholders from the outset. In the first month of the project we held a workshop with over 20 stakeholders working in public health and planning roles (*e.g.,* Directors of Public Health; Housing Officers; Planning Policy Planners) to discuss the direction of the work and to obtain guidance on how best to present findings to influence decision-makers; a strategy advocated in the recently proposed revisions to the MRC guidance (Skivington *et al.,* 2019).

At the time of being commissioned umbrella reviews were published relatively rarely but were highly regarded in the public health arena for their ability to collate

and synthesise a wide range of the best available evidence. Dr Pilkington and I, having a long running interest in the built environment and health, were aware of the breadth of the existing systematic review evidence base, and in developing our ideas for the bid we acknowledged that this project was likely to be a huge undertaking. We were also conscious of a key limitation of umbrella review methodology: namely that the compilation of evidence from systematic reviews, as opposed to drawing upon evidence from original empirical studies, may lack granularity (Fusar-Poli and Radua, 2018). It was also noted that the review may demonstrate limited consideration of wider socio-ecological factors, such as the financial and political environment (Brownson, Fielding and Maylahn, 2009; Orton *et al.,* 2011). On balance, however, we felt that in order to build upon current thinking the application of an alternative and pragmatic methodological approach was essential.

As we had anticipated, the volume of eligible evidence was large, totalling 117 review-level documents. From the evidence we identified fourteen evidence-informed and actionable planning principles. With specific reference to physical activity-related evidence, we identified a range of environmental-level features, including street connectivity, mixed land use, compact residential design, quality street lighting, affordable and diverse housing, urban food growing, provision of and access to allotments and garden space, reduced exposure to environmental hazards (*e.g.,* poor air quality), provision of active travel infrastructure and public transport, and traffic calming measures, that were each associated with higher or increased physical activity.

Up to this point in my career, I had experience of conducting and publishing a range of studies utilising evidence synthesis methods (see: Allison, Bird and

McClean, 2017; Almohammed and Bird, 2018; Bird *et al.,* 2013a; Evans *et al.,* 2017; Powell *et al.,* 2017), but never on this scale. Involvement in this review therefore required excellent project management skills to complete the task in the time available. Tasks included: working with our subject librarian to develop the search strategy; conducting an independent assessment of review eligibility; assessing evidence quality; undertaking data extraction; and, leading the write-up of the manuscript for publication in the well-respected journal *BMC Public Health* (Impact Factor: 2.420).

An important quality of this review was the utilisation of rigorous and robust umbrella review methods to collate and synthesise the best available evidence. Although perhaps unsurprising, it was disappointing that much of the eligible evidence was drawn from observational studies, which limited our ability to draw causal conclusions. In addition, evidence on associations between the built environment and health inequalities was extremely sparse. The findings of this umbrella review therefore highlighted some significant gaps in the existing evidence base and clear directions for future research.

Another key contribution of this work was the generation of a series of diagrams alongside detailed textual findings; one diagram was developed for each domain of the built environment examined (neighbourhood design, housing, food environment, natural and sustainable environment, and transport) (see Appendix D for an example). As the dissemination of accessible and convincing evidence is essential for successful implementation (Kelly, Speller and Meyrick, 2004), the diagrams were specifically designed to be visually engaging and 'light' on detail in order to facilitate discussions between public health and planning professionals. These professionals are encouraged to consider the diagrams alongside the

narrative synthesis of evidence to ensure that detailed evidence from the original empirical studies is not overlooked. Unlike previously published systematic or umbrella reviews, this is the first known umbrella review to incorporate a visual representation of findings in this way.

Completion of this project led to another important output – *Spatial Planning for Health* – published by Public Health England (PHE) in 2017 (PHE, 2017). Unlike Publication 1, chiefly written for an academic audience, the *Spatial Planning for Health* evidence resource is targeted specifically for use by public health and planning practitioners. The resource was prepared by project funders, with input from our research team at UWE Bristol, including passages of text and the diagrams from our original review. This output has been downloaded over 5,500 times since publication and is included as a recommended resource in a number of UK governmental documents (*e.g.,* PHE, 2019; PHE, 2018a; PHE, 2018b). At the time of writing, Publication 2 has been cited 6 times.

Successful completion of this project led to a second funding award from PHE's Healthy Places team in September 2018. We were funded to undertake the *Getting Research Into Practice* (GRIP) project, to evaluate the local-level implementation of our umbrella review findings. I was the co-Principal Investigator for the project (see Appendix B). Towards the end of the GRIP project, the Healthy Places team at PHE hosted the first *Spatial Planning for Health Seminar*, attended by approximately 150 public health and planning professionals. Alongside UWE Bristol colleagues, I was invited to open the event with a plenary presentation that was focused on the findings of the original umbrella review. The day included a series of presentations from experts working across each of the five built environment areas covered in the umbrella review and it was exciting to hear

examples of how findings from our review are being used in public health practice across England. For example, one presentation by Jamie Blackshaw (PHE Lead for Obesity and Healthy Weight) highlighted how planning principles from our umbrella review contributed to the recently published PHE Health Matters *Whole systems approach to obesity* (PHE, 2019).

The findings of the umbrella review have been presented at a number of national and international conferences, including: *International Conference on Urban Health 2017; Healthy City Design International Congress 2018*; *Public Health England Conference 2018*; *South West Public Health Scientific Conference 2018*; and, *AMPS Conference – Health: The design, planning and politics of how and where we live 2018*. A bibliography of published works and full details of all conference presentations are provided in Appendix E.

5.1.2 Publication 2

> Bird, E.L., Baker, G., Mutrie, N., Ogilvie, D., Sahlqvist, S. and Powell, J., on behalf of the iConnect consortium. (2013a) Behavior change techniques used to promote walking and cycling: a systematic review. *Health Psychology*. 32 (8), pp. 829-838.

Publication 2 stemmed from my first academic post as a researcher working on the *iConnect* study (see Ogilvie *et al.,* 2011; Ogilvie *et al.,* 2012). Unlike Publication 1, which focused on the identification of built and natural environmental-level factors associated with health-related impacts and outcomes, Publication 2 focused on identifying evidence of individual-level behaviour change techniques utilised in walking and cycling interventions delivered in community settings. The

findings of this review therefore provide insight into physical activity promotion strategies from another socio-ecological level.

The initial idea to undertake a systematic review was conceived during attendance at my first *iConnect* study meeting at the University of Southampton in 2010. As a very recent MSc Health Psychology graduate with next to no research experience, I was anxious about what the day would hold. However, during the morning break I spoke with Professor Nanette Mutrie (then based at the University of Strathclyde, now University of Edinburgh) about our shared background in health psychology and our interest in physical activity. I was subsequently invited to visit Nanette's research group based at the University of Strathclyde, where I met Dr Graham Baker (who soon joined the *iConnect* project team), and to contribute to the *iConnect* project workstream focused on the development and evaluation of a tailored self-help intervention designed to enhance the effects of newly constructed infrastructure for walking and cycling.

In the mid-2000s, there was growing recognition that evidence for the effectiveness of public health interventions was inconsistent; this was attributed to differences in study design and methodological quality, and differences in intervention content and underpinning theory (e.g., Grimshaw *et al.,* 2004). Ultimately, without understanding how intervention content is related to effectiveness, it was argued that it is difficult to know how best to replicate interventions and to identify techniques that might be well suited to future intervention design and implementation. In our early discussions, we touched upon these issues and talked about the relatively newly published taxonomy of 26 behaviour change techniques (BCTs) (Abraham and Michie, 2008). A BCT is defined as an "observable, replicable, and irreducible component of an

intervention designed to alter or redirect causal processes that regulate behaviour" (Michie *et al.,* 2013, pp. 82). The 2008 taxonomy is mostly comprised of individual-level BCTs and was designed to standardise intervention vocabulary and thus address the problems highlighted above.

In 2010, the taxonomy of BCTs was gaining recognition but was not as well known or utilised as it is today. We recognised that while a systematic review of BCTs utilised in general physical activity interventions had been published (Michie *et al.,* 2009), the BCTs specific to interventions designed to promote walking and cycling behaviours in community settings had yet to be identified. I therefore decided, with support from Professor Mutrie and Dr Baker, that I would pursue plans to conduct a systematic review of this evidence, firstly to inform aspects of the *iConnect* study workstream, and secondly to add to the evidence base for developing physical activity interventions specific to walking and cycling.

The review identified 46 eligible studies of community-based walking and cycling interventions, with findings providing novel insight into the BCTs used in such interventions and highlighting areas for enhancing the intervention development process. For example, more than half of eligible interventions reporting a statistically significant improvement in walking and cycling included the BCTs "prompt self-monitoring of behaviour" and "prompt intention formation", lending support to the inclusion of these techniques in future development of walking and cycling interventions. Although our review found no specific technique that was conclusively linked to intervention effectiveness, the frequent coding of these BCTs is consistent with the findings of a recent umbrella review of physical activity interventions (Rhodes *et al.,* 2017).

The broad remit of the review on individual-level interventions delivered in community settings meant that it was not possible to identify evidence for associations between BCTs, intervention effectiveness, and socio-demographic characteristics; thus limiting our understanding about how to develop effective intervention strategies that may aid reductions in health inequalities. Interestingly, Bull and colleagues' recently published review of the BCTs used in healthy eating and physical activity interventions in low-income groups (Bull *et al.,* 2018) revealed support for different BCTs to those identified in our review, and that of Michie and colleagues' earlier review focused on healthy eating and physical activity interventions for the general population (Michie *et al.,* 2009). Further examination of community-based interventions to promote walking and cycling behaviours, with a specific focus on BCTs and socio-demographic characteristics, is therefore warranted.

Our findings revealed substantial heterogeneity in the vocabulary used to describe intervention content and in the number of BCTs reported in each of the studies. Poor or unclear reporting of the use of theoretical frameworks was also identified, limiting our understanding of the role of theory in promoting walking and cycling behaviour change. Interestingly, a recent meta-analysis of general physical activity interventions found that theory-based interventions incorporated a higher number of BCTs than those not explicitly guided by theory, although a greater number of BCTs was not found to be associated with improved physical activity outcomes (McEwan *et al.,* 2018). The findings of our review led to further examination of the application of theory in predicting walking and cycling behaviour change through an empirical research study published in 2018 (see Publication 3, Bird *et al.,* 2018b).

The review left many questions unanswered, partly due to limitations associated with available evidence, and partly due to the focused nature of the review on controlled studies alone. This decision to focus on controlled studies was made for reasons of scientific rigour; however, it does limit our understanding of the BCTs that may have the potential to bring about change in walking and cycling behaviours in practice (Sniehotta, Presseau and Araujo-Soares, 2015). Furthermore, translating the findings of this review to those responsible for promoting walking and cycling behaviours may not be easy, as only limited evidence exists of decision-makers' and practitioners' understanding and application of BCTs (Curtis *et al.,* 2018).

Since publication of this article, and as already highlighted, there has been growing appreciation of a complex systems model for public health (Rutter *et al.,* 2017). The 2008 taxonomy (Abraham and Michie, 2008) focused mostly on individual-level BCTs, and in our review it was applied to identify evidence of individual-level behaviour change techniques utilised in walking and cycling interventions delivered in community settings. The contribution of such individual-level research is contested, and it is useful to reflect upon this debate within the context of a complex systems model for public health.

For some public health researchers, studies which aim to understand single levels (*e.g.,* individual) within a system may be of limited use in promoting health and wellbeing (Moore *et al.,* 2015); however, others contest that individual behaviours are an integral component of a complex system. For example, in a 2017 article published in The Lancet, Falko Sniehotta and colleagues argued that "To improve population health, individual behaviours should be recognised as key elements that affect population health; to intervene without a thorough understanding of

behavioural complexities is to ignore a key part of the complex system of population health and to undermine the potential for effective interventions" (Sniehotta *et al.,* 2017).

In the context of Publication 2, it is acknowledged that the findings of the review are limited to individual-level behaviour change techniques, and that future intervention development should include consideration of other levels (*e.g.,* community, population) of the system. However, it is also the case that the findings, focused on categorising individual-level intervention content, shed new light on how individual-level walking and cycling intervention content is related to effectiveness, and they also offer up individual-level strategies that may be incorporated into future system-wide walking and cycling intervention design and implementation.

When embarking on this project, evidence synthesis was a relatively new concept to me; through undergraduate and postgraduate studies I had developed an appreciation of the importance of reviewing evidence, but the application of rigorous and robust systematic review methods was a skill I was required to develop on the job, and one that I have continually sought to develop as my career has progressed. For example, since publishing this review in 2013, I have been a co-applicant on many evidence syntheses projects (e.g., Publication 1 and Appendix B). Furthermore, I provide evidence synthesis methods support to colleagues and students in my Faculty at UWE Bristol, and most recently, I co-authored the forthcoming Sage textbook *Research Methods for Public Health*, writing two chapters on evidence synthesis ('Systematic Reviews' and 'Meta-Ethnography and Realist Synthesis'), and one titled 'Mixed methods research and evaluation design' (McClean *et al.,* 2019).

Publication 2 was the first article I published, and it is one that I remain very proud of. With support and encouragement from colleagues willing to guide me through the research process, I led each aspect of the review, from conception, to searching the evidence, to critical appraisal, to the presentation of the results and subsequent publication in *Health Psychology* (Impact Factor = 3.530). As the review was concerned with identification of BCTs in addition to traditional data extraction processes, I also led the coding of intervention content, and statistical analysis of these data, with independent validation of results conducted by the second author.

To publish my first article in *Health Psychology* was such a joy, since it showed me that I could continue to utilise my health psychology training in a public health environment. Second, publication of the article in this specific journal was particularly good, as this is where the original taxonomy of BCTs was published years earlier (Abraham and Michie, 2008). This has resulted in this article receiving high levels of exposure. Looking back, I think this was a defining moment in my career – I could see how I wanted to develop as a researcher: contributing to public health without forgetting my health psychology roots. One action I have taken with this in mind has been to join the Behavioural Science and Public Health Network (BSPHN), a network recently formed to promote sharing of behavioural and social science for the promotion of health. Another example comes from co-authorship of a discussion piece, published in *Preventive Medicine*, with colleagues from Public Health and Health Psychology teams at UWE Bristol, which advocates the need for a combined public health and health psychology approach to promoting body image and tackling overweight/obesity (Bray *et al.,* 2018).

In 2013, as our manuscript was under peer review, the original 26-item BCT taxonomy was updated and it now includes a total of 93 hierarchically clustered techniques derived from a Delphi-type exercise (Michie *et al.,* 2013). The latest version of the taxonomy forms part of the Behaviour Change Wheel (Michie *et al.,* 2011), a method for designing behaviour change interventions and one which has gained increased recognition in health psychology and public health in recent years. It could be suggested that in light of the revised 93-item taxonomy, the 2013 review of BCTs is out-of-date. However, while work on BCTs has progressed in recent years, the original 26-item taxonomy arguably still holds value for physical activity research; this is the because the original 26-item taxonomy of BCTs was formulated and tested using systematic review evidence from interventions designed to promote physical activity (and healthy eating) (Michie *et al.,* 2009). Having said that an update to our review, based on the 93-item taxonomy, could be considered.

This work has been presented at numerous national and international conferences: *4th International Congress of Physical Activity and Public Health (ICPAPH) 2012; South West Public Health Scientific Conference 2012; and Changing Lives Changing Behaviour 2012*. For a full bibliography of published works, see Appendix E. At the time of writing, Publication 2 has been cited 110 times.

5.1.3 Publication 3

> Bird, E.L., Panter, J., Baker, G., Jones, T. and Ogilvie, D., on behalf of the iConnect Consortium. (2018b) Predicting walking and cycling behaviour change using an extended Theory of Planned Behaviour. *Journal of Transport and Health*. 10, pp. 11-27.

The third publication submitted also contributes new knowledge to understanding of community-based physical activity intervention development. However, unlike Publications 1 and 2, which collate and synthesise existing evidence, Publication 3 presents findings from an empirical study which developed and refined psychological theory regarding physical activity behaviour change.

Given my background in health psychology and recent publication of the systematic review of walking and cycling BCTs (Publication 2), in 2013 I was invited to contribute to a project that would use baseline *iConnect* survey data to examine predictors of walking and cycling intentions according to the Theory of Planned Behaviour (TPB) (Ajzen *et al.,* 1991). My role was to support the study lead, contribute to the analysis plan and provide critical edits to the manuscript. Unfortunately, the manuscript that was prepared was rejected in 2014 by two journals, first *Health Psychology* and then *British Journal of Health Psychology*. The main criticisms from reviewers centred on the use of cross-sectional data, and the focus of the research on walking and cycling intentions, as opposed to actual behaviours. These criticisms were disappointing but fair, and at the request of the lead author this discrete project was side-lined.

Approximately one year after the original manuscript was rejected, I met with colleagues, Dr David Ogilvie and Dr Jenna Panter, from the *iConnect* study. At this meeting we talked about the original TPB study and our desire to continue to examine *iConnect* survey data, but from a new angle. Around this time, I was aware of new evidence highlighting the value of examining theory to identify behavioural constructs that should be targeted by interventions (Dombrowski *et al.,* 2016), and evidence suggesting that the incorporation of theory into intervention design may provide more consistent improvements in physical

activity outcomes (McEwan *et al.,* 2018). We conceived a plan to use observational cohort data from the *iConnect* study to examine whether an extended TPB (eTPB), including the construct of habit, predicted walking and cycling behaviour change.

The revised study was conducted as part of the larger *iConnect* study, which aimed to evaluate the effects of newly constructed infrastructure for walking and cycling (Ogilvie *et al.,* 2012). It was based on a theoretical framework, which hypothesised that new infrastructure for walking and cycling may improve the physical accessibility of local destinations by improving the convenience, safety, psychological perceptions or other aspects of the routes to those destinations and that these changes may lead to increases in walking and cycling and wider changes in physical activity behaviours (Ogilvie *et al.,* 2011). The study which led to Publication 3 sought to build upon existing *iConnect* study findings, and to develop theory on associations between individual- and social-psychological factors and walking and cycling behaviours (hypothesised in the original *iConnect* theoretical framework (Ogilvie *et al.,* 2011)), to improve the transferability of interventions in real-world settings (Skivington *et al.,* 2019).

Cognitive models such as the TPB (Ajzen *et al.,* 1991) are frequently used in research on the correlates of physical activity behaviours. In the context of walking and cycling behaviours specifically, the predictive ability of TPB constructs is mixed; for walking, there is some support for attitude (*e.g.,* Beenackers *et al.,* 2013) and PBC constructs (*e.g.,* Darker *et al.,* 2010), while only few studies have evaluated the predictive ability of the TPB for cycling. The main criticism levelled at the TPB is its focus on only three behavioural constructs (Sniehotta *et al.,* 2014). To overcome this, in our study, measures of walking and cycling *visibility*, *social*

norms and *habit* were added to the original model; each of which have been identified in previous studies as potentially important influences on walking and cycling (e.g., Kwasnicka *et al.,* 2016; Sahlqvist *et al.,* 2015); . The application of the TPB to assessing physical activity behaviour *change* is also limited to few studies (e.g., Akbar *et al.,* 2015), and importantly, at the time of conducting our study, no studies had applied the TPB to predicting walking and cycling behaviour change.

In developing the plan for the study, I was mindful to learn from, and respond directly to, the criticism received in relation to the earlier study. I was confident that this new approach, using cohort panel data, could help to strengthen the evidence base and generate new knowledge relating to the development of walking and cycling interventions. During our discussions, it was agreed that this work followed on coherently from my earlier systematic review (Publication 2), and so I was tasked with leading the work, from the assessment of existing literature, to quantitative analysis, to interpretation of the findings, and writing the manuscript.

Observational cohort data were collected via postal invitation at three time points (baseline, 1-year follow-up, 2-year follow-up) from a population-based sample of adults from three UK communities. Multinomial logistic regression was used to examine associations between baseline responses to walking- and cycling-related eTPB constructs (attitude, perceived behavioural control (PBC), subjective norms, intention, visibility, and habit) and changes in walking and cycling for transport and recreation. At this point in my career I had some experience in the application of inferential statistics, but I was not an expert. Added to this, the study was ambitious: there were two matched samples (1-year and 2-year), six baseline constructs of the eTPB, and four behavioural outcomes of interest, with regression

models adjusted for seven covariates. I returned to my postgraduate study SPSS training manuals and spent many months preparing and analysing the data, alongside pre-existing research and teaching commitments.

In brief, findings provided limited support for the eTPB as a whole in predicting walking and cycling behaviour change, and indicated that the eTPB model might not be a useful standalone framework for predicting changes in walking and cycling for transport or recreation outcomes. However, attitudes, PBC, intention, visibility, and habit strength were associated with changes in at least one of the four walking and cycling outcomes assessed, and implications for the development of future walking and cycling interventions were identified. For example, this study was one of the first studies to identify attitude as a significant predictor of changes in walking for transport. From this, we concluded that "future interventions may benefit from the promotion of positive walking-related attitudes for those with negative or neutral attitudes, with messages individually tailored to address the underlying factors influencing such attitudes" (Bird *et al.,* 2019, pp. 15). Further thoughts on how findings may contribute to future intervention development can be found in the discussion section of Publication 3.

Importantly, while the study highlights a possible role for individual- and social-level factors in developing walking and cycling interventions, it does not present the full picture. In our study, the framework applied was one small part of a larger conceptual model (Ogilvie *et al.,* 2011) and we did not examine the influence of wider socio-ecological influences, such as the physical environment or household and family factors, on walking and cycling as this was beyond the remit of our analysis. As such, the interplay between psychological and socio-ecological constructs in influencing physical activity behaviour change remains unclear.

Similar to the key limitation associated with Publication 2, findings reflected a general 'community' population, with limited consideration of associations between socio-demographic characteristics and psychological constructs, and their relationship with walking and cycling behaviour change. In completing data analysis, I began the process of writing up the findings for publication, and rather fortuitously at the same the *Journal of Transport and Health* (Impact Factor: 2.583) put out a call for manuscripts on 'Behaviour Change in Transport'.

Given the feedback received on the earlier project, I knew it was important to convey the key strengths of the new research, namely, the large sample size and the use of cohort panel data, and the novel focus on walking and cycling behaviour *change* as opposed to behavioural intentions or behaviours alone. Notably, the use of longitudinal data responds directly to a common criticism of existing evidence on theory-based correlates and determinants of physical activity, which relies on cross-sectional data (Rhodes *et al.,* 2017).

Following advice from my co-authors, special attention was also paid to the visual presentation of findings. We were all too aware of the complexity of the analysis and subsequent findings, and we spent a lot of time discussing the best way to aid reader interpretation. In the end we presented the findings in two ways: 1) Detailed tables presenting the findings for each of the outcomes of interest, 2) A table synthesising the findings for each domain of the eTPB (see Table 1 in Publication 3). I was pleased when journal reviewers provided positive feedback on the manuscript, including the communication of key findings.

In response to reviewers' feedback, throughout the manuscript I enhanced the content describing the *iConnect* study and we better contextualised the findings in

light of the broader *iConnect* evaluation. One reviewer also highlighted recent criticism of the TPB (Sniehotta, Presseau and Araujo-Soares, 2014) and indicated that a more compelling argument was required for application of the eTPB in this study. This feedback was extremely helpful and resulted in the production of a more robust publication.

The work was accepted for publication in the *Journal of Transport and Health* special edition on behaviour change. Up to this point, the effectiveness of theory-based interventions compared with those not explicitly related to theory was mixed; evidence from primary studies suggested that behaviour change interventions underpinned by theory are more effective (Cole-Lewis and Kershaw, 2010; Webb, Joseph and Yardley, 2010), while more recent meta-analyses of health behaviour interventions have been unable to identify conclusive evidence (Prestwich *et al.,* 2015; Rhodes, Gray and Husband, 2019). Our work, although by no means conclusive, contributes to this debate and the journal article was credited with demonstrating the importance of theory development and use in the intervention development and evaluation process (Chatterjee and Carey, 2018).

This work has been presented at the following conferences: *8th Conference of HEPA Europe; South West Public Health Scientific Conference 2018;* and, *Public Health and Sustainability Summit 2019*. For a full bibliography of published works, please see Appendix E. At the time of this DPhil submission, Publication 3 has been cited 10 times.

5.1.4 Publication 4

> Bird, E.L. and Powell, J. (2019) Chapter 5 Economic Evaluation. In Jago *et al.,* Action 3:30: A cluster randomised feasibility study evaluation of a

teaching assistant led, extracurricular physical activity intervention for 8 to 10 year olds. *Public Health Research* (in press).

Publication 4 moves beyond community-based physical activity intervention *development*, the focus of Publications 1 to 3, to examine the *feasibility* of an economic evaluation design, to guide decisions about progression to a full effectiveness study.

On joining UWE Bristol as a researcher in 2010, I first worked on the *iConnect* study under the supervision of Jane Powell, Professor of Public Health Economics (then Reader in Public Health Economics). My main duty was to provide research support in undertaking the *iConnect* study of newly constructed infrastructure for walking and cycling across 84 sites in the UK. I originally applied for the job because I was interested in physical activity promotion research, and the multi-disciplinary nature of the *iConnect* study was particularly appealing. I had no experience of public health economics research, but this did not seem to be of concern to Professor Powell who quickly took me under her wing and encouraged me to attend various professional development courses, including *Public Health Economics*, a core module of UWE Bristol's MSc Public Health programme. Learning through a combination of on-the-job research experience and professional training, I have developed a strong appreciation for public health economics principles and a critical understanding of public health economics research methods.

As evidenced by authorship of publications included this submission and beyond (see Appendix E), Professor Powell and I have collaborated for many years. One project we recently completed which led to Publication 4, was *Action 3:30*: A

cluster-randomised feasibility study evaluation of a teaching assistant led, extracurricular physical activity intervention for 8 to 10 year olds, funded by NIHR PHR. The feasibility trial was led by Professor Russ Jago (University of Bristol) and centered on a RE-AIM framework (Reach, Effectiveness, Adoption, Implementation and Maintenance) evaluation (Glasgow *et al.,* 1999). RE-AIM is a multi-level framework that aims to measure the effects of complex interventions while also identifying the barriers and facilitators to real-world intervention implementation. Professor Powell was a co-applicant and economic evaluation lead on the bid and I was the named project researcher at UWE Bristol.

Briefly, *Action 3:30* was an after-school physical activity intervention delivered by teaching assistants to primary school pupils aged 8-10 years. The project team conducted a cluster-randomised feasibility study to assess the potential evidence of promise for increasing pupils' physical activity levels. Pupils were recruited from 12 participating schools, with six schools randomised to receive the intervention, and six schools acting as controls. It was delivered over 15 weeks, with physical activity outcome measures taken at baseline and again at follow-up (during the last six weeks of the intervention period). For the economic evaluation feasibility testing, our role at UWE Bristol was concerned with assessing the potential costs of *Action 3:30* preparation and delivery, the potential for changes in health-related quality of life (HRQoL), and intervention sustainability from a cost perspective.

I project managed the economic evaluation element of the study and was responsible for developing the economic evaluation protocol, which included the development and selection of data collection measures and the data analysis plan. Having not been involved in a feasibility study before, the value of taking such an

approach soon became clear. It was extremely satisfying to have the space and time to explore and test options; a luxury not always afforded to the development and evaluation of public health interventions (Kessler and Glasgow, 2011). I conducted data analysis in SPSS v.20 and led the write-up of the economic evaluation chapter for publication in the journal *Public Health Research*. I also contributed to the publication of main findings in the *International Journal of Environmental Research and Public Health* (Impact Factor: 2.468) (Jago *et al.,* 2019).

As an advocate for physical activity, it was disappointing to learn that the main feasibility trial indicated no evidence for an effect of *Action 3:30* on physical activity outcomes. Schools are often presented as an ideal setting to engage children, their families, and their teachers in health promoting behaviours such as physical activity; this is reflected in the allocation of millions of pounds by national funding bodies (e.g., National Institute for Health Research Public Health Research) to academic research projects conducted in school settings. Despite this, the findings of our study are comparable with those reported in a systematic review (Waters *et al.,* 2011) and findings from other recent evaluations of school-based health promotion programmes (e.g., Adab *et al.,* 2018; Lloyd *et al.,* 2018; Nightingale *et al.,* 2018). The interventions trialled in each of these studies followed best practice thinking at the time – they were theoretically informed and tested for acceptability and feasibility at child and school levels.

However, a limitation applicable to each of these intervention studies is that they focused on only one or two levels of the socio-ecological model, with limited consideration of interactions between levels within a wider system (Rutter *et al.,* 2017). Notably, in Lloyd and colleagues' 2018 paper which reported the main

outcomes of the Healthy Lifestyle Programme (HeLP) to prevent obesity in primary schools, the authors acknowledged that "the programme did not explicitly seek to affect school policies or physical aspects of the school environment" and that the burden on school resources required for such interventions (for example, time and staffing) "might have minimised any effect on school culture" (Lloyd *et al.,* 2018, pp. 44). It is possible to level the same criticism at the *Action 3:30* and *Bristol Girls Dance Project* (BGDP) (Publication 5 – see below) interventions. Viewed alongside the findings of other similar studies, the findings presented in Publications 4 and 5 raise an important question about whether individually-focused school-based interventions – which do not explicitly consider the wider system or the potential importance of co-producing interventions tailored to a specific context – will ever have the ability to tackle non-communicable diseases such as physical inactivity and obesity in school-aged children.

While neither *Action 3:30* nor *BGDP* interventions found an effect on physical activity outcomes, the findings from both economic evaluations provide important additional feasibility-related information about the parameters of the evaluation design. For example, our work identified that *Action 3:30* was a low-cost intervention compared with existing after-school physical activity provision. In light of this, and in response to the finding that no adverse effects were associated with the intervention, we concluded that *Action 3:30* may provide a viable low-cost alternative after-school club for schools to implement. The type of contextual information is rarely reported, even though it is likely to be of interest to decision-makers with limited resources at their disposal (Weatherley *et al.,* 2009). It is therefore encouraging to read the proposed revisions to the MRC guidance, which place emphasis on the importance of feasibility testing, including consideration of

economic evaluation approaches (Skivington *et al.,* 2019). It is also positive to learn of plans for the development of guidance focused specifically on feasibility study design and evaluation (known as GUEST) (Moore *et al.,* 2018).

This study generated important information about the feasibility of economic evaluation outcome measures proposed for use in full trials; the importance of which is due to be highlighted in the forthcoming MRC guidance update (Skivington *et al.,* 2019). The *Action 3:30* feasibility study, and the results of a full randomised controlled trial of another school-based physical activity intervention (Publication 5), found no difference in intervention and control group responses to HRQoL measures at baseline or at follow-up. When viewed alongside the findings from other recently published trials, which also reported no differences in HRQoL (Jago *et al.,* 2015; Sebire *et al.,* 2018), these outcomes are perhaps unsurprising. However, it does raise an important methodological question about the measures recommended for use in economic evaluations of intervention studies conducted with children.

Our study assessed changes in children's responses to two HRQoL measures: KIDSCREEN-10 (Europe TKG, 2006) and the Child Health Utility Instrument (CHU9D) (Stevens, 2010). These measures were selected chiefly because they have been validated for use with a 'healthy' school-aged child population (Europe TKG, 2006; Stevens, 2010); overcoming issues associated with other well-known measures such as the European Quality of Life-5 Dimensions Youth survey (EQ-5D-Y) (Wille *et al.,* 2010), which was originally designed for use with adults living with a health condition (Gudex, 2005) and has been shown to be insensitive to school children's responses (see Publication 5, Bird and Powell, 2016). While HRQoL measures were carefully selected and approved by project funders for this

feasibility study, a ceiling effect was observed, with high HRQoL scores at each time point making it difficult to identify small changes in health-related outcomes. Further development and consideration of age- and health status-appropriate measures is therefore strongly recommended.

Evidence generated from this project and that of Publication 5 were recently cited in the NIHR's *Moving Matters*, a review of interventions to increase physical activity (NIHR, 2019). For a full bibliography of published works, please see Appendix E. At the time of writing this thesis, Publication 4 has been accepted for publication in *Public Health Research* and is due to be published online in November 2019. The main findings are published in the *International Journal of Environmental Research and Public Health*. Results of the process evaluation of *Action 3:30* are published in *BMC Public Health* (Tibbitts *et al.,* 2019).

The fifth and sixth publications are *evaluations* of community-based physical activity interventions. Publication 5 builds upon evidence presented in Publication 4, in that it generates new knowledge from an economic evaluation of a full effectiveness study of a school-based dance intervention. Publication 6 presents the findings from a RE-AIM framework evaluation of general practice referral of 'at risk' populations to community-based physical activity. It generates evidence about programme effectiveness while also considering factors influencing programme implementation and context; thus, maximising the usefulness of evidence for decision makers.

5.1.5 Publication 5

> Bird, E.L. and Powell, J. (2016) Chapter 4 Economic Evaluation. In Jago *et al.,* Bristol Girls Dance Project: a cluster randomised controlled trial of an

after-school dance programme to increase physical activity among 11- to 12-year-old girls. *Public Health Research*. 4 (6), pp. 47-53.

The *Action 3:30* research project described above led on from an earlier research project: the Bristol Girls Dance Project (BGDP). As with *Action 3:30*, BGDP was led by Professor Jago at the University of Bristol, with Professor Powell and I as the economic evaluation team at UWE Bristol. Prior to my involvement in BGDP, a feasibility trial of the intervention was conducted between 2010 and 2011. The findings that school-based delivery of the intervention was feasible and that participation in dance has the potential to increase the physical activity levels of Year 7 girls (Jago *et al.,* 2012) led to funding from NIHR PHR to conduct a full randomised controlled trial (RCT) of BGDP. The aim was to attribute intervention effects with confidence. It was at this point that I was invited to join the project team.

Briefly, the BGDP set out to determine the effectiveness and cost-effectiveness of an after-school dance intervention designed to increase physical activity levels among girls aged 11-12 years. Eighteen secondary schools in the Bristol area were recruited, with pupils from nine schools allocated to receive the intervention. The intervention was comprised of 40, 75-minute dance sessions delivered by trained dance instructors, with content underpinned by self-determination theory. The trial found no evidence for an effect on moderate and vigorous physical activity levels between arms at 1-year follow-up. For further details of the BGDP, see the project report (Jago *et al.,* 2016) or the main outcomes paper (Jago *et al.,* 2015). The lack of evidence for an effect on physical activity was disappointing, partly because this was the first trial I had worked on and as an advocate of physical activity I was hoping for a positive outcome, but mainly because the intervention had been

unsuccessful in tackling a growing public health issue - gender inequality in physical activity (The Lancet Public Health, 2019).

As with all NIHR PHR-funded projects, there is in-depth scrutiny by experts from the moment the project is funded to the project close. This rightly reflects the large investment in each research project and the need to undertake highly rigorous research that is of value to public health. Experts representing each methodological element of the project were invited along to regular steering group meetings, to review project protocols and to provide feedback on findings and interpretation. This level of scrutiny was not something I had experienced prior to this project, and it must be said that it was daunting to share ideas with the health economics expert during the early stages of the project. Looking back, I can now see that the process was extremely valuable; it taught me a lot about the importance of listening to different viewpoints and adapting methods, where appropriate, as projects progress. It also exposed me to challenging discussions and debate, which strengthened my critical understanding of public health economics as a discipline.

My role involved project managing the economic evaluation, from protocol development, to data analysis (including sensitivity analysis), to leading the write-up of results for funders and for academic publication in the prominent physical activity journal *International Journal of Behavioural Nutrition and Physical Activity* (Impact Factor: 5.548) (Jago *et al.,* 2015). I was required to utilise a number of economic evaluation methods that were new to me at that time. For example, I was responsible for collating and analysing data on intervention costs and resource use using a specially designed checklist. I also utilised traditional cost-effectiveness methods to determine the average cost per minute of physical activity attributable to the intervention, and cost-utility methods to assess HRQoL.

Given that much of the existing physical activity economic evaluation evidence-base is focused on the cost-effectiveness of individual-focused interventions (Abu-Omar *et al.,* 2017; Laine, Kuvaja-Kollner and Pietila*,* 2014), the prospect of contributing new knowledge on community-based physical activity interventions was exciting.

Through our economic evaluation we were able to determine intervention costs and resources and to demonstrate its low delivery cost. This is an important contribution, as the presentation of costs according to each stage of an intervention is evidence that is rarely reported in the literature, and furthermore, it is likely to be of interest to commissioners who are currently funding programmes of work in schools based on little or no knowledge of mainstream costs and resource use (Abu-Omar *et al.,* 2017).

Our economic evaluation also allowed us to report that due to changes (or a lack thereof) in physical activity, the BGDP was not cost effective. This is, of course, unsurprising, given the main trial result. It does, however, highlight a limitation with our research in that 'cost effectiveness' was determined according to a single outcome: changes in physical activity. While BGDP ultimately aimed to promote girls' physical activity through dance, such an intervention is likely to impact upon other aspects of health and wellbeing (Abu-Omar *et al.,* 2017) that were not quantified or considered through our cost-effectiveness analysis (*e.g.,* self-esteem or physical activity self-efficacy), which focused on physical activity alone.

The null findings reported for both *BGDP* and the *Action 330* studies are consistent with the findings of a recent systematic review of school-based physical activity interventions (Love, Adams and van Sluijs, 2019). Drawing upon evidence from

25 cluster randomised controlled trials assessing the efficacy of school-based physical activity interventions on objectively measured moderate-to-vigorous physical activity (MVPA), Love and colleagues' review identified no significant change in MVPA, and no evidence for differential efficacy according to sex or socio-economic status. Consistent with conclusions from both projects, the review called for studies to consider wider intervention benefits, moving away from a sole focus on the primary outcome of physical activity. For example, as demonstrated through this work, the incorporation of economic evaluation into the main study design can provide insight into barriers and facilitators to success in real world settings.

Undertaking a combined cost-effectiveness and cost-utility analyses is recommended in the literature as it considers multiple economic perspectives (Weatherley *et al.,* 2009). Cost-utility analysis (CUA) based on HRQoL, was conducted using the validated EQ-5D-Y (Wille *et al.,* 2010). We found no evidence for a difference in HRQoL outcomes when comparing intervention and control group participants; health outcomes were high in both groups at each time point, suggestive of a ceiling effect. Interestingly, the project funders, not the research team, stipulated the inclusion of the EQ-5D-Y as a central measure of the economic evaluation. As anticipated by the project team, the EQ-5D-Y measure, originally designed for use with patients living with specific conditions or diseases (Payakachat *et al.,* 2015), was unresponsive to a 'healthy' population of girls. As such, we concluded that there is a need to consider alternative measures to ensure appropriate estimates of effectiveness.

Systematic review evidence suggests that interest in conducting economic evaluations of physical activity interventions has increased in recent years (for

example, Balzer *et al.,* 2012; Campbell *et al.,* 2015). As mentioned earlier in relation to Publication 4, much of the existing evidence is focused on the cost-effectiveness of individual-level interventions (Abu-Omar *et al.,* 2017; Laine *et al.,* 2014), despite indications that community- and population-level interventions may have more potential for cost-effectiveness (Abu-Omar *et al.,* 2017). In Abu-Omar and colleagues' 2017 umbrella review, 18 eligible systematic reviews of physical activity interventions were appraised and it was concluded that while physical activity interventions can be cost-effective, the evidence base is dispersed and may have limited value for public health practice. In the case of school-based interventions the review revealed that they were broadly cost-effective. However, differences in the intervention approaches utilised, the assessment of physical activity outcomes, and definitions for the cost-related benefits associated with interventions limit understanding of the cost-effectiveness of interventions and restrict the ability to replicate good practice. This highlights the importance of clear reporting and demonstrates the value of producing detailed project documentation that goes further than a traditional journal article, such as the BGDP and Action 3:30 NIHR project reports included in this submission.

This work was cited in *Moving Matters* (NIHR, 2019), and findings were presented as part of a symposium at the UK Society for Behavioural Medicine Conference, 2015. Publication 5 is freely available to download from the NIHR's *Public Health Research Journals Library*. The main outcomes paper, published in the *International Journal of Behavioural Nutrition and Physical Activity* (Jago *et al.,* 2015). Other publications from this project for which I am named author are published in *BMC Public Health* (Sebire *et al.,* 2016a), *Psychology of Sport and*

Exercise (Sebire *et al.,* 2016b), and *BMJ Open* (Edwards *et al.,* 2016). For a full bibliography of published works, see Appendix E.

5.1.6 Publication 6

> Bird, E.L., Kok, M.S.Y. and Powell, J.E. (2019) General practice referral of 'at risk' populations to community leisure services: Applying the RE-AIM framework to evaluate the impact of a community-based physical activity programme for inactive adults with long-term conditions. *BMC Public Health* (in press).

In 2015, I was contacted by a Healthy Lifestyles Officer at South Somerset District Council (SSDC) and invited to collaborate on a joint funding bid to Sport England's *Get Healthy Get Active* funding stream. Our bid was successful, and the final publication submitted here presents the results of a RE-AIM framework evaluation of general practice referral for inactive adults with, or at risk of developing, a long-term condition to community-based physical activity leisure services. The programme was called *CLICK into Activity*, and it was delivered in a rural community setting in South Somerset.

Unlike studies leading to Publications 4 and 5, where the interventions assessed were developed by a team of academic researchers, *CLICK into Activity* was conceived by a team of locally-based General Practitioners, local authority public health specialists, and physical activity providers, in response to an identified need within the local community. Local-level long-term conditions data indicated a high prevalence of type 2 diabetes, pre-diabetes, and hypertension, and at the time there was no local provision meeting the UK's recommendations for promoting physical activity among those with, or at risk of, type 2 diabetes (NICE, 2017). Co-

production techniques were utilised, where stakeholders (including local residents and potential participants) were invited to contribute to programme development. This 'local' focus enabled the development of a programme that was tailored to local needs; for example, as South Somerset is a rural area with limited public transport, it was crucial for any new programme to be delivered in easily accessible locations at appropriate times of the day.

A total of 326 participants attended at least one 30-min session; these participants attended nine sessions, on average, during the 12-week programme, and just over one third attended at least 12 sessions during their 12-week enrolment period. These findings suggested that the programme was well-received; once participants had attended one session they often returned for more. Qualitative interview data revealed that the co-production approach to programme development and ongoing programme modification was an important component of promoting programme acceptability and local community buy-in; an approach to public health intervention development advocated elsewhere (Hawkins *et al.,* 2017).

Towards the end of the project, steering group members were concerned that, despite positive programme findings, an upcoming restructure at the District Council may affect the potential sustainability of the programme beyond the funding period. In the months that followed, these concerns became a reality. The public health team that led the programme was disbanded, and despite efforts to promote the programme with other possible funders (*e.g.,* Health and Wellbeing Executive), there was a lack of support and no further funding awarded. This is not a problem unique to the *CLICK into Activity* programme; the implementation and long-term sustainability of potentially effective public health programmes is an ongoing issue (Walugembe, *et al.,* 2019).

The funding award marked an exciting moment in my career because I was directly approached to collaborate with SSDC after they had read about other evaluation projects I had worked on. Secondly, the nature of the programme was ideal for conducting an evaluation using the RE-AIM framework (Glasgow *et al.,* 1999); a framework supported by the MRC (Craig *et al.,* 2006), and one I had wanted to use for a few years. Unlike some of the more traditional public health study designs I had utilised up to this point (*e.g.,* RCT, cohort), the RE-AIM framework provided an opportunity to explore external as well as internal validity, through a combination of impact, process and economic evaluation, to determine the population impact of *CLICK into Activity*.

Given the high-profile nature of the funding, it was agreed that Professor Powell would lead the evaluation, and I would act as project manager. Similar to other projects we have collaborated on, I was responsible for conceptualising, designing and implementing the evaluation, and writing up the findings for publication in *BMC Public Health* (Impact Factor = 2.420). However, unlike many of the previous projects I had worked on, this project involved a large number of community-based stakeholder organisations and external partners, each with their own agendas. While this provided a good opportunity for community-focused action, it also presented our research team with a challenging environment for setting up and conducting an independent evaluation. For example, there was scepticism about the need for an evaluation among some of the steering group members; for some, it was seen to be an unnecessary use of project resources. This made it essential for our project team to work to the best of our ability, not only to generate new knowledge for an academic audience, but to also appropriately communicate and justify our work to those working at the community level. One

approach I took was to ensure my presence at each of the six-weekly project steering group meetings, and to provide well-prepared and professional progress updates.

Another issue encountered was the deterioration in relations between the project lead (SSDC) and the project stakeholder responsible for delivering technological capabilities and collecting digital evaluation data. As a member of the steering group, I was invited to contribute to a discussion on how the situation should be managed; the technology company was ultimately removed from the project for failing to meet agreed deliverables. This type of situation was entirely new to me, and although it was unsettling at the time, I can now see that the experience was invaluable to my own development; I learned how to manage and robustly discuss issues between project partners, how to manage conflict, and how to come to an effective agreement on the best way for a project to proceed. In this specific situation the removal of the technology company resulted in further funding for our evaluation, and this funding allowed us to provide additional support to data collection management and data analysis.

Involvement in this project allowed me to apply a combination of quantitative, qualitative and economic evaluation research methods. In addition to collecting and analysing quantitative questionnaire data, I was responsible for conducting qualitative interviews with *CLICK into Activity* participants and project stakeholders, and for undertaking thematic analysis of data (Braun and Clarke, 2006) with specific reference to the RE-AIM framework. Up to this point most of my research had been quantitative in nature, so it was enjoyable to return to the qualitative skills obtained during my time on the MSc Health Psychology programme at UWE Bristol. Furthermore, drawing upon economic evaluation

skills from earlier projects, I was able to collate and analyse programme-level documentation to estimate the mainstream implementation costs and resources of the programme. Data on implementation costs and resources associated with 'real world' physical activity interventions are rarely reported by evaluations using alternative study designs (Hanson and Jones, 2017); our study therefore contributed new knowledge to the evidence base.

Despite collecting data from a range of sources, the 'real-world' delivery of *CLICK into Activity* did pose challenges for data collection. In previous studies I have worked on, data collection has been well resourced by a team of researchers. For this project, the limited availability of resources meant that the team was reliant on questionnaire data being collected by those involved in programme delivery (i.e. the exercise specialists). While this approach was reasonably successful for baseline data collection, follow-up data collection was more difficult; programme deliverers were responsible for overseeing numerous tasks, and follow-up data collection was not a priority. As such, the long-term impact of *CLICK into Activity* on physical activity and other outcomes remains uncertain, and this is an important limitation of this work. Linked to this is the limitation of relying on self-report measures to determine change in some of the key evaluation outcomes, including physical activity. There is evidence to suggest that self-report measures result in over-reporting of time engaged in physical activity (Prince *et al.,* 2008). A recent commentary piece raised valid concerns about the potential implications of relying on self-report data for future allocation of resources and policymakers' decisions, and advocated for the use of objective measures (Chaput, 2019). For our evaluation, however, much as the use of objective measures (*e.g.,*

accelerometers) would have been desirable, we were working to a small budget and had to be pragmatic in the evaluation approach taken.

The project provided me with an opportunity to use the RE-AIM framework for the first time, and it has certainly raised questions in my mind about how to generate evaluation evidence that is academically robust, but also of value in the real world. Much of my training and research experience leading up to my involvement in this project was focused on the importance of RCT-level evidence. While the RCT study design has the ability to determine intervention effectiveness, this project has opened my eyes to alternative approaches that may provide more useful and meaningful evidence for real-world intervention development, evaluation and implementation. Interestingly, this is something that is explored in detail in proposed revisions to MRC guidance, where authors discuss the importance of identifying an intervention that "works", but also considers how valuable the evidence is in supporting real-world decision making (Skivington *et al.,* 2019). In my view this is a refreshing development for public health; it explicitly acknowledges the need for public health researchers to consider the wider social context of health surrounding people's lives and how this context may influence outcomes.

At the time of writing, Publication 6 has been accepted for publication in *BMC Public Health* and is currently in press. Findings from this work were presented at the 2019 *South West Public Health Scientific Conference* and have also been shared with the *South Somerset District Council Healthy Community Group* and UWE Bristol's *Centre for Public Health and Wellbeing*. There are plans for further conference presentations, including the 2020 *International Congress for Public*

Health and Physical Activity, for which I am a member of the Conference Scientific Committee.

5.2 Summary evidence of meeting the UWE Bristol doctoral descriptors

A summary of how, in submitting this evidence of scholarship, the UWE Bristol doctoral descriptors have been addressed will now be provided:

1) Has conducted enquiry leading to the creation and interpretation of new knowledge through original research or other advanced scholarship, shown by satisfying scholarly review by accomplished and recognised scholars in the field

I was the lead author of each publication submitted and all works are published in peer-reviewed journals. This satisfies the need to demonstrate scholarly review by accomplished and recognised scholars in the field. The works respond to gaps in the physical activity evidence base, and led to the generation of new knowledge. All works are published in reputable journals from a range of disciplines, including public health and health psychology, and each journal has a high Impact Factor for its field.

2) Can demonstrate a critical understanding of the current state of knowledge in that field of theory and/or practice

For each publication, I undertook a literature review to examine existing evidence on theory, research and practice related to each of the discrete research projects. As works submitted cover a range of settings, populations, and disciplinary perspectives, this has involved in-depth exploration and constructive critique of the contributions of public health, health promotion, health psychology, and public

health economics literature related to community-based physical activity intervention development, evaluation and implementation.

3) Show the ability to conceptualise, design and implement a project for the generation of new knowledge at the forefront of the discipline or field of practice including the capacity to adjust the project design in the light of emergent issues and understandings

I collaborated with colleagues on the conceptualisation, design and implementation of research leading to Publications 4 and 5. For Publications 1, 2, 3 and 6 I had an active leading role in the initiation, design and implementation of the research. Furthermore, I was the project manager for research projects leading to Publications 1, 4, 5, and 6, which required skills in research bidding, project development and delegation of roles, data collection and analysis, time management, and dissemination of project outputs to academic and lay audiences.

All works submitted are framed within the wider context of authoritative MRC guidance on the development and evaluation of complex interventions, and they therefore explore issues relating to the conceptualisation, design and implementation of community-based physical activity interventions. This critical commentary also reflects upon the proposed revisions to MRC guidance (Skivington *et al.,* 2019) with reference to works submitted.

Project designs and methods employed, which led to each of the publications submitted have been adjusted in the light of a range of emergent issues and understandings. As one example, the research that led to Publication 3 was preceded by an earlier discrete project that was rejected by a journal for failing to

demonstrate a valuable enough contribution to the field. Building upon feedback from reviewers, an alternative research question was developed.

4) Can demonstrate a critical understanding of the methodology of enquiry

A range of robust methodological approaches and research methods were utilised, including, but not limited to: evidence synthesis; regression analysis of cohort panel data; economic evaluation; and, thematic analysis of qualitative data. As per the pragmatic research paradigm (Weaver, 2018; Murphy, 1990), for each work submitted the methodological approach utilised was deemed to be the best suited to the research aims and questions under investigation.

Through research at UWE Bristol I have developed a strong critical understanding of evidence synthesis methodology, and now consider it to be an area of expertise. This is supported by my recent contributions to the textbook *Research Methods for Public Health* (McClean *et al.,* 2019). I have also developed a critical understanding of quantitative, qualitative and economic evaluation methodologies and methods. Although I do not consider myself an expert in these areas, through this submission I have been able to demonstrate my knowledge and ability to apply a range of pragmatic methods to examine public health issues.

5) Has developed independent judgement of issues and ideas in the field of research and / or practice and are able to communicate and justify that judgement to appropriate audiences

This doctoral thesis demonstrates independent judgement of issues associated with the development, evaluation and implementation of community-based interventions designed to promote physical activity. For example, works submitted have been developed through independent thought, collaboration with colleagues,

and engagement with a range of stakeholders (including local and national government organisations). Dissemination of these works has not been through peer-reviewed publication alone; as evidenced in this submission, my research findings have been presented to a range of audiences (*e.g.,* academics, funders, stakeholders, lay audiences).

6) Can critically reflect on their work and evaluate its strengths and weaknesses including understanding validation procedures

Each work submitted includes a reflection on the strengths and weaknesses of the research and demonstrates understanding of validation procedures. These publications have each been through peer-review, demonstrating an ability to critically reflect upon, and respond to, the limitations of the research. Consideration of research validation is apparent in each of the publications submitted. For example, the critical appraisal of empirical research included in Publications 1 and 2, and critical reflections on research instrument validity relevant to Publications 3 to 6. The supporting critical commentary examines the value of the research in more depth.

Chapter 6: Discussion

Through submission of a body of published academic works, alongside a critical commentary, this doctoral thesis demonstrates a contribution to knowledge in the area of community-based physical activity intervention development, evaluation and implementation. This chapter sets out to synthesise findings from each publication, and identify their strengths and limitations; to consider the impact of the research; and, to identify recommendations for future development, evaluation and implementation of interventions that promote physical activity in community settings.

6.1 Contributions to community-based physical activity intervention research

In constructing the narrative for this doctoral thesis, publications are presented with reference to the four non-linear phases of intervention development and evaluation proposed by the MRC (Craig *et al.,* 2006): development; feasibility; evaluation; and, implementation.

Publications 1, 2 and 3 contribute to the evidence base related to community-based physical activity intervention *development*. Publications 1 and 2 collated and synthesised existing evidence, through the application of evidence synthesis methods, to improve understanding of individual- and environmental-level correlates of physical activity. In the case of Publication 1, evidence-informed principles for promoting health, including physical activity outcomes, through environmental change were identified, while in Publication 2 the individual-level behaviour change techniques associated with walking and cycling behaviour change have been highlighted. Taken together, the reviews identify gaps in the

evidence base and provide direction for future physical activity intervention development and evaluation research.

Publication 3 focused on developing theory regarding walking and cycling behaviour change in community settings, an area that has received little attention to date. Robust methods, using cohort panel data were applied to identify evidence for associations between an extended Theory of Planned Behaviour and changes in walking and cycling outcomes. The findings of the study provide novel evidence on the psychological predictors of walking and cycling behaviour change, and highlight the value of theory testing and refinement in the development of community-based physical activity interventions.

The study leading to Publication 4 was concerned with the *feasibility* testing of an after-school physical activity intervention. Findings from the economic evaluation were used to guide decisions about progression to a full effectiveness study, and generated novel evidence about the costs and resources associated with real-world intervention delivery; evidence that is not traditionally reported in economic evaluations, and is likely to be of value to decision-makers responsible for resource allocation.

Publications 5 and 6 were concerned with the *evaluation* of community-based physical activity interventions. Building upon the evidence presented in Publication 4, Publication 5 reports the results of a full economic evaluation conducted as part of a larger RCT. An assessment of costs and resources was conducted, as well as a combined cost-effectiveness analysis and cost-utility analysis; evidence of which is limited in the literature in relation to community-based interventions. Publication 6 utilised the RE-AIM framework to generate new

evidence about the internal and external validity of a physical activity intervention, in order to demonstrate its impact in a real-world community setting. The findings of the study are based on the collection and triangulation of data from a range of sources, and they highlight strategies to be explored in the future development and implementation of real-world interventions designed for the target population.

Each of the works presented in this submission contribute to community-based physical activity intervention *implementation*. In the current MRC guidance (Craig *et al.*, 2006), in addition to recommending that research is published in the academic literature, five strategies for successful implementation are presented: 1) involve stakeholders in research; 2) present evidence in an integrated and graded way (*e.g.,* conduct reviews and produce research summaries); 3) take account of context, including costs; 4) make specific recommendations; and, 5) use a multifaceted approach to dissemination.

As demonstrated in this critical commentary, the evidence generated through works submitted has been presented in an integrated and graded way (Strategy 2). For example, Publications 1 and 2 satisfy this recommendation, in that they are evidence reviews. Evidence summaries were also produced for Publications 3 to 6 alongside journal article submissions for the benefit of non-academic audiences. With regards to Strategy 4, recommendations for physical activity intervention research, policy and practice, arising from each of the research studies are included within all publications submitted.

Each of the publications submitted used a multifaceted approach to disseminate research findings (Strategy 5). Alongside publication in reputable journals, findings have been presented at numerous academic and practice-focused

conferences and workshop events (see Appendix E). For example, with regards to Publication 1, a series of diagrams to aid understanding of key issues for public health and planning professionals and facilitate discussions within and across professions, were produced (see Appendix D), in addition to a supporting summary document (PHE, 2017). Strategies 1 and 3 have been enhanced in proposed revisions to the MRC guidance (Skivington *et al.*, 2019) and are further discussed below with reference to research presented in this submission.

6.2 Reflections on submitted works with reference to proposed revisions to MRC guidance

As earlier described, a revised MRC guidance document is due for publication in 2020. Although the four original phases of intervention development and evaluation remain, six new factors are proposed for consideration (Skivington *et al.*, 2019): 1) Consideration of context; 2) Involvement of stakeholders; 3) Development and iteration of programme theory; 4) Consideration of economics; 5) Ongoing intervention modification; and, 6) Consideration of uncertainty surrounding an intervention.

6.2.1 Consideration of context

A central theme of my research, both in relation to works submitted in this thesis and my wider research portfolio (see Appendix E), is an appreciation of the socio-ecological model of health (Dahlgren and Whitehead, 1992). In the case of community-based physical activity promotion, my research seeks to explore how the context within which people live, work and play influences physical activity, in addition to examining individual-level physical activity behaviours and their complexities, in order to better design interventions that address a range of socio-

ecological influences and can be implemented across all levels of the socio-ecological model.

Publication 1 was concerned with identifying evidence for associations between features of the built and natural environment and health and health-related behaviours, including physical activity, and Publication 3 examined associations between individual- and social-level influences on walking and cycling, and walking and cycling behaviour change. Publications 2, 4, 5 and 6 were concerned with better understanding individual-level behaviours and their complexities. One limitation applicable to these works is that their findings are specific to one or two levels of the socio-ecological model, with limited consideration of interactions between levels within a wider system (Rutter *et al.,* 2017). This is particularly important when findings are considered in the light of recent evidence indicating that interventions focused on one level alone may be insufficient to support behaviour change (Adab *et al.,* 2018; Lloyd *et al.,* 2018; Nightingale *et al.,* 2018). It is therefore important that the findings and implications of these publications are considered not in isolation, but as contributions to the wider multi-level evidence base on community-based physical activity intervention development and evaluation.

6.2.2 Involvement of stakeholders

The term ‘stakeholder’ refers to those affected in some way by an intervention or programme, regardless of their ‘public’ or ‘professional’ status (Concannon *et al.,* 2015). Proposed revisions to the MRC guidance recommend that stakeholders are encouraged to participate in research projects from inception to completion (Skivington *et al.,* 2019). Research leading to publications included in this

submission, and research from my wider portfolio (see Appendix E), included some form of stakeholder engagement. For example, in conducting the umbrella evidence review that led to Publication 1, a workshop was held with public health and planning professionals at the project outset to ensure that the review would explore issues of relevance to people working in practice. Due to the tight project timescale, this was the only element of stakeholder engagement for the project.

Research leading to Publications 4, 5, and 6 involved collaboration with stakeholders responsible for locally-based physical activity provision. To an extent, this created opportunities for engagement with practitioners throughout the life of each project. However, due to the busy working schedules of stakeholders involved in each of the projects, stakeholder attendance at project meetings was often sporadic. Challenges associated with stakeholder engagement are not unique to the projects I have worked on (*e.g.,* Boaz *et al.,* 2018; Concannon, 2015), and so it is encouraging to see the recent publication of two new guidance documents from INVOLVE, an NIHR-funded advisory group supporting active public involvement in research, that detail new best practice principles for stakeholder engagement and co-production (Elliott *et al.,* 2019; INVOLVE, 2019). I intend to draw upon this guidance in future research studies.

6.2.3 Development and iteration of programme theory

The value of programme theory in developing and evaluating interventions is one that has received increased attention in recent years (*e.g.,* O'Cathain *et al.,* 2019; Mills, Lawton and Sheard, 2019; Wight *et al.,* 2016), and is also demonstrated by works presented in this thesis. For example, research involved theory testing (Publication 3) feasibility testing (Publications 4 and 5) and logic model

development and refinement (Publication 6) with the aim of better informing community-based physical activity intervention development, evaluation and implementation. Support for improving the effectiveness of interventions through underpinning theory is contested (Cole-Lewis and Kershaw, 2010; Rhodes *et al.*, 2019); however, theory development and refinement is credited with improving the transferability of interventions in real-world settings, evidence which is of value to decision-makers (Skivington *et al.*, 2019).

6.2.4 Consideration of economics

Proposed revisions to MRC guidance suggest that consideration should be given to the "economic aspects of developing and evaluating complex interventions from the outset" (Skivington *et al.*, 2019, pp. 28). Publications 4 and 5, which report on school-based physical activity intervention evaluation, involved cost-effectiveness analysis (CEA) and cost-utility analysis (CUA) alongside the establishment of intervention costs and resources. CEA and CUA types of economic evaluation are commonly applied in the assessment of physical activity interventions, but as they often focus on a single outcome of interest, they have been criticised for their inability to explore the full range of costs and consequences associated with an intervention (Abu-Omer *et al.*, 2017; Skivington *et al.*, 2019).

The latest guidance from NICE promotes cost-consequences analysis (CCA) – where health and non-health costs are compared across sectors, and can incorporate CEA and CUA – for a more comprehensive, socio-ecologically minded assessment (NICE, 2018). This is a desirable approach to be adopted where possible, but it is important to recognise that not all intervention evaluations have resources available for comprehensive economic assessment. For example,

Publication 6 which presents the findings of an evaluation of a community-based physical activity intervention, had a limited budget and was able to collect and report on intervention costs and resource use alone. Although clearly limited in scope, when compared with a more comprehensive CUA, the costs and resources associated with 'real world' physical activity interventions are likely to be of interest to decision-makers (Hanson and Jones, 2017).

6.2.5 Ongoing intervention modification

The 'ongoing modification' of complex interventions in response to the context within which it is being delivered is recommended in proposed revisions to MRC guidance (Skivington *et al.,* 2019), so long as central elements of programme theory are maintained (Hawe *et al.,* 2004). Two approaches to modification are proposed: 1) reactive modification, in which a project protocol responds to feedback in real time and, 2) empirical optimisation, whereby theories are identified and rapidly tested. Reactive modification was an important element of the evaluation that led to Publication 6, and is therefore a welcome addition to the revised MRC guidance. Qualitative feedback from a range of project stakeholders about how best to engage the target population (at the individual- and setting-level) identified the need to relax the target population eligibility criteria to include obese and overweight individuals; to increase the number of General Practice settings involved in programme implementation; and, to adapt physical activity session content to cater to participants' needs and abilities.

6.2.6 Consideration of uncertainty

Each of the publications submitted in this thesis aimed to generate evidence about physical activity promotion in community settings, and thus reduce uncertainties

about how this can best be achieved. Careful consideration of the methodological approach utilised in each study was required, in order to ensure a valuable contribution to new knowledge (Skivington *et al.,* 2019). For example, in the case of Publications 1 and 2, I was aware that while there was existing evidence relating to the two topics under investigation, there was uncertainty about what conclusions could be drawn when the existing evidence was consolidated – hence the decision to utilise evidence synthesis methods in those instances. In contrast, it is well established that there is limited existing evidence on the costs and resources associated with 'real world' community-based physical activity interventions (Hanson and Jones, 2017). As such, empirical research methods were applied to the research leading to Publications 4, 5 and 6, with the aim of reducing uncertainties about the monetary value of the interventions under investigation.

6.2.7 General reflections on proposed revisions to MRC guidance

Advancements in the field of developing and evaluating complex interventions have led to timely revisions of the 2006 MRC guidance, due to be published in 2020. The revised guidance has been developed through a range of project activities, which include a literature review and consultation events (Skivington *et al.,* 2018). Given my interests in exploring how socio-ecological context may influence physical activity, the additional focus on context, which has been highlighted in alternative intervention development guidance (*e.g.,* Michie *et al.,* 2011; Wight *et al.,* 2016), is welcomed.

Although not exclusively designed for developing and evaluating complex interventions in public health, the provision of guidance to public health audiences is certainly within its remit (Skivington *et al.,* 2019). Reducing health inequalities

is a central aim of those working in public health, and so it is somewhat disappointing to see no mention in the draft guidance of health inequalities. As demonstrated throughout the critical commentary and works submitted, my own experience of identifying existing evidence on health inequalities and generating new evidence on how best to reduce health inequalities, has presented a challenge that has yet to be addressed. Further guidance to support intervention development and evaluation research, which appreciates the importance of identifying and tackling health inequalities, is therefore recommended. Notably, proposed revisions to MRC guidance have yet to be published; the final version may yet address this concern.

6.3 Methodological considerations

A key strength of the publications submitted is their utilisation of a range of methodological approaches best suited to answering a research question (Weaver, 2018; Murphy, 1990): evidence synthesis (Publications 1 and 2); a longitudinal study using cohort panel data from a larger natural experimental study (Publication 3); economic analysis as part of a larger RCT (Publications 4 and 5); and, a mixed methods evaluation using the RE-AIM framework (Publication 6). The publications also sought to address an important criticism of the existing evidence base on physical activity interventions, namely the over-reliance on evidence from cross-sectional studies (Biddle *et al.*, 2015).

Within the field of public health, evidence synthesis is highly regarded for its ability to identify and summarise evidence related to a specific topic. The utilisation of evidence synthesis methods for Publications 1 and 2 allowed for conclusions to be drawn about the breadth and quality of the existing evidence

base, the identification of gaps in the evidence base, and for future directions for research to be highlighted. A key strength of an umbrella review is its ability to explore a broad topic area and produce findings that are readily available to decision-makers (Aromarteris *et al.*, 2014). Given the focus of Publication 1, on identifying and summarising evidence to aid public health and planning professionals, the application of umbrella review methods was particularly apt. For Publication 2, the application of systematic review methods allowed for not only the identification of behaviour change techniques, but also the identification of frequent examples of poor and unclear reporting; both of which led to recommendations for future walking and cycling intervention development.

Evidence synthesis methodologies are not without criticism. For example, the broad remit of many evidence synthesis projects is a limitation, as well as a strength. Evidence syntheses generate top-level findings, but their ability to translate evidence into granular recommendations that can be applied by those working in practice may be limited (Curtis *et al.*, 2018; Fusar-Poli and Radua, 2018). Secondly, and as already discussed, there are numerous factors which influence and interact with health and health behaviours. This ever-present complexity is difficult to address through the application of highly structured evidence synthesis methodologies; the revised MRC framework, due to be published in 2020, will include much needed guidance on this (Skivington *et al.*, 2019).

Publications 3 to 6 each report findings from primary research studies undertaken in community settings. Publication 3 examines longitudinal cohort panel data collected over two years as part of the wider *iConnect* natural experimental study (see Ogilvie *et al.*, 2011; Ogilvie *et al.*, 2012). Natural experiments are

increasingly valued within public health (Craig *et al.*, 2017), for their ability to examine real-world interventions within a context where multi-level influences on health are known to operate. This is an important challenge associated with the RCT, where the rigorous experimental study design has been criticised for failing to account for the complexity present in real world public health (Victora, Habicht and Bryce, 2004). This critique is potentially relevant in the case of Publications 4 and 5, which were part of two larger RCTs; despite interventions being piloted and theoretically informed, no evidence was observed for an effect of interventions on physical activity outcomes (Jago *et al.*, 2019; Jago *et al.*, 2015). The pragmatic application of the RE-AIM framework in the mixed methods evaluation that led to Publication 6 provided an alternative approach to evaluation, which was limited by its lack of control or comparison group, but did provide evidence on the real-world impact of the community-based intervention that was of value to decision-makers.

A strength of Publications 3 to 6 was the collection of follow-up data at 12 months (Publications 4, 5 and 6) and at 2 years (Publication 3); a feature not always associated with physical activity research. A review of interventions for promoting physical activity highlighted the need for the long-term follow-up beyond 12 months to establish long-term effectiveness (Foster *et al.*, 2013). However, while this is desirab*le, it is important to recognise that studies of community-based physical activity interventions are often faced with time, money and resource constraints.

Publications 3 to 6 each utilised outcome measures validated for use with the populations under investigation. A review of community-wide interventions for promoting physical activity identified many studies where this was not the case

(Baker *et al.*, 2015), highlighting the strength of the evidence submitted. Importantly, however, the findings reported in Publications 4 and 5 indicated that the use of validated measures is not always sufficient. Despite adjusting measures in response to testing, newly applied measures remained insensitive to change.

Publications 3 to 6 relied on self-report data, which, in the case of physical activity research has been associated with over-reporting (Prince *et al.,* 2008). One strategy used in the RE-AIM evaluation that led to Publication 6, where budget constraints meant that it was not possible to collect objectively-measured accelerometer data, was the corroboration of self-report data through collation of programme-level and qualitative data from a variety of sources; an approach which has been applied elsewhere (Koorts and Gillson, 2015).

6.4 Collaborative research

Multidisciplinary public health research that draws upon expertise and methods from a range of disciplines has grown exponentially since the 1990s and is now commonplace (Berridge, 2007; Manyara *et al.,* 2018). Each of the publications submitted in this thesis are bounded under the umbrella of 'public health', with input from individuals from the disciplines of psychology, geography, medicine, town planning, economics, and environmental sciences, to name but a few, employed in academic- and practice-based roles in the UK (*e.g.,* UWE Bristol; Centre for Diet and Activity Research, University of Cambridge; University of Bristol; University of Edinburgh; Oxford Brookes University; Public Health England) and further afield (Deakin University, Australia).

Working with individuals from such diverse, backgrounds presented its challenges; for example, differing perspectives on how "evidence" is defined and

how it can and should be generated through research. However, public health itself is now widely considered to be multidisciplinary (Berridge, 2007), and engagement with those from other disciplines ultimately provided an excellent opportunity for sharing and developing understandings. This collaborative approach to research is not unique to the publications submitted here; it is an approach that I have utilised throughout my career to date (see Appendix E) and one that I intend to pursue in the years that follow.

6.5 Research impact

The impact of the submitted works, both for academia and practice, is presented throughout this thesis. In summary, each of the works submitted have been published in reputable peer review journals from a range of disciplines, including public health and health psychology, and each journal has a high Impact Factor for its field. Since 2013, I have presented the research submitted here at national and international peer reviewed conferences and invited events. To date, the combined works submitted have been cited by academic journals more than 100 times, and by a range of reports published by National bodies, including those beyond academia (*e.g.*, NIHR, 2019; PHE, 2019; PHE, 2018a; PHE, 2018b).

My contribution to public health research extends beyond the works submitted here, as evidenced by the 29 peer reviewed publications I have co-authored and 28 presentations I have delivered (see Appendix E). I am also a reviewer for *BMC Public Health*, *Journal of Adolescence*, *Journal of Health and Place*, *Journal of Public Health*, *Journal of Transport & Health*, *Perspectives in Public Health*, and *Transportation Part A: Policy and Practice*. Although not directly related to the

publications submitted in this thesis, in 2017 I was invited to talk about my wider school-based research on BBC Radio 4 show 'Inside Health'.

The Research Excellence Framework (REF) is a system used to assess the quality of research in UK higher education institutions, and I am delighted that the findings of Publication 1 will form the basis of a REF2021 Impact Case Study from UWE Bristol. As earlier discussed, the work has received a high level of interest at the National level and there is now evidence that the findings are being used to guide public health and planning practice (PHE, 2019; PHE, 2018a; PHE, 2018b).

Finally, as part of the demonstration of my wider influence in this research field, I asked a number of colleagues to provide a short testimonial (see Appendix F).

6.6 Future plans

Importantly, the research presented in this submission does not end my interest in seeking to better understand how best to promote physical activity in community settings. The research has raised a number of questions that I would like to continue to explore as my career progresses. A key area of concern identified through my work is the lack of evidence on how to develop and implement physical activity interventions that tackle health inequalities. Linked to this is a desire to more actively consider all levels of the socio-ecological model of health in relation to physical activity promotion, from a systems perspective, when undertaking research. In 2018, Rutter and colleagues published an initial physical activity system map, highlighting some of the main drivers of physical activity (Rutter *et al.,* 2018). It is acknowledged that systems approaches for action on public health are at an early stage of development and understanding (Lloyd *et al.,*

2018; Rutter *et al.*, 2018), but it is an approach that I would like to learn more about.

Experience in utilising traditional RCT methods alongside more pragmatically-focused research approaches, has ignited a strong interest in pursuing intervention development and evaluation research utilising the RE-AIM framework (Glasgow *et al.*, 1999). From my perspective, research undertaken in real-world settings with limited resources, time and money, requires a pragmatic approach whereby the focus of the research is on translating evidence into practice. RCTs, which have the ability to determine intervention effectiveness, are costly to undertake and arguably generate evidence relevant to experimental settings that is of less value in the real-world. Such is my interest in RE-AIM methods, I will be delivering training on the framework at two events to public health professionals in the South West in the next three months.

A thread that flows through my experiences is health psychology. I hope to continue to draw upon my training and put it to good use in the context of public health teaching and research. The importance of better understanding individual behaviours and their complexities, within a system, in trying to improve population health is acknowledged (Sniehotta *et al.*, 2017), and the recent collaboration between Public Health England, the Faculty of Public Health (FPH), the Behavioural Science and Public Health Network (BSPHN), and the Local Government Association (PHE, 2018c) indicates that the climate is right for pursuing health psychology-informed public health research.

I am an author of the forthcoming *Research Methods for Public Health* textbook, for which I wrote three chapters: Systematic Reviews; Meta-Ethnography and

Realist Synthesis; and, Mixed Methods Research and Evaluation Design (McClean *et al.,* 2019). The textbook is informed by the socio-ecological model of health, and has been written chiefly for students undertaking an MSc in Public Health. It has provided me with an excellent opportunity to draw upon my research experiences and learning from others, to guide the next generation of public health professionals. I intend to use the book to support teaching, but also to validate my position as a researcher with evidence synthesis and mixed methods methodological expertise as I apply for future research grants.

Chapter 7: Conclusions and recommendations

Through submission of six first-authored and peer-reviewed academic works, alongside a critical commentary, this doctoral thesis demonstrates a contribution to knowledge in the area of community-based physical activity intervention development, evaluation and implementation. Overall, this submission highlights a concern about rising levels of physical inactivity and makes the case for the development, evaluation and implementation of effective and replicable physical activity interventions for the real world, that explicitly consider the socio-ecological factors influencing physical activity behaviours within a complex system and that reduce inequalities in health.

The submission proposes a number of recommendations to support public health researchers, practitioners and decision-makers in the future development, evaluation and implementation of interventions that promote physical activity in community settings:

- Researchers involved in community-based physical activity intervention research should actively consider all levels of the socio-ecological model of health at all phases of intervention development and evaluation. This may include consideration of newly developed systems approaches to physical activity.
- Future research is needed to develop the evidence base on associations between individual-, social- and environmental-level factors and physical activity-related health inequalities, and the development and implementation of effective strategies to reduce health inequalities.

- The development and evaluation of community-based physical activity interventions can benefit from collaboration with researchers from a range of disciplines and the consideration of different disciplinary understandings. For example, health psychology-informed public health research may lead to better understanding of individual behaviours and their complexities in trying to improve population health.
- The value of psychological theory testing and refinement in the development of community-based physical activity interventions has been established, but further research is required to investigate the interplay between psychological and socio-ecological constructs in influencing physical activity behaviour change.
- The economic evaluation of community-based physical activity interventions is still in its relative infancy; a socio-ecologically sensitive approach to economic evaluation is recommended, alongside further research to develop measures that are specific to the population under investigation.
- The identification of costs and resources attributable to community-based physical activity interventions is of relevance to decision-makers but rarely reported; it is therefore recommended that future economic analyses of community-based physical activity interventions record and report these data in detail.
- The value of drawing upon a range of robust methodological approaches to generate evidence relevant to the development and evaluation of community-based physical activity interventions has been demonstrated. In designing future physical activity intervention research studies, a pragmatic approach is recommended that is mindful of resource constraints, that seeks to identify

solutions to the real-world problem of physical inactivity, and that generates evidence that is of use to practitioners and policy makers.

- The development and evaluation of community-based physical activity interventions can benefit from co-production and stakeholder engagement to better understand the issue under investigation, the context of the community setting targeted, and the best approach for communicating findings to decision-makers. Failure to engage stakeholders throughout the development and evaluation process may result in interventions that are not contextually-sensitive to real-world scenarios, and may be difficult to translate.
- The effective communication of new research evidence to audiences beyond academia is essential for achieving research impact in the real-world. Researchers are therefore encouraged to produce evidence summaries, which may include visual representations of findings, to facilitate discussions and aid decision-makers with allocation of resources. Furthermore, researchers are encouraged to ensure that that all aspects of an intervention are reported in detail.

These recommendations have been generated over time as I have developed as a public health researcher at UWE Bristol. It is encouraging to see that many of the ideas presented in this critical commentary reflect current thinking on best practice for developing and evaluating complex interventions. I'm pleased to have contributed new knowledge to this field of research, and I look forward to continuing this work in the years ahead.

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Appendix A. Works submitted: validation, citations and journal esteem

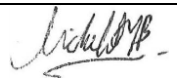
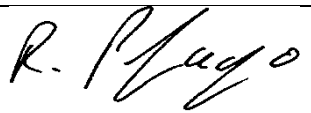
Citation (abbreviated)	Type of research validation*	Citations and Journal Impact Factor**
Publication 1 **Bird, E.L.** *et al*. (2018a) Built and natural environment planning principles for promoting health: An umbrella review. *BMC Public Health*. 18:930.	Open peer-review	Citations: 6 Impact Factor: 2.567
Publication 2 **Bird, E.L.** *et al*. (2013) Behavior change techniques used to promote walking and cycling: a systematic review. *Health Psychology*. 32 (8), pp. 829-838.	Single-blind peer-review	Citations: 110 Impact Factor: 3.530
Publication 3 **Bird, E.L.** *et al*. (2018b) Predicting walking and cycling behaviour change using an extended Theory of Planned Behaviour. *Journal of Transport and Health*. 10, pp. 11-27.	Double-blind peer-review	Citations: 10 Impact Factor: 2.583
Publication 4 **Bird, E.L.** and Powell, J.E. (2019) Chapter 5 Economic Evaluation. In Jago *et al*. Action 3:30: A cluster randomised feasibility study evaluation of a teaching assistant led, extracurricular physical activity intervention for 8 to 10 year olds. *Public Health Research* (in press).	Single-blind peer-review	Citations: N/A (article in press) Impact Factor: N/A
Publication 5 **Bird, E.L.** and Powell, J.E (2016) Chapter 4 Economic Evaluation. In Jago *et al.,* Bristol Girls Dance Project: a cluster randomised controlled trial of an after-school dance programme to increase physical activity among 11- to 12-year-old girls. *Public Health Research*, 4 (6), pp. 47-53.	Single-blind peer-review	Citations: 4 Impact Factor: N/A
Publication 6 **Bird, E.L.** *et al*. (2019) General practice referral of 'at risk' populations to community leisure services: Applying the RE-AIM framework to evaluate the impact of a community-based physical activity programme for inactive adults with long-term conditions. *BMC Public Health* (in press).	Open peer-review	Citations: N/A (article in press) Impact Factor: 2.567

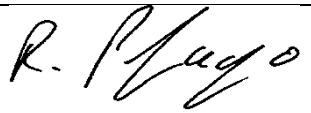
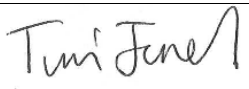
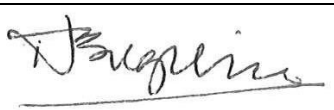
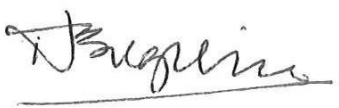
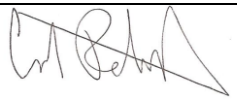
Note *Single-blind peer-review = The author does not know who the reviewers are; Double-blind peer-review = The reviewers do not know the identity of authors, and vice versa; Open peer-review = The identity of the author and the reviewers are known by all participants. Wiley (2018) *Types of peer review*. Accessed 27-09-19 from https://authorservices.wiley.com/Reviewers/journal-reviewers/what-is-peer-review/types-of-peer-review.html#singleblind. **Citations according to Google Scholar, up to 27-09-19; Journal esteem according to Impact Factor as of 27-09-19.

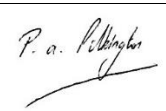
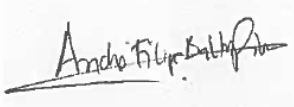
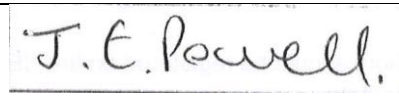
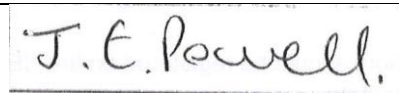
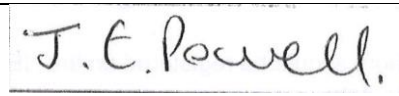
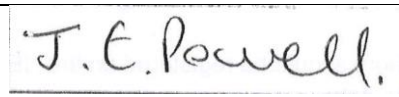
Appendix B: Grants awarded (in chronological order)

Grant Title	Year	Investigators	Funder	Amount (£)	Role
Coroners' records for Action on Road Safety (CARS) in Wiltshire	2011	Pilkington, Gray, Towner, **Bird**	NHS Wiltshire	£23,000	Co-applicant Lead researcher
Facts4Life Outcome Evaluation	2015	Oliver, **Bird**, Orme	Gloucestershire Clinical Commissioning Group	£11,500	Co-applicant Lead researcher
Facts4Life Process Evaluation	2015	**Bird**, Oliver	Gloucestershire Clinical Commissioning Group	£11,000	Principal Investigator Lead researcher
CLICK into Activity Evaluation of a social prescribing intervention for inactive adults at risk of type II diabetes	2015	Powell, **Bird**	Sport England	£55,000	Co-applicant Lead researcher
Healthy People Healthy Places Evidence Tool	2016	Pilkington, **Bird**	Public Health England	£30,000	Co-applicant Lead researcher
The Role of Home Adaptations in Improving Later Life: A Research Review	2016	Powell, Mackintosh, **Bird**, Ige, Gray	Centre for Ageing Better	£54,477	Co-applicant
Facts4Life (Phase II) Informing the decision-making processes of the commissioners of a healthy lifestyle intervention in schools	2016	Powell, **Bird**, Oliver	Gloucestershire Clinical Commissioning Group	£55,943	Co-applicant Lead researcher
The Bristol Twenty Miles Per Hour Limit Evaluation (BRITE) Study	2017	Pilkington, Bray, **Bird**	Bristol City Council	£14,949	Co-applicant
Do community businesses related approaches improve user outcomes? A Systematic Review	2018	McClean, Powell, Jones, Kimberlee, **Bird**, Ismail	Power to Change	£20,000	Co-applicant
Getting Research Into Practice (GRIP)	2018	Gray, **Bird**, Mindell, Pilkington	Public Health England	£55,000	Co-Principal Investigator

Appendix C: Signed statements of intellectual contribution to works submitted

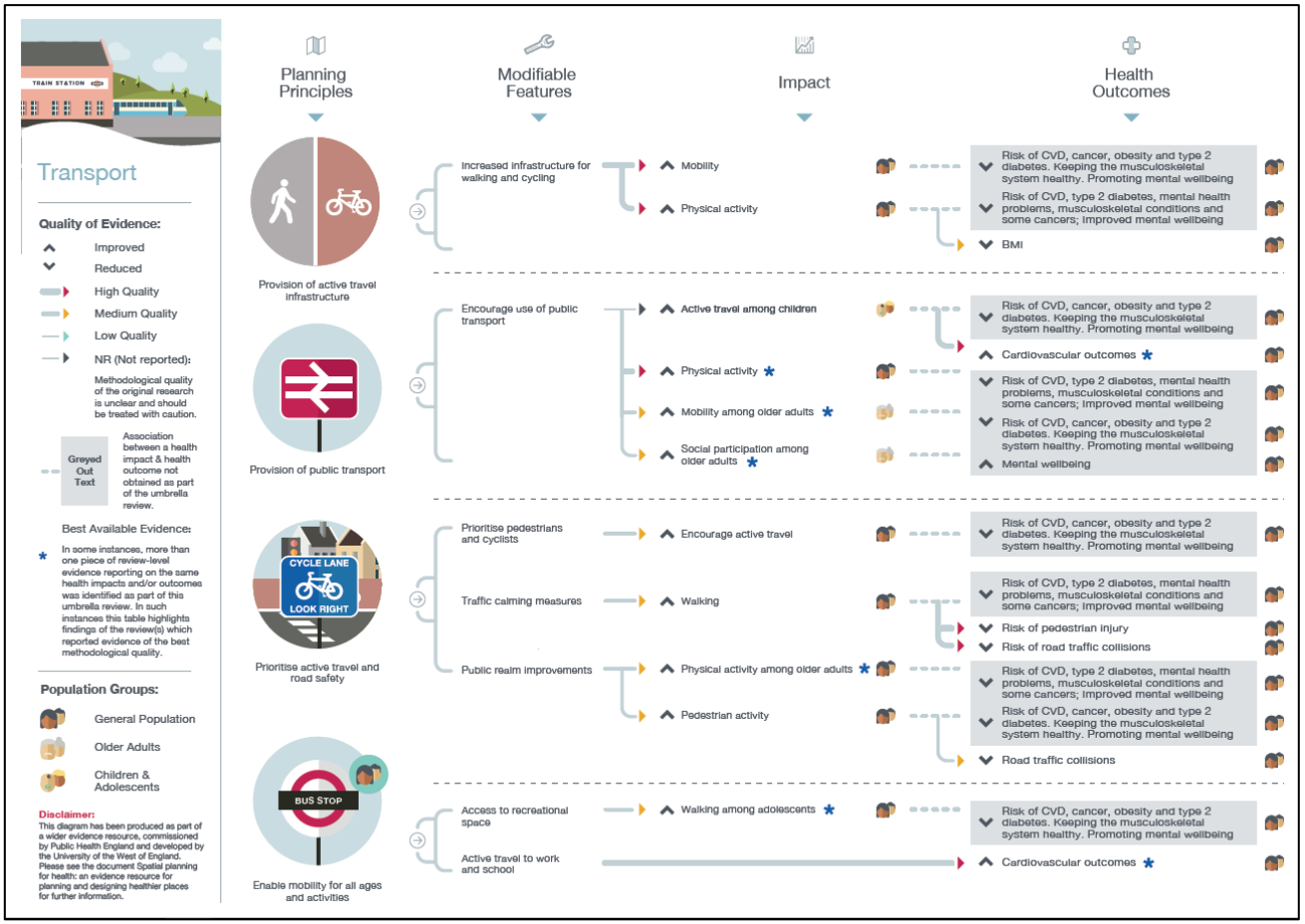
Name (in alphabetical order)	Publication number	Statement*	Signature	Date
Dr Graham Baker	2	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		07-06-18
	3	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		07-06-18
Mrs Michele Biddle	6	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		01-08-19
Ms Jilla Burgess-Allen	1	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		19-09-18
Mrs Janet Ige	1	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		18-09-18
Prof Russ Jago	4	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		16-04-19

	5	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		16-04-19
Dr Tim Jones	3	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		11-06-18
Prof Nanette Mutrie	2	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		23-03-18
Dr David Ogilvie	2	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		05-03-19
	3	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		05-03-19
Dr Jenna Panter	3	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		15-02-19
Mr Carl Petrokofsky	1	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		24-09-18

Dr Paul Pilkington	1	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		21-09-18
Mr Andre Pinto	1	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		16-11-18
Prof Jane Powell	2	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		09-08-19
	4	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		09-08-19
	5	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		09-08-19
	6	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		09-08-19
Dr Shannon Sahlqvist	2	I confirm that the statement reflects the contributions that Emma Bird made to the works that I co-authored.		26-03-18

*Statements of Emma Bird's contribution to each submission are provided in Table 2.

Appendix D: Visual presentation of findings from Publication 1: An example for Transport (Bird *et al.,* 2018a)



Appendix E: Bibliography of published works and conference presentations (in chronological order)

Peer-reviewed publications

In total, I have contributed to 29 peer-reviewed publications since November 2012:

2012 Baker, G., **Bird, E.L.,** Powell, J. and Mutrie, N., on behalf of the iConnect consortium. (2012) Examining theory and evidence to inform the development of an active commuting intervention: an iConnect case study. *Journal of Science and Medicine in Sport*. 15:1.

2013 **Bird, E.L.**, Baker, G., Mutrie, N., Ogilvie, D., Sahlqvist, S. and Powell, J., on behalf of the iConnect consortium. (2013) Behavior change techniques used to promote walking and cycling: a systematic review. *Health Psychology*. 32 (8), pp. 829-838.

Bird, E.L., Halliwell, E., Diedrichs, P.C. and Harcourt, D. (2013) Happy Being Me in the UK: A controlled evaluation of a school-based body image intervention with pre-adolescent children. *Body Image*. 10, pp. 326-334.

Jago, R., Edwards, M.J., Sebire, S.J., Cooper, A.R., Powell, J.E., **Bird, E.L.,** Simon, J. and Blair, P.S. (2013) Protocol for a cluster randomised controlled trial of an after-school dance programme to increase physical activity among 11-12 year old girls. *BMC Public Health*. 13:1003.

2014 Pilkington, P., **Bird, E.L.,** Gray, S., Towner, E., McKibben, M-A. and Weld, S. (2014) Understanding the social context of fatal road traffic collisions among young people: a qualitative analysis of narrative text in coroners' records. *BMC Public Health*. 14:78.

2015 **Bird, E.L**. (2015) Book Review: The Handbook of Health Behavior Change, by K.A. Riekert, J.K Okene and L. Pbert. Health: An Interdisciplinary *Journal for the Social Study of Health, Illness and Medicine*. 19 (1), pp. 107-109.

Jago, R., Edwards, M.J., Sebire, S.J., Tomkinson, K., **Bird, E.L.,** Banfield, K., May, T., Kesten, J.M., Cooper, A.R., Powell, J.E. and Blair, P.S. (2015) Effect and cost of an after-school dance programme on the

physical activity of 11-12 year old girls: The Bristol Girls Dance Project school-based cluster randomised controlled trial. *IJBNPA*. 12:128.

2016 Edwards, M., May, T., Kesten, J., Banfield, K., **Bird, E.L.,** Powell, J., Sebire, S. and Jago, R. (2016) Lessons learnt from the qualitative process evaluation of the Bristol Girls Dance Project: Implications for the design and implementation of after-school physical activity interventions. *BMJ Open*. *6*:e010036.

Sebire, S.J., Edwards, M.J., Kesten, J.M., May, T., Banfield, K.J., **Bird, E.L.,** Tomkinson, K., Blair, P.S., Powell, J.E. and Jago, R. (2016) Using self-determination theory to promote adolescent girls' physical activity: Exploring the theoretical fidelity of the Bristol Girls Dance Project. *Psychology of Sport and Exercise*. 24, pp. 100-110.

Sebire, S.J., Edwards, M.J., Kesten, J.M., May, T., Banfield, K.J., **Bird, E.L.,** Tomkinson, K., Blair, P.S., Powell, J.E. and Jago, R. (2016) Process evaluation of the Bristol Girls Dance Project. *BMC Public Health*. 16:349.

Bird, E.L. and Powell, J. (2016) Chapter 4 Economic Evaluation. In Jago *et al*. Bristol Girls Dance Project: a cluster randomised controlled trial of an after-school dance programme to increase physical activity among 11- to 12-year-old girls. *Public Health Research*. 4 (6), pp. 47-53.

2017 **Bird, E.L.** (2017) Student and staff perceptions of the international postgraduate student experience: A qualitative study of a UK university. *Journal of International Students*. 7 (2), pp. 329-346.

Bird, E.L. and Oliver, B. (2017) Pilot evaluation of a school-based health education intervention in the UK: Facts4Life. *Journal of Public Health* [online]. 1-9.

Allison, R., **Bird, E.L.** and McClean, S. (2017) Is team sport the key to getting everybody active, every day? A systematic review of physical activity interventions aimed at increasing girls' participation in team sport. *AIMS Public Health*. 4 (2), pp. 202-220.

Evans, D., **Bird, E.L.,** Chin, T.L., Gibson, A., Grier, S., Stoddart, S. and Macgowan, A. (2017) Extent, quality and impact of patient and public involvement in antimicrobial drug development research: a systematic review. *Health Expectations*. 21 (1), pp. 75-81.

Tibbitts, B., Porter, A., Sebire, S.J., Metcalfe, C., **Bird, E.L.,** Powell, J. and Jago, R. (2017) Action 3:30: protocol for a cluster randomised feasibility study of a revised teaching assistant led extra-curricular physical activity intervention for 8 to 10 year olds. *Pilot and Feasibility Studies*. 3:69.

2018 Manyara, A., Buunaaisie, C., Annett, H., **Bird, E.L.**, Bray, I., Ige, J., Jones, M., Orme, J., Pilkington, P. and Evans, D. (2018) Exploring the multidisciplinary extent of the public health career structures in 12 countries: An exploratory mapping. Jou*rnal of Public Health.* 40 (4), e538-e544.

Buunaaisie, C., Manyara, A., **Bird, E.L.,** Annett, H., Bray, I., Ige, J., Orme, J., Jones, M., Pilkington, P. and Evans, D. (2018) Employability and Career Experiences of International Graduates of an MSc Public Health: A Mixed-Methods Study. Pu*blic Health*. 160, pp. 62-69.

Bird, E.L., Panter, J., Baker, G., Jones, T. and Ogilvie, D., on behalf of the iConnect Consortium. (2018) Predicting walking and cycling behaviour change using an extended Theory of Planned Behaviour. *Journal of Transport and Health*. 10, pp. 11-27.

Bird, E.L., Ige, J.O., Pilkington, P., Pinto, A., Petrokofsky, C. and Burgess-Allen, J. (2018) Built and natural environment planning principles for promoting health: An umbrella review. *BMC Public Health*. 18:930.

Bray, I., Slater, A., Lewis-Smith, H, **Bird, E.L**. and Sabey, A. (2018) Promoting positive body image and tackling overweight/obesity in children and adolescents: A combined health psychology and public health approach. *Preventive Medicine*. 116, pp. 219-221.

Almohammed, R. and **Bird, E.L.** (2018) Public knowledge and behaviours relating to antibiotic use in Gulf Cooperation Council Countries: A systematic review. *Journal of Infection and Public Health*. 12 (2), pp. 159-166.

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2019 Jago, R., Tibbitts, B., Sanderson, E., **Bird, E.L.**, Porter, A., Metcalfe, C., Powell, J.E., Gillett, D. and Sebire, S.J. (2019) Action 3:30R: Results of a cluster randomised feasibility study of a revised teaching assistant-led extracurricular physical activity intervention for 8 to 10 year olds. *IJERPH*. 16 (1), E131.

Tibbitts, B., Porter, A., Sebire, S.J., **Bird, E.L.**, Sanderson, E., Metcalfe, C., Powell, J.E. and Jago, R (2019). Action 3:30R: Process evaluation of a cluster randomised feasibility study of a revised teaching assistant-led extracurricular physical activity intervention for 8 to 10 year olds. *BMC Public Health*. 19 (1): 1111.

Bird, E.L. and Powell, J. (2019) Chapter 5 Economic Evaluation. In: Jago *et al.,* (2019) Action 3:30: A cluster randomised feasibility study evaluation of a teaching assistant led, extracurricular physical activity intervention for 8 to 10 year olds. *Public Health Research* (in press).

Bird, E.L., Kok, M.S.Y. and Powell, J. (2019) General practice referral of 'at risk' populations to community leisure services: Applying the RE-AIM framework to evaluate the impact of a community-based physical activity programme for inactive adults with long-term conditions. *BMC Public Health* (in press).

Books

2019 McClean, S., Bray, I., de Viggiani, N., **Bird, E.L.** and Pilkington, P. (2019) *Research Methods for Public Health*. London: SAGE Publications.

Project reports

2014 Brook, J., Salmon, D., Kimberlee, R., Orme, J. and **Bird, E.L.** (2014). *Meeting the challenges of the Health Visitor Implementation Plan at the University of the West of England, Bristol. Project Report*. University of the West of England, Bristol. Available from: http://eprints.uwe.ac.uk/26898 [Accessed 03 September 2019].

2015 **Bird, E.L.** and Oliver, B. (2015). *Facts4Life primary school resource: Pilot evaluation report. Executive summary*. Project Report. University of the West of England. Available from: http://eprints.uwe.ac.uk/27140 [Accessed 03 September 2019].

2017 **Bird, E.L.,** Ige, J., Burgess-Allen, J., Pinto, A., Pilkington, P. and Public Health and Wellbeing Research Group (2017) *Healthy people healthy places evidence tool: Evidence and practical linkage for design, planning and health. Technical Report*. University of the West of England, Bristol. Available from: http://eprints.uwe.ac.uk/31390 [Accessed 03 September 2019].

Buunaaisie, C., Manyara, A., Annett, H., **Bird, E.L.,** Bray, I., Ige, J., Jones, M., Orme, J., Pilkington, P., and Evans, D. (2017). *Recruitment, employability and career development for international students undertaking the UWE MSc Public Health: Final report*. Project Report. University of the West of England, Bristol. Available from: http://eprints.uwe.ac.uk/32771 [Accessed 03 September 2019].

Powell, J., Mackintosh, S., **Bird, E.L.,** Ige, J.O., Garrett, H., and Roys, M. (2017). *The role of home adaptations in improving later life. Technical Report*. University of the West of England, Bristol. Available from: http://eprints.uwe.ac.uk/33945/ [Accessed 03 September 2019].

2018 Pilkington, P., Bornioli, A., Bray, I. and **Bird, E.L.** (2018). *The Bristol Twenty Miles Per Hour Limit Evaluation (BRITE) Study*. University of the West of England, Bristol. Available from: http://eprints.uwe.ac.uk/34851 [Accessed 03 September 2019].

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Bird, E.L., Oliver, B., Beardmore, A. and Powell, J. (2018) *Facts4Life: Phase II evaluation of the school-based resource. Final evaluation report*. University of the West of England, Bristol. Available from: http://eprints.uwe.ac.uk/36934 [Accessed 03 September 2019].

Invited presentations

2019 **Bird, E.L.,** Kok, M.S.Y. and Powell, J.E. (2019) *Implementation of 'CLICK into Activity' in South Somerset: Social prescribing through general practice referral of 'at risk' populations to community leisure services*. Presentation delivered at the Active People: Promoting Healthy Life Expectancy (APPHLE) Quarterly Steering Group Meeting. 11th December, 2018, Bristol, United Kingdom.

Bird, E.L., Kok, M.S.Y. and Powell, J.E. (2019) *Implementation of 'CLICK into Activity' in South Somerset: Social prescribing through general practice referral of 'at risk' populations to community leisure services*. Presentation delivered at the Centre for Public Health and Wellbeing Research Centre, UWE Bristol. 13th March, 2019, Bristol, United Kingdom.

Bird, E.L., Ige, J.O. and Pilkington, P. (2019) *Spatial planning and health: From evidence identification to implementation*. Presentation delivered at the PHE Spatial Planning and Health Seminar. 14th March 2019, London, United Kingdom.

Bird, E.L. (2019). *Sharpening behaviour change initiatives*. Presentation delivered at the Public Health + Sustainability Summit, 27th March 2019, Bristol, United Kingdom.

Peer-reviewed presentations

Since 2012 I have contributed to 20 national and 8 international conferences.

2012 **Bird, E.L.,** Halliwell, E. and Diedrichs, P.C. (2012) *'Happy Being Me' in the UK: A controlled evaluation of a school-based body image intervention with pre-adolescent children*. Paper presented at the South West Public Health Scientific Conference, 1st February 2012, Weston-super-Mare, United Kingdom.

Bird, E.L., Baker, G., Powell, J. and Mutrie, N. (2012) *A systematic review of effective behaviour change techniques in community walking and cycling interventions: the iConnect study*. Paper presented at the South West Public Health Scientific Conference, 1st February 2012, Weston-super-Mare, United Kingdom.

Diedrichs, P.C., **Bird, E.L.** and Halliwell, E. (2012) *Happy Being Me in Britain: The Evaluation of a School-based Disordered Eating and Negative Body Image Intervention with Pre-adolescent Girls and Boys*. Paper presented at the International Conference on Eating Disorders, 3rd May, Texas 2012, USA.

Bird, E.L., Baker, G., Mutrie, N., Ogilvie, D., Sahlqvist, S. and Powell, J. (2012) *Behaviour change techniques used to promote walking and cycling: A systematic review*. Poster presented at Changing Lives, Changing Society, 28th June 2012, University of the West of England, Bristol, UK.

Bird, E.L., Halliwell, E. and Diedrichs, P.C. (2012) *'Happy Being Me' in the UK: A controlled evaluation of a school-based body image intervention with pre-adolescent children*. Paper presented at Appearance Matters 5, 3rd July 2012, Bristol, United Kingdom.

Jones, T., **Bird, E.L.,** Baker, G., Mutrie, N. and Ogilvie, D. (2012) *The application of an extended theory of planned behaviour to understand cycling intentions: The UK iConnect study*. Paper presented at Traffic and Transport Behaviour: interaction between theory and practice, 31st August 2012, Groningen, The Netherlands.

Bird, E.L., Baker, G., Mutrie, N., Ogilvie, D., Sahlqvist, S. and Powell, J. (2012) *Using a reliable taxonomy to code the content of walking and cycling interventions: challenges and recommendations for future reporting*. Poster presented at the 4th International Congress on Physical Activity and Public Health, 31st October – 3rd November 2012, Sydney, Australia.

2013 Pilkington, P., **Bird, E.L.,** Gray, S., Towner, E., Weld, S. and McKibben, M-A. (2013) *Coroners' records for action on road safety (CARS) in Wiltshire*. Paper presented at the South West Public Health Scientific Conference, 7th February 2013, Weston-super-Mare, United Kingdom.

Pilkington, P., **Bird, E.L**., Gray, S., Towner, E., Weld, S. and McKibben, M-A. (2013) *Understanding the social context of fatal road traffic collisions among young people: a qualitative analysis of coroners' records*. Moderated poster presented at the European Public Health Conference, 13th – 16th November 2013, Brussels, Belgium.

2014 **Bird, E.L.,** Powell, J., Ogilvie, D., Goodman, A. and Rutter, H. (2014) *Health economic assessment of walking and cycling interventions in the physical environment: Interim findings from the iConnect study*. Paper presented at the South West Public Health Scientific Conference, 5th February 2014, Weston-super-Mare, United Kingdom.

Bird, E.L., Powell, J., Ogilvie, D., Goodman, A. and Rutter, H. (2014) *Health economic assessment of walking and cycling interventions in the physical environment: Interim findings from the iConnect study*. Poster presented at the at the 5th International Congress on Physical Activity and Public Health, 8th-11th April 2014, Rio de Janeiro, Brazil.

2015 Preece, D. and **Bird, E.L**. (2015) *"A stepping stone": Constructing a peer educator role*. Poster presented at the South West Public Health Scientific Conference, 3rd February 2015, Weston-super-Mare, United Kingdom.

Bird, E.L., Powell, J.E., Sebire, S.J., Edwards, M.E. and Jago, R. (2015) *Economic evaluation of the Bristol Girls Dance Project*. Paper presented at the UK Society for Behavioural Medicine Conference, 8th December 2015, Newcastle, United Kingdom.

2016 **Bird, E.L.,** Oliver, B. and Powell, J.E. (2016) *A pilot controlled evaluation of a primary school-based health education intervention: Facts4Life*. Paper presented at the South West Public Health Scientific Conference, 16th March 2016, Bristol, United Kingdom.

2017 Allison, R., **Bird, E.L.** and McClean, S. (2017). *Is team sport the key to getting everybody active, every day? A systematic review of physical activity interventions aimed at increasing girls' participation in team sport*. Poster presented at the South West Public Health Scientific Conference, 14th March 2017, Bristol, United Kingdom.

Preddy, A. and **Bird, E.L.** (2017). *Parents' experiences of receiving feedback from national child weight screening programmes in the UK: A mixed methods systematic review*. Poster presented at the South West Public Health Scientific Conference, 14th March 2017, Bristol, United Kingdom.

Pinto, A., **Bird, E.L.,** Ige, J.O., Burgess-Allen, J. and Pilkington, P. (2017) *Spatial planning for health: an evidence resource for planning and designing healthy places*. Paper presented at the 14th International Conference on Urban Health, 26th-29th September 2017, Coimbra, Portugal.

Bird, E.L., Panter, J., Baker, G., Jones, T. and Ogilvie, D. (2017) *Predicting walking and cycling behaviour change using an extended Theory of Planned Behaviour*. Paper presented at the 8th Conference of HEPA Europe, 15th-17th November 2017, Zagreb, Croatia.

2018 **Bird, E.L.,** Ige, J.O., Pinto, A. and Pilkington, P. (2018) *Built and natural environment planning principles for promoting health: An umbrella review*. Paper presented at the AMPS Conference - Health: The Design, Planning and Politics of How and Where We Live, 25th-26th January 2018, Bristol, United Kingdom.

Bird, E.L., Panter, J., Baker, G., Jones, T. and Ogilvie, D. (2018) *Psychological predictors of walking and cycling behavior change: An iConnect study*. Paper presented at the South West Public Health Scientific Conference, 13th March 2018, Bristol, United Kingdom.

Bird, E.L., Ige, J., Pinto, A. Pilkington, P. (2018) *Built and natural environment planning principles for promoting health: An umbrella review*. Paper presented at the South West Public Health Scientific Conference, 13th March 2018, Bristol, United Kingdom.

Bird, E.L., Ige, J., Pilkington, P., Pinto, A., Petrokofsky, C. and Burgess-Allen., J. (2018) *Built and natural environment planning principles for promoting health: An umbrella review*. Poster presented at the Public Health England Conference, 12th September 2018, Warwick University, United Kingdom.

Pinto, A., Pilkington, P., **Bird, E.L.** and Ige, J. (2018) *Built and natural environment planning principles for promoting health: An umbrella review*. Poster presented at the Healthy City Design 2018 International Congress, 15th October 2018, Royal College of Physicians, United Kingdom.

2019 **Bird, E.L.,** Kok, M.S.Y. and Powell, J.E. (2019) *Implementation of 'CLICK into Activity' in South Somerset: Social prescribing through general practice referral of 'at risk' populations to community leisure services*. Paper presented at the South West Public Health Scientific Conference, 19th March 2019, Bristol, United Kingdom.

Bornioli, A., Pilkington, P., Bray, I. and **Bird, E.L.** (2019) *Public health evaluation of the 20mph speed limit policy in Bristol, UK*. Paper

presented at the South West Public Health Scientific Conference, 19th March 2019, Bristol, United Kingdom.

Bornioli, A., Bray, I., Pilkington, P. and **Bird, E.L.** (2019) *The 20mph speed limit policy in Bristol: Analysis of speed and collisions variations*. 15th World Conference on Transportation Research, 26th – 31st March 2019, Mumbai, India.

Bird, E.L., Oliver, B., Beardmore, A., van't Hoff, H., Davis, J. and Powell, J.E. (2019) *Facts4Life: A mixed methods evaluation of a school-based health education intervention.* Paper presented at the Global Perspectives on Improving Population Health 2019: A Public Health Approach, 15th May 2019, Liverpool John Moores University, United Kingdom.

Gray, S., Pilkington, P., Ige, J., **Bird, E.L.**, Mindell, J., Petrokofsky, C., Stimpson, A., Gallagher, D. and Chang, M. (2019) *Spatial Planning and Health: Getting Research into Practice (GRIP): project report*. Poster presented at the Public Health England Conference, 10th September 2019, University of Warwick, United Kingdom.

Appendix F: Testimonials

To demonstrate my development as a researcher and the influence of my research, a number of colleagues were invited to provide a testimonial.

Jane Powell

Director Centre for Public Health and Wellbeing and Professor Public Health Economics, UWE, Bristol

I am delighted to provide this testimonial for Emma's DPhil.

I recruited Emma to Health and Applied Sciences in September 2010 to work as a research associate on a research project, Impact of Connecting Non-motorised Networks and Evaluating Changes in Travel (iCONNECT). This was a high profile five year, £2.2m EPSRC funded project involving a consortium of seven universities and three non-governmental organisations. On her first day in the job, I asked her to help me finish another piece of research work for the National Institute for Health and Care Excellence (NICE) which involved writing a critical appraisal of some economic evaluation studies. After around one hour, she appeared having completed the first appraisal and I was very impressed to find that I could put it straight into the final report without making one change. Not only was this an enormous relief given my extremely high workload at the time, but I quickly realised that Emma was a total pleasure to work with and line manage.

It is a source of great pride that Emma has progressed through the ranks to Senior Lecturer, which she fully deserves and has demonstrated great ability to manage projects and people. She has played a significant role in the team and has proved

herself an excellent teacher and expert in real world evaluation, synthesis of evidence and systematic review. Her skills as a methodologist and analyst are important for the current and future success of the Centre for Public Health and Wellbeing at UWE. There is no doubt in my mind at all that she will make senior levels in academia in the not too distant future.

Emma and I have worked on six projects together since the completion of iConnect in 2013. These include the National Institute for Health Research (NIHR) funded Bristol Girls Dance Project and Action 3.30 with colleagues at Bristol University. Research and evaluation projects, such as, Click into Activity funded by Sport England looking and Facts4Life funded by Gloucestershire Clinical Commissioning Group. Emma led the fieldwork, outputs and project management in both of these projects.

Emma demonstrated her expertise in systematic review and synthesis on a project funded by the Centre for Ageing Better on the Role of Home Adaptations in Improving Later Life and the iConnect project cited above. Across diverse projects, partners and funders, Emma has demonstrated she is an all-round academic with excellent research, writing and presentation skills. The quality and quantity of her outputs for the Research Excellence Framework is excellent. Emma has presented research findings at high profile events both externally, overseas and within the university. She is an important and valued member of our team.

Sam Wenden-de-Lira

Case Team Leader, South Somerset District Council, and Project Manager for CLICK into Activity

My role was the 'Project Lead' for the Click into Activity Project. Emma was my regular contact at UWE, who were doing the data collection and Evaluation for the project. The work was produced at a high level, meeting what was expected from the evaluation team. Emma also completed regular updates and presentations for the steering group and for Sport England reports, which were informative and highlighted positive impacts of the project which otherwise may have been missed.

Emma was very easy to work with; she is prompt in replies and friendly yet professional with her communication. I would recommend other organisations to work with UWE from my experience of working with Emma, and I would also work with her again in future. She is credit to her organisation.

John Davis and Hugh van't Hoff

Co-Directors of Facts4Life

We have worked with Emma Bird in our capacity as Directors of Facts4Life over the last 5 and 7 years respectively. Facts4Life is a Gloucestershire based organisation that has developed a curriculum for primary and secondary schools aiming to build health resilience and encourage young people to take responsibility for their physical and mental health. We lead a team of specialist teachers in the creation of an innovative approach to health education, translating that into a range of resources for use in the classroom and training teachers in its implementation across the school. We have so far worked with around 180 primary and secondary schools in the county.

Emma has been instrumental in designing, implementing and bringing to publication a full evaluation of the work we have carried out in Gloucestershire schools. The evaluation was carried out in 2 phases: an initial study with Key Stage 2 children between 2012-2015 and a second larger study involving children across Keys Stages 1, 2 and 3 (primary and secondary age) from 2015-2018. The primary school studies involved a quasi-experimental design with children participating in the intervention and a control group. In both cases a qualitative process and outcome evaluation was conducted using focus group and interview data, to complement quantitative findings and to examine the wider context, implementation and mechanisms of Facts4Life in a school setting. In addition, a qualitative evaluation was carried out in four secondary schools as part of the second phase involving qualitative focus groups and semi-structured interviews with pupils and teachers.

In every case, the organisation of the work with schools by Emma was exemplary. Good contact was made in advance with teachers, roles clearly explained and good relationships established. Teachers commented on the quality of the support provided in the process. Reports on the research were accurate, evaluations written up in a clear style and Emma was always open to discussion on how best to express the context of our work. In presentations to the CCG on outcomes of the evaluation, Emma was measured, always on top of detail and unfailingly professional with commissioners.

Above all, Emma established high levels of confidence and trust in the quality of her work. We are delighted with the impact of our efforts but also grateful to Emma for the rigour of her work, which has led to further commissioning of Facts4Life within Gloucestershire.

It has been a pleasure to work with Emma during the lifetime of this project. Her sharp understanding of the nature of our objectives, the quality of her research and her excellent people skills have contributed significantly to the development of our evidence base.

Janet Ige

Research Fellow in Public Health, UWE Bristol

I, Janet Ige, a Research Fellow in Public Health at University of the West of England, hereby provide this written testimonial for Emma Bird to support her DPhil by publication qualification. I have known Emma professionally for over three years, and we have worked together on several research projects which she supervised either as the project manager or co-principal investigator. In 2016, I worked with Emma on the Healthy People Healthy Places project funded by Public Health England (PHE) to illustrate the linkages, and strength of evidence, between spatial planning and health. Emma dutifully executed the role of the project manager and authored the peer-reviewed publication from the research as the lead author. In addition to overseeing the project, Emma contributed significantly to undertaking research activities on the project.

The success and impact of the Healthy People Healthy Places project led to a follow-on project, Getting Research Into Practice project (GRIP) in 2018. This project sought to investigate the barriers and opportunities for implementing the principles set out in the Healthy People Healthy Places project report called the Spatial Planning for Health resource. Emma secured funding as a co-principal investigator for GRIP. I worked as the primary researcher on the project while

Emma provided leadership and oversight on the project. Emma contributed to the qualitative data analysis on NVivo along with other team members. She also drafted the introduction and methods section of the report and reviewed drafts of other sections of the reports.

Emma is an all-round academic with excellent research, writing and presentation skills. Her research and writing skills can be evidenced by her portfolio of high-quality research papers and reports. Emma has presented research findings at high profile events both externally and across the university. In March 2019, Emma co-presented emerging findings from the GRIP project at a PHE's inaugural spatial planning and health seminar at The Oval, London.

Emma is well-organised and able to co-ordinate tasks efficiently. Emma's managerial and leadership skills are worthy of emulation. Emma is a well-respected and highly valued member of the Centre for Public Health and Wellbeing.

David Evans

Professor of Health Services Research, UWE Bristol

I have worked with Emma Bird as part of the public health group at UWE since 2010, both in terms of her teaching on the MSc Public Health and as a research colleague.

In terms of research, I have worked closely with Emma on two projects. As part of COMBACTE-MAGNET, a major European project to develop new antimicrobials, I led the patient and public involvement (PPI) element and we agreed we needed a systematic review to establish a baseline for PPI involvement in antimicrobial

drug development. We were working to a tight deadline to produce this, so knowing her expertise in this area, I asked Emma if she would lead the development and conduct of the literature search. She agreed with her customary enthusiasm, and delivered a high-quality search to the required timescale. We then collaborated on writing up the systematic review and were successful in achieving publication in Health Expectations, the leading international journal for PPI studies.

The second project was a study of the career development experiences of international graduates of our MSc Public Health, which was carried out by two student research interns and where Emma was part of the team supporting the research. As always Emma was very generous with her time and expertise in supporting the interns, which contributed to their own career development, a successful project and two good quality papers in key peer reviewed public health journals, the Journal of Public Health and Public Health.

In terms of the MSc I was first programme leader and then took on managing the dissertation module. My experience of Emma in both roles was of an exemplary colleague. She has been highly committed and enthusiastic about teaching and supporting our students, and has in my experience been an excellent teacher and supervisor. I worked most closely with her in respect of the dissertation module where she led the work stream on evidence synthesis, a particular interest and area of expertise of hers. The workshops she ran for students were superb and, as we needed to expand the pool of supervisors with experience of evidence synthesis, she also ran very useful CPD sessions for colleagues to support their taking on further such supervision. Emma also produced guidance documents for students and supervisors on evidence synthesis which are very useful.

My experience of working with Emma has been wholly positive; she is an engaged, enthusiastic colleague, a real team player, always willing to make a contribution. She is methodologically rigorous, expert in a range of research methods, ethically focused and writes well. I am delighted to be able to provide this testimonial to support her DPhil submission.

Appendix G: Copyright approvals

Figure 2: Socio-ecological model of health. Source: Reproduced from *Policies and strategies to promote social equity in health. Background document to WHO – Strategy paper for Europe*, Dahlgren and Whitehead, 1992, with permission from WHO Europe ©.

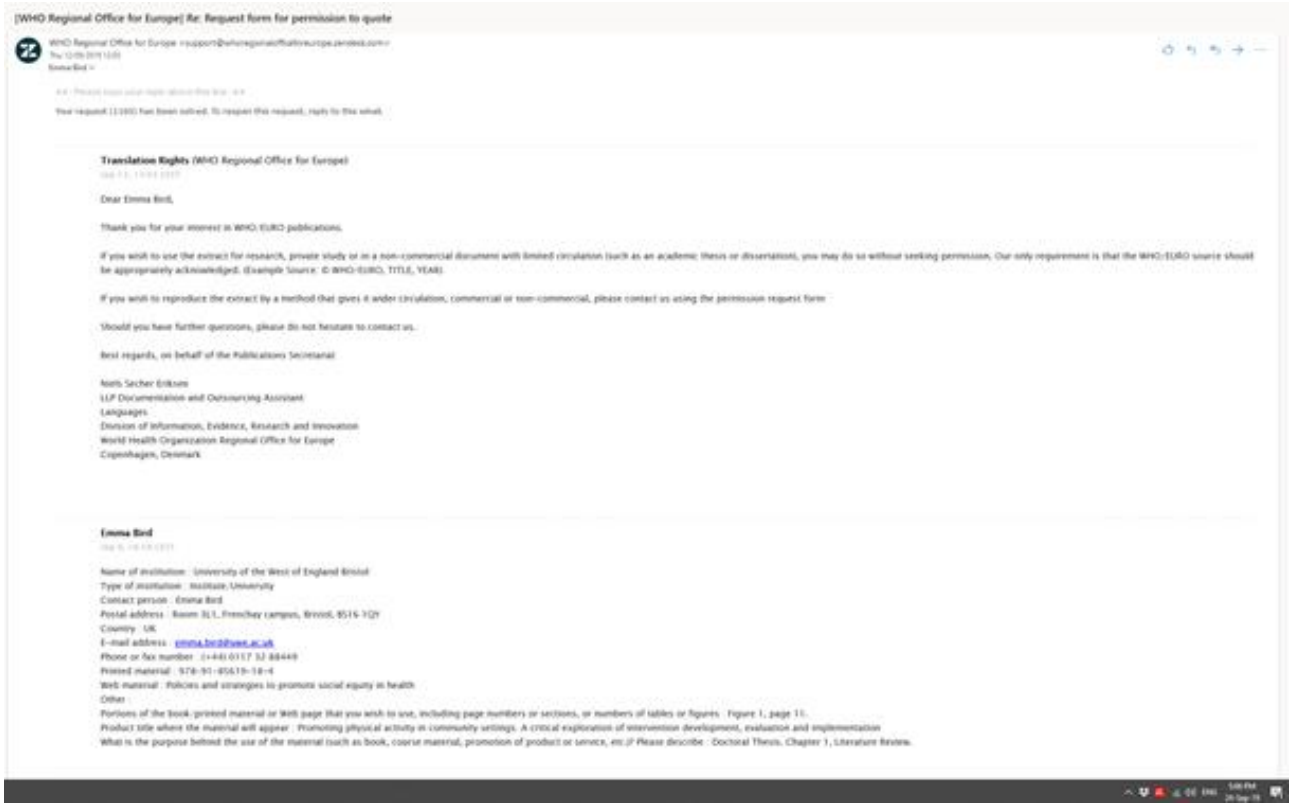
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Figure 3: Social ecology model of behaviour change. Reproduced from *Culturally compelling strategies for behaviour change: A social ecology model and case study in malaria prevention*, Panter-Brick *et al.,* 2006, 62, 2006, with permission from Social Science & Medicine.

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Figure 5: Published works mapped onto the Medical Research Council framework. Source: Adapted by permission from BMJ Publishing Group Limited *Developing and evaluating complex interventions: the new Medical Research Council guidance*, Craig *et al.,* 337, 2008.

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