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Physical Activity and Healthy Eating Interventions Review: *Final Report*

AD Research & Analysis and ICF GHK for Public Health England

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Executive Summary

This report brings together the findings and conclusions from a desk research study into effective interventions for encouraging physical activity (PA) and healthy eating (HE) behaviours among children aged 2 to 11. The study was commissioned from AD Research & Analysis and ICF GHK by the planning team in what was then the Department of Health (DH), and is now Public Health England (PHE).

The study aimed to provide practical insights for those designing interventions to prevent overweight and obesity among children aged 2 to 11, and their parents and main carers. The brief placed a particular focus on the potential role for 'tools' (such as pedometers / accelerometers) in interventions targeting these audiences. Accordingly, the methods selected for the study included reviews of the published and grey literature, case studies of effective interventions (based on written evidence and interview findings), and less formal evidence and insights provided by expert researchers and practitioners, through depth interviews, and by means of a collaborative workshop.

The main findings from the study can be summarised as follows:

- Obesity is the outcome of a complex system of factors which determine weight. Preventing weight gain is extremely challenging because of the multiplicity of these factors. Not only are these so numerous as to be extremely difficult to influence simultaneously, but they are also networked together into a system, which means that, as a whole, weight is resistant to change. Intervention designers should be mindful that no single intervention will prove effective on its own ("*there is no one silver bullet*"), and that any intervention represents "*a small input into a big system*", such that any change will be proportionally limited. That point is especially relevant to this study with its focus on tools: they will need to be part of multi-level and integrated packages of interventions if substantial impacts on overweight and obesity are to be achieved.
- At the centre of the systemic web of influences on weight is the balancing feedback loop of energy in and energy out. Accordingly we need to understand how to influence behaviours relating to healthy eating and physical activity if we wish to have an impact on weight. The available literature on these two areas of behaviour is extensive, albeit much less well evolved in relation to the 2 to 11 age range.
- It is possible to arrange the evidence on the determinants of physical activity and healthy eating behaviours into a theoretical framework according to the context, or level of scale, in which those factors operate: Individual Social and Material (or 'ISM' model). Having analysed the available evidence through that framework, the study finds that most of the factors relating to PA and HE among under 12s fall into the Social context. While there is an extensive literature on obesogenic environments which highlights factors in the Material world, the Social world is shown here to be equally influential, especially for younger people. Important Social factors identified in the review include the influence of parents, schools and peers, as well as media habits.
- Age is also a critical dimension, and the review underlines how the relative influence of different factors varies by the age of the child in question. While the specific obesity prevention evidence base is very weak here, there is a wealth of generic evidence available from disciplines concerned with child development. Among other lessons, this emphasises that children lower down the age range are still developing rudimentary physical skills, and have only a limited sense of self and identity. Around the age of 9 and above, children develop a keener sense of self and other, and become more interested in thinking about themselves and comparing themselves to (and competing with) others. Again, these findings imply different intervention approaches will work well at different ages.
- Recent work in behavioural insight in the health sphere has identified specific 'Behaviour Change Techniques' (BCTs) as the active ingredients in interventions. Since BCTs reveal the mechanisms of change, they can be used as the basis for designing effective interventions. However, the major limitation to this body of evidence from the perspective of a study of 'what works' for 2 to 11 year olds is that the entire evidence base is derived from analysis of interventions with adults. Accordingly we have had to build on the work on BCTs for adults, and "*extrapolate*" for under 18s,

based on a sound knowledge of developmental stages in childhood. This work has arrived at a ranked set of techniques which should underpin effective interventions for under 12s. While the precise mechanisms vary by age of child, the top three mechanisms across the age range are:

- i) Fun
Sheer and immediate pleasure from doing, which brings its own rewards
- ii) Rewards
Extrinsic benefits for taking part, ideally immediate, and only lasting for the short-term (to prevent dependency)
- iii) Social Support
Ensuring important others are involved in, or enable, the activity; for younger children, this will be their parents, but increasingly friends as children move up the age range

This analysis brings clear implications for intervention designers: they should differentiate their interventions by focussing tightly on the age of their audience; and they should consider which mechanisms of change are appropriate for their target age group.

- These conclusions are borne out by the review of effective interventions for 2 to 11 year olds. The interventions were selected by the research team based on an international review of published evaluations, and on suggestions from expert interviewees. In all 9 interventions were selected for review as case studies; they combined a mix of UK and US-based programmes, all of which could prove effectiveness among the 2 to 11 age range. The case studies supported the study's conclusions on effective mechanisms, and also presented a range of tools appropriate at different ages. Examples of effective case study interventions include:
 - i) Beat the Street
A UK-originated scheme for 9 to 13 year olds. Uses swipe cards and sensors on lamp-posts ('Beatboxes') to encourage walking to school. Individual pupils and schools compete: those with the most miles are rewarded with prizes and donations to a charity.
 - ii) Walk Once a Week
A UK-based scheme for 5 to 11 year olds. Involves school classes recording their daily journey on a wall chart. At the end of each month every child that has walked at least once each week, is rewarded with a collectable badge. Supported with parents' activity.
 - iii) Zamzee
A US-based activity concept for 9 to 15s, which uses an accelerometer and website to provide "a game that gets kids moving". Users create a personal account that supports goal setting, tracking progress - and rewards PA with the website currency, 'Zamz', which can be exchanged for goods in the real world.
- Tools are the final element in our framework for explaining what works: they do so not because of inherent capacity to drive change but because they anchor effective mechanisms. Hence a key finding from this study is for intervention designers not to start from the tool, but from the mechanism for change, which the tool should support. The review identifies eight kinds of tool, and writes them up as fact files; these are not effective tools per se, as their effectiveness will depend on the context in which they are used, and the mechanisms and interventions they relate to. It is notable that there are more tools for PA across the 2 to 11 age range, while the HE tools tend to suit older children. Pedometers and accelerometers also tend only to work for older children, and those who are motivated to set or pursue their own goals. Rewards however work across the age range, and can be applied to PA or HE behaviours.

- Synthesising the evidence from the literature review, the intervention case studies, the tools fact files, and the expert interviews and collaborative workshop enables us to arrive at specific points of guidance for intervention designers ('ten top tips') of which the five most important are outlined here:
 - i) Have a precise audience in mind from the outset
Effective interventions must be tightly targeted: children change fast across the 2 to 11 range.
 - ii) Deliver PA & HE separately...but have a plan for both
Children aren't much into 'health' and don't see the links between having fun, being active, and eating well. But programmes need to address both if they want to impact on weight.
 - iii) Most behaviour is social – so focus on the social context
Most of the behaviours we're interested in involve children doing things with others, most of the influences on their behaviours are social, and most effective interventions work with children as part of their social groups.
 - iv) Lead with the mechanisms
Once you have defined your target audience and desired behaviour, you need to identify which mechanism will help this group to achieve the specified change; this will then help guide your selection of tools.
 - v) Do one thing, then another (and get others to do things too)
There's no silver bullet for obesity prevention: so try one thing, and then try another. Get other practitioners to try things too, in order to have a system-wide impact on obesity. Finally, don't tell the public to 'just do one thing' in case they think that's all they need to do. Get them to do one thing (and maintain it) then move on to another, and another: in simple steps, amounting to lasting change.

1. Introduction

In October 2012, the Department of Health (DH)¹ commissioned AD Research & Analysis Ltd and ICF GHK to undertake a piece of desk research into behaviour change in relation to physical activity (PA) and healthy eating (HE). The overall aim was to bring together a range of new approaches and effective solutions, to inform the development of interventions to encourage PA and HE in children aged 2 to 11 and their parents and main carers (referred to simply as 'parents' throughout this report). A particular focus was maintained on the DH priority behaviours which are most pertinent to tackling obesity in the under 12 audience, namely: Eat 5 a Day; Undertake 60 Active Minutes a Day; Cut Down on Fat, Sugar, and Salt.

The specific objectives of the study were to:

- Gather information on 'what works' in terms of practical approaches and theoretical underpinnings.
- Describe effective interventions and the 'active ingredients' within them: i.e. their constituent tools and formats, the mechanisms which underpin them, plus evidence on audiences and impacts.
- Review recent tools and mechanisms used to encourage health-related change among individuals.
- Explore ways to differentiate recommended targets for daily PA and HE between audience subgroups, and identify the potential contribution of different interventions and tools to achieving those targets.
- Explore the extent to which HE and PA interventions can usefully be brought together in the same intervention.

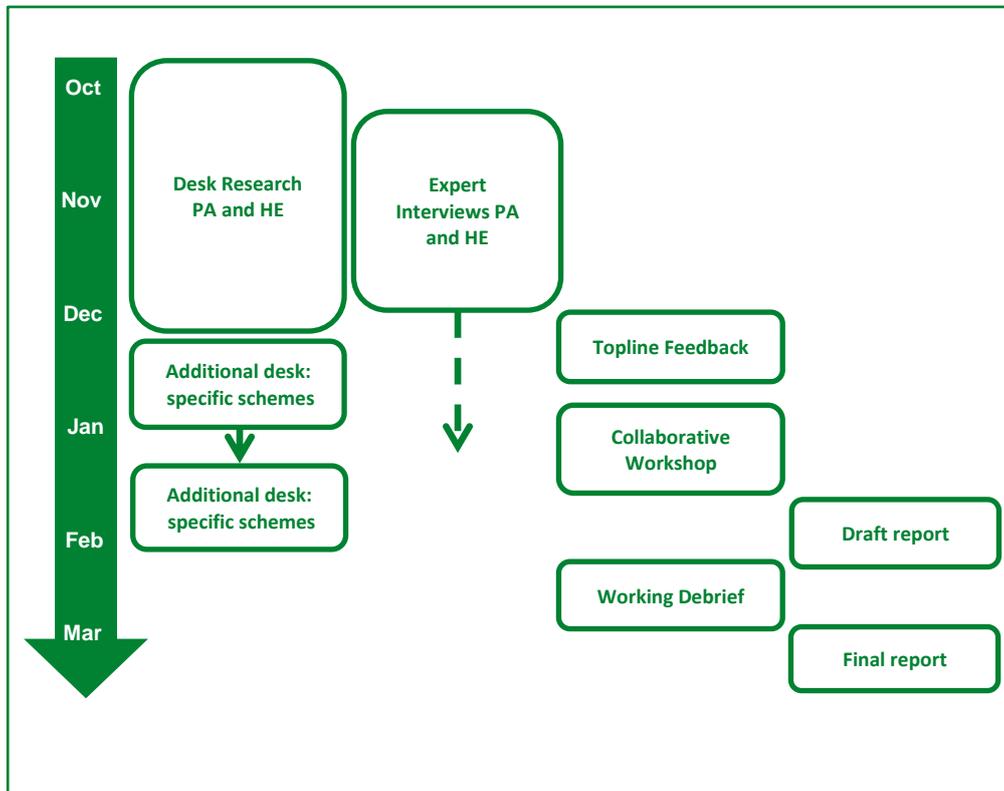
In order to fulfil the aim and objectives described above, the study involved a range of research tasks. 0 summarises this, showing that evidence was gathered through expert interviews / desk research and synthesised / developed through a collaborative workshop and working debrief. The study was conducted between October 2012 and March 2013. Specifically, the method was as follows:

- *Inception stage.* A meeting was held between DH and the research team to clarify and agree the purpose, aims, method and timing for the work. This was summarised in a workplan, which guided the remainder of the study;
- *Literature review.* Sources were gathered from DH, before database searches were performed and results extracted using a common template (see Annex 1 for a description of the search methodology). This process resulted in the identification of 327 initial sources, which were logged and provided as a separate output. These sources were then reviewed and a full analysis of the 161 most relevant was performed. The complete selection of sources cited for this review appears in Annex 4.
- *Expert interviews.* 24 interviews were undertaken, predominantly by telephone (see Annex 2 for list of interviewees). Initially, interviewees were selected purposively to offer coverage of HE and PA; snowball sampling was then used to uncover experts with specific knowledge of relevant interventions. Experts were also used as a source of grey literature for the literature review.
- *Supplementary desk research.* Where the literature / expert interviews highlighted specific interventions / tools, then supplementary searches were performed to provide more information (e.g. on examples of pedometer use and cost).
- *Collaborative workshop.* The resultant evidence and approach were presented and discussed at a half-day workshop, held at MEC (Change4Life's media planning agency) on 16th January 2013. The workshop was attended by 19 participants who were a mix of DH staff (policy, campaigns and analytical roles), academic experts, and media specialists – plus all five of the research team. A full list of is provided at Annex 3. Following presentations by the research team and discussions in plenary, creative work

¹ During the project, the team that commissioned the review transitioned to Public Health England (PHE).

in small groups produced intervention ideas and considerations. Further literature searches were then performed based on points raised during the workshop.

Figure 1.1 Workflow of tasks and timings in the PHE PA and HE Interventions Review 2012-13



Although straightforward in many respects, this brief presents several challenges:

- The evidence base for almost all health-related interventions is generally less comprehensive for children than adults and is often more available in non-British settings (mostly US and Canada);
- At least two behavioural domains are implied – PA and HE, each of which has several aspects such as level, weekly pattern, and context, and also incorporates numerous specific activity and eating behaviours, their determinants and consequences;
- Evaluated interventions are mostly school-centred;
- Evaluated interventions are mostly treatment-focused but note that what evidence is available shows that prevention interventions can also be effective;
- Even within the target group’s nine year age range, there are dramatic changes in the nature of PA and HE and the factors which influence them. Some consideration of developmental sociology, psychology and kinesiology is therefore essential.
- The research and publishing time lag for academic papers means that establishing reliability, validity, and effectiveness of interventions lags behind programme development. This is particularly the case where new technology such as web-instrument interfaces is concerned. Saying that a given technology is effective is thereby beset with on-going definitional challenges.

This review has been carefully constructed to take consideration of the available evidence. It also gives specific attention to the appropriateness of programmes for the motives and stages of development of children and their families. As required by the research brief, this involved synthesis of evidence from sources outside the formal literature. Our aim has been to generate grounded practical recommendations for ways forward. Hence expert interviews became a progressively more important element of our approach (we undertook nearly double the number anticipated).

The review combines practical guidance with more ‘formal’ evidence and case descriptions of effective interventions and ‘fact files’ on each of the tools mentioned. There is an emphasis in the formal literature review on identifying **robust, recent** and **innovative** tools and mechanisms – hence a willingness to include grey literature and information provided by expert interviews, alongside evidence from peer-reviewed literature. In summary:

- *The focus* is on **prevention**, not treatment. It is on evidence-based **interventions**, rather than the determinants of obesity. There is a general emphasis on new developments, especially those involving **‘tools’ or ‘kit’**;
- *PA and HE* are considered separately and together;
- *Geography*: the geographic focus was entirely on the developed world, and **predominantly UK-based**. Where robust studies of interventions were found in the USA, Australia, and the rest of Europe, these were included;
- *Types of publication*: the review looked to source a **wider variety of evidence** than just that provided by peer-reviewed academic papers. Grey literature, including evaluations, were important, as was less formal evidence such as presentations, policy positions, and studies that were not yet peer-reviewed or published;
- *Target audience and setting*: this was defined as **children aged 2-11, and their families**, although we were willing to source good ideas from beyond this age range. Likewise, the settings for interventions (i.e. the contexts in which they were delivered) was broad and unlimited;
- *Publication date*: the focus was predominantly on literature reviews post-2008 (due to an earlier review by A&D Research and Analysis, published by DH in 2009), and interventions post-2002. Again, this was somewhat flexible.

1.2 Structure of this report

The format of this report reflects the practical focus of our brief from what was then the Department of Health (DH) Planning Team (now within PHE): what works for preventing overweight and obesity among children aged 2 to 11 and their parents. The brief placed a particular focus on the potential role for ‘tools’ (such as pedometers / accelerometers) in interventions targeting these audiences.

The report is organised into the following sections:

2. **Understanding PA and HE Behaviours, and Audiences**: this section of the review focuses upon the two key behavioural domains that determine energy balance and consequently obesity: PA and HE. It provides an overview of the evidence base, in the context of children aged 2 to 11, and their parents.
3. **Key Features of Effective Interventions**: this section sets out principles of what works in obesity prevention for (and within) the 2-11 age range. It presents a synthesis of evidence on the key features of effective interventions, structured around the three dimensions of behavioural influences in individual, social and material contexts. The section concludes with a consideration of what the ‘active ingredients’ of interventions are likely to be, in order to draw out transferable insights for designing interventions.
4. **Case Study Interventions**: this section features nine case study interventions for obesity prevention in the UK and the US. The section concludes with an approximate ranking of the mechanisms at work in each of the interventions.
5. **Tools Fact Files**: this section features a set of ‘fact files’ on particular tools that can be used in obesity prevention interventions. The section concludes with a discussion of the attributes of selected tools appropriate for interventions with 2 to 11 year olds.
6. **Implications for intervention designers**: this final section of the review presents emerging implications for those designing interventions to encourage PA and HE among the under 12s. The implications include lessons derived from the case study interventions, practical tips for designers, and a set of potential future interventions – to show what interventions based on the recommendations from this review might look like.

1.3 Acknowledgements

This report has been drafted by Andrew Darnton (AD Research & Analysis), with Fraser Battye, David Scott and Holly Krelle (of ICF GHK). The authors are very grateful for expert input from Dr Ken Fox (University of Bristol) in the developing of this report.

The authors would also like to record their thanks to the expert academics and practitioners who fulfilled the roles of advisors and interviewees during this review [for a full list, see Annex 2]. Likewise, the authors acknowledge the energy and insights provided by DH colleagues and associated stakeholders throughout the study, and especially at the collaborative workshop [see Annex 3].

2. Understanding physical activity and healthy eating behaviours, and audiences

This Section brings together the evidence on the determinants of the main behaviours relating to obesity. It represents a logical starting point for this report, and for policy makers and practitioners working on obesity, as many of the determinants featured here contribute to the broader social and environmental context within which the obesity-related behaviours are undertaken.

Summary of key points

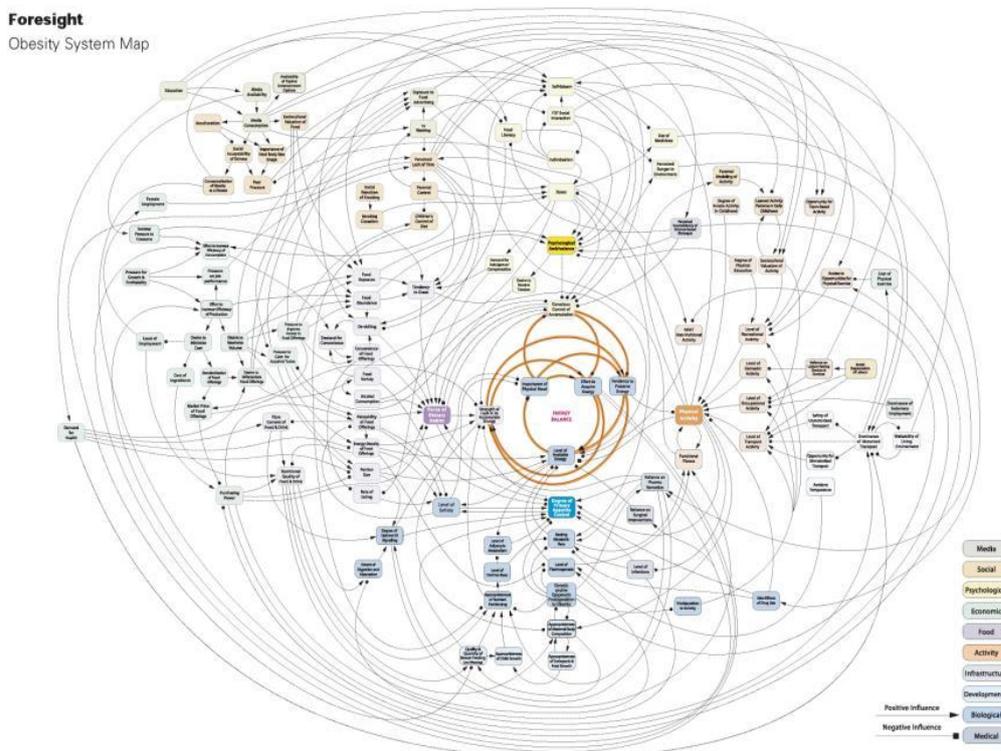
- Obesity is the outcome of a complex system of determinants, with multiple trajectories ('obesities'), involving multiple behaviours, based on interactions between multiple factors, and resistant to interventions.
- The ISM model arranges the principal factors influencing behaviour (as observed by a range of disciplines including economics, psychology, and sociology) into the three main contexts in which they are most commonly found – the Individual, Social and Material.
- Determinants of PA focuses upon moderate to vigorous PA, but the evidence also covers PA for leisure/recreation and PA for utility (i.e. active travel). It is also important to consider sedentary behaviour.
- Determinants of PA include: **Material:** built environment and transport infrastructure; car culture. **Social:** socio-demographics; family activity patterns; parenting; school; peers; media. **Individual:** habits; self-perceptions.
- The evidence on determinants of HE in children is generally more plentiful and comprehensive than that for PA.
- Determinants of HE include: **Material:** convenience food culture; food supply chains. **Social:** socio-demographics; family activity patterns; parenting; school; peers; media. **Individual:** habits; skills.
- **Target audiences** need to be defined tightly in order for practitioners to make headway in designing effective interventions.

2.1 The Challenge of Tackling Obesity

Preventing obesity is understood as a challenging objective. We are all familiar with the findings from the Foresight Tackling Obesities project (2007) which concluded that:

- As a society we are on an upward trend in the prevalence of obesity and overweight (albeit that the rate of increase among children and young people has since been revised downwards).
- Obesity is the outcome of a complex system of factors which determine weight. Preventing weight gain is extremely challenging because of the multiplicity of these factors (the Foresight map identifies 108 factors in four dimensions – food intake; PA; psychological factors; physiological factors – see Figure 2.1). Not only are these so numerous as to be extremely difficult to influence simultaneously, but they are also networked together into a system, which means that, as a whole, weight is resistant to change (if affected in one or several factors, the system adapts to maintain its inherent outcomes).

Figure 2.1 The Foresight Obesity System Map



In the face of these complexities it can be hard for policymakers and practitioners to know where best to concentrate their efforts. While extremely eloquent of the challenges in tackling obesity, the Foresight Map does not easily lend itself to devising tightly focused interventions. Instead it suggests that several synchronous strategies will be required to tip the balance of this complex system. As one of our expert interviewees commented: “*There is no silver bullet... we don’t even need shotgun pellets*”. This may be a source of frustration to policy makers who have to do their best when faced with the reality of restricted funds and short timescales.

When considering the growing magnitude of the obesity problem, it is important to consider three key points in relation to children – as noted in the Health Survey for England (NHS Information Centre, 2012):

- The first is that, in children, mean BMI varies by both gender and age. It is 0.3kg/m² higher among girls than boys aged 2-15 (18.6kg/m² and 18.3kg/m² respectively). BMI generally increases with age in both sexes, and older children were also more likely than younger children to be obese, or overweight.
- The second is that prevalence of obesity (but not mean BMI) varies by equivalised household income. In the lowest quintile of income, 25% of boys were overweight or obese, whereas in the highest three income quintiles the proportion was considerably lower (9%) (2011 HSE). For girls, those in the third and lowest income quintiles were more likely to be obese (22% and 19% respectively) than those in highest quintile (5%). A similar pattern is evident in respect to deprivation (as measured by the Index of Multiple Deprivation, IMD). In the most deprived quintile 29% of boys and 22% of girls aged 2-15 were obese. In the least deprived quintile the same figures were 11% and 10%. The same variation is true when looking at the proportion of children who were overweight (including obese), with prevalence in the most deprived quintile at 39% of boys and 36% of girls. Again the pattern is not evident for mean BMI measures.
- The third is that overweight and obesity prevalence among children varies by parental BMI status (NHS information Centre, 2012, based on HSE 2007). Obesity prevalence

rates among children were found to be higher in households where both natural parents or lone natural parent were classed as either overweight or obese. Nearly one quarter of boys aged 2-15 living in overweight/obese households were classed as obese compared with 11% in normal / underweight households. Equivalent figures for girls classed as obese were 21% and 10%.

Determinants of energy balance and obesity

PA and HE behaviours determine energy balance and consequently obesity. Pivotal to the Foresight model is a balancing loop (in fact two overlapping loops) which determines energy balance. The loop displays the process of feedback at play as energy is acquired (through eating) and expended (through biological function and PA). At its simplest weight gain is determined by the imbalance between energy in and energy out (which is termed 'positive' energy balance).

The balancing loop is naturally biased towards the accumulation of energy. It has been calculated that just a small positive balance will result in significant weight gain if sustained over a period of time.

Understanding determinants by 'individual', 'social' and 'material' contexts: the 'ISM Model'

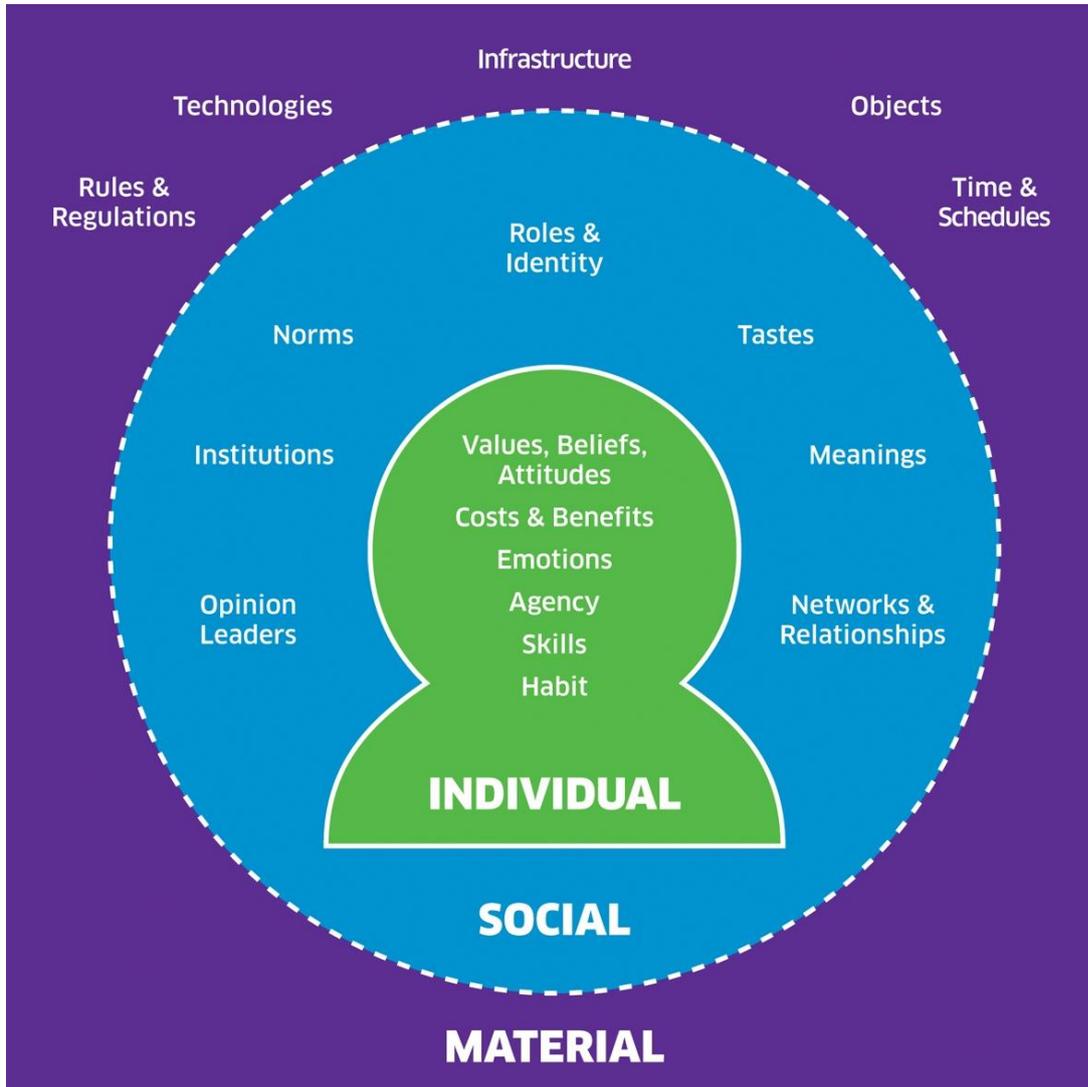
For the purposes of this Review we have drawn on a new model of the factors influencing behaviour (broadly, not just obesity related) developed by Andrew Darnton (of this research team) and David Evans of the Sustainable Consumption Institute at the University of Manchester (see Figure 2.2).

The ISM model arranges the principal factors influencing behaviour (as observed by a range of disciplines including economics, psychology, and sociology) into the three main contexts in which they are most commonly found – the Individual, Social and Material. As with many behavioural models, ISM can best be understood as a thinking device ("models are concepts for using our heads" – Triandis, 1977). In this case, ISM has already proven useful as a tool for devising potential policy interventions, and as an evaluative framework for classifying existing interventions. The central premise of work using the ISM Model is that interventions should target factors in all three contexts simultaneously if they are to result in lasting change. This is a conclusion in keeping with the implications of the Foresight Map, although the ecological approach here is broken down into three contexts or levels, whereas in the flat map of the Foresight report it is more difficult to find a formula for effective interventions.

We have used the ISM model in this Review accordingly: to help us analyse the evidence on existing interventions, and to help set the parameters for generating ideas for potential interventions (in the breakout groups of the collaborative workshop). ISM is also used in this section to arrange the evidence on determinants of obesity among the target audience of 2 to 11 year olds.

The overview of the determinants of obesity among 2 to 11 year olds is used to frame the practical guidance which follows in this report. Put simply, we need to understand the factors which are salient in determining PA and eating behaviours for the target audience in order to design effective interventions (within which, mechanisms and tools) to influence them, and thus help prevent overweight and obesity. As stated above, the overview of determinants is ordered according to the three contexts of Individual, Social and Material – see Figure 2.3:

Figure 2.2 The ISM model (Darnton & Evans, in Darnton & Horne 2013)



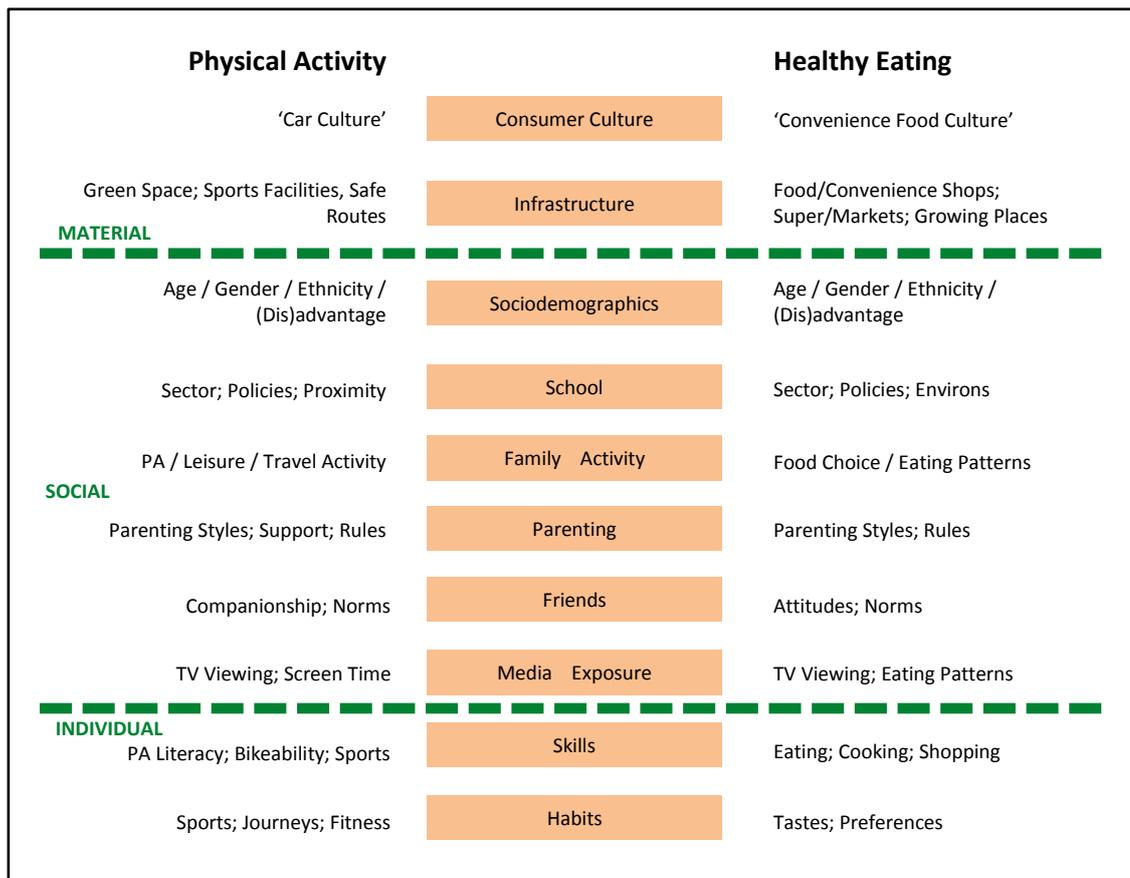
In keeping with the concept of energy balance at the centre of behavioural influences on obesity, the overview of determinants is split between factors applying to PA and factors applying to HE. This corresponds to the positive feedback loop at the heart of the Foresight model – which reinforces itself over time. Whatever the precise projections of prevalence predict, there is a sense in the literature of a worsening epidemic because the environment in which we live is becoming more obesogenic.

For example, Harry Rutter wrote in the *Lancet* in 2011: “Increasing fatness is the result of a normal response by normal people to an abnormal situation”.

This is also borne out in our expert interviews, in the context of both PA: “Opportunities to expend energy are being designed out of the environment” ...and HE: “The environment within which we live is jam-packed with calorie dense food. Food is everywhere and everyone can have it...compared to our society fifty years ago, the proliferation of food is a major change”.

Figure 2.3 shows how determinants are split between factors applying to PA and factors applying to HE:

Figure 2.3 The Determinants of PA and HE for 2 to 11 year olds



Before we discuss the influence of each determinant, some observations can be made about the Figure above:

1. There is considerable overlap between the determinants of PA and the determinants of HE.
2. PA and HE are not singular behaviours and are better conceptualised as complex sets of behaviours. Walking to school carries very different determinants and characteristics to playing for a football team, whilst eating snacks at school is different to family meals. It is therefore critical to define precisely, and target, the behaviours we wish to change through an intervention (“*If you want to change a behaviour, first specify that target behaviour*”).
3. Behaviours in the two domains of PA and HE may compete with each other, so that changing one might either negatively or positively influence another. For example, there is recent evidence (being prepared by one of our expert interviewees, Sara Kirk, working on the Speedy project) that when parents take their children to out-of-school sports or physical activities, those activities can then displace HE practices that evening. In other words, with limited leisure time, it is structured and HE events which suffer, while physical activities are scheduled in.
4. For children in this age group, the ISM framework indicates that social factors are the key determinants of PA and HE. The behaviour of young children is largely influenced by their parents through shared values, routines, and the home environment. For school-aged children, the routines and experiences at school become highly significant. Finally from around age 7 or 8, friendship groups become increasingly salient. This implies that mechanisms around parenting, schools and friendships may work as good targets.
5. Evidence for the relative influence of specific determinants in the 2 to 11 age range is patchy – indeed this entire overview is of great value, given that most summaries of the determinants of obesity relate only to adults, and are not child-specific. However, the variations in motives and influences on behaviour across this age range means special consideration needs to be given to the key determinants for distinct age groupings such as pre-schoolers, young children and older

children. Where possible, we have drawn in some of these variations in our summaries of the key determinants which follow.

Finally, policy makers and practitioners may like to refer back to this overview of determinants when designing their interventions. Interventions need to be set in a delivery context (e.g. a place such as home or school, and a time such as a weekday evening or in the holidays). If the delivery context can address some of the determinants, then it is likely the intervention would have ‘added value’, not just for the individual participants but also for wider society. For instance, walking to school interventions deliver regular PA through active travel, but they also counteract car culture – a key determinant of obesity in everyday life.

A summary table of the determinants overview follows here, observing the structure in Figure 2.3 above. Fully-referenced text describing the evidence on each determinant follows after the summary table.:

Table 1: Summary Overview of the Determinants of PA and HE for 2 to 11 year olds

PA	Consumer Culture	HE
	<p>Car Culture is central to consumer culture, and relates to our car dependency –for getting around, for consuming goods and services, and for our sense of identity. Under 12s rely on access to a car to pursue leisure PA, meanwhile car use is a barrier to ‘active travel’, eg. on the school run.</p>	<p>Consumer culture is associated with convenience, and in terms of food with ready meals and fast food – some of which is targeted at children, and which disproportionately appeals to lower income groups. Less time is spent preparing food from scratch, and eating events become more fragmented. All this is associated with increased weight.</p>
PA	Infrastructure	HE
	<p>Much work on obesogenic environments addressed the provision of green space and leisure amenities in local areas. While these are linked to higher PA for residents, there is evidence that some people increasingly drive to distant places in order to get their PA.</p>	<p>Food choice in large part depends on what is provided: hence availability, accessibility and affordability are all important dimensions. Supermarkets are particularly influential on food choice, given 75% of all food eaten in the UK comes from the ‘big four’ supermarkets. The most profitable lines in supermarkets tend to be processed foods, and high in fat sugar and salt.</p>
PA	Socio-Demographics	HE
	<p>Age is seen to have an important effect on levels of PA, which fall sharply from roughly the age of 9. Gender compounds this trend, such that levels of PA “<i>plummet</i>” among girls of secondary school age. Meanwhile car use is seen to be higher among higher social grades.</p>	<p>Like PA, levels of fruit and vegetable eating appear to decline after the move to secondary school. Lower social grades report even lower levels of eating 5 a Day than do less deprived groups. Affordability (and perceptions of cost) can be a barrier to healthy eating among those on low incomes.</p>
PA	School	HE
	<p>Schools are locations for organised sports and games, and equally important to PA, informal play. Survey data show that boys do more school sport and PE than girls. Both genders report less sedentary behaviour on school days</p>	<p>School food accounts for nearly half of children’s daily energy intake; this especially matters in association with reports that healthy foods are still relatively scarce in UK schools. As well as deciding what food is provided in</p>

than at weekends. The proximity of school to children's homes is a key determinant of active travel .	schools, schools influence children's food choices in all settings: through what they teach, and the influence of peers.	
PA	Family Activity	HE
Parents play both a gatekeeping and a modelling role in influencing their children's PA. When parents do more PA themselves, so do children; parents' play skills are also critical. Parents have a gatekeeping role regarding both walking to school and playing outside, and a chauffeur role in terms of driving children to PA and sports venues.	Parents appear to exert an even stronger influence on HE than PA (especially for under 12s), given they control what food comes into the house, and is served. Parental food skills and confidence are therefore critical. Children's fruit and veg intake also correlates with that of their parents. Finally, family eating patterns influence children's food intake: structured mealtimes are associated with healthier eating.	
PA	Parenting	HE
Parental beliefs, attitudes, perceptions and behaviours are related to children's levels of obesity. Meanwhile an 'authoritative' parenting style has been found to correlate with higher levels of children's PA. Finally, emerging evidence from an interviewee suggests that children do more PA in families who spend more time together.	'Authoritative feeding styles' by parents have been associated with greater fruit and vegetable availability, higher intake of fruit and vegetables, and lower intake of fast food among their children. Meanwhile it is widely reported that parents are unable to recognise obesity and overweight in their own children, which prevents them from taking remedial measures, and reduces the chance of them responding to child obesity prevention messages.	
PA	Friends	HE
'Peer pressure' has an important influence on children's behaviour, increasingly so in the secondary school age range. Children with 'active friends' do more PA than those without. There is also a companionship (as well as a norms) dimension to these patterns, especially among teen girls who often need a companion to do PA.	Peer pressure is important in food choices, but most often contributes to children eating unhealthy food . The influence of brands on children's food choices is particularly amplified by the influence of peer groups eg. in lunchbox contents.	
PA	Media Exposure	HE
TV viewing has been shown to be a risk factor for obesity; this is not simply because screen time displaces PA time, but also because of the content of what is viewed. A 2006 study found no significant association between hours of TV viewed and hours of physical activity undertaken.	Increasing hours of TV viewing is associated with decreasing fruit and/or vegetable consumption among children, on a dose-response basis. Meanwhile TV viewing is linked to less structured family eating patterns, as well as children snacking whilst watching TV.	
PA	Skills	HE
'PA Literacy' (in skills such as balancing, running, jumping, throwing and catching) is vital in enabling PA among children, and determining	The role of skills in HE is less obvious than in PA, but no less critical: for instance, knowing what foods are healthy and in what proportions	

<p>participation in PA in later life. Lack of confidence in PA skills is a commonly cited barrier to playing sports among adolescents and young adults. Finally, cycling offers an obvious example of how essential basic skills are to PA.</p>	<p>is instrumental in supporting everyday healthy choices. Meanwhile teaching children cooking skills can increase their familiarity with and confidence in handling fresh and healthy foods – especially if their parents lack these skills.</p>	
<p>PA</p>	<p style="text-align: center;">Habits</p>	<p>HE</p>
<p>Being a regular journey, the school run tends to be a habitual behaviour – having worked out our route, we then repeat it without much further consideration. Changing schools or moving house can provide a moment of disruption when routes need to be reconsidered. PA more broadly is also linked to habits: the more it is done, the easier it becomes (by accumulating 'fitness'). The reverse is also true; asking less fit people to make small increases in PA may be most feasible for them.</p>	<p>Food preferences are both formed by habits, and habit forming. Exposure to a food has been shown to increase our preference for it. This is the 'familiarity effect' which is particularly apparent in children. Interventions which enable children and their parents to try unfamiliar and healthy foods are likely to be effective: simply tasting a food makes it more likely to be liked the next time.</p>	

2.2 Determinants of Physical Activity

This brief review of the determinants of physical activity (and that on healthy eating which follows) builds on a 2009 review by Andrew Darnton, revised mainly in the light of two recent reviews (Craggs et al. 2011; Uijtdewilligen et al. 2011). This review of the published evidence is supplemented by (anonimised) verbatims taken from the expert interviews (see Annex 2)

The focus of this review on the determinants of physical activity is upon moderate to vigorous PA, but the evidence also covers PA for leisure/recreation and PA for utility (i.e. active travel). However it is also important to consider sedentary behaviour (Uijtdewilligen et al. 2011). Katzmarzyk (2010) argues that biological, social, and environmental pathways leading to sedentary behaviour versus PA may be different. However, it should be noted that Uijtdewilligen et al. (2011) found insufficient evidence for the identification of determinants of sedentary behaviour in children and adolescents. The two most frequently studied types of sedentary behaviour in children were TV viewing and gaming. In adolescents, research mainly focused on sedentary behaviour in general.

Overall, evidence on determinants of PA is more plentiful and robust. Yet sedentary behaviour should not be neglected. The burgeoning research on sedentary behaviour suggests that this also has an important influence on preventing obesity alongside moderate-to-vigorous PA (although time spent in *vigorous* PA is reported by Steele et al. (2009) to be more strongly associated with adiposity than sedentary time).

Research and health interventions have tended to focus upon the role of moderate-to-vigorous PA in the prevention and management of obesity. However, non-exercise activity thermogenesis (NEAT) (those activities of daily living other than exercise per se, which encompass such things as sitting, standing, walking, and fidgeting) also result in higher levels of energy expenditure beyond the supine resting metabolic rate. Human movement patterns below the intensity thresholds of moderate or vigorous activity may play a significant role in the maintenance of energy balance. Given this, and also that sedentary behaviour has an independent effect on health outcomes, interventions that act on the determinants of sedentary behaviour may well be just as important as those that act on PA, especially given the trend towards less active lifestyles, including a shift away from manual occupations, the proliferation of labour-saving devices, and the expansion of media channels and in-home entertainment (e.g. Sturm, 2008; Fox & Hillsdon, 2007).

The NHS Information Centre (2012) reports on HSE 2008 data and shows that among both boys and girls there was a relationship between sedentary time and BMI category. For boys, on weekdays, the proportion who spent four or more hours doing sedentary activities was 35% for those who were not

overweight or obese. The equivalent figure for those classed as overweight was 44%; 47% of those classed as obese. For girls, a similar pattern was found; 37%, 43% and 51% respectively.

The review now considers the evidence on determinants of PA arranged according to their material, social and individual contexts in turn.

Material

Built environment and transport infrastructure

Craggs et al. (2011) finds that very few studies have investigated the effects of environmental factors on PA in children. Uijtdewilligen et al. (2011) also suggest that few studies have focused on environmental determinants of PA and sedentary behaviour.

The conclusion reached in the review for Foresight on 'Obesogenic Environments' was that "the environment does influence levels of PA and obesity..." but "that any influences of the environment are small...and that the exact environmental components that affect body weight and activity are yet to be identified." (Jones et al. 2007: p 38). In a short review, Fox and Hillsdon also conclude that associations between the environment and PA are "relatively weak" (Fox & Hillsdon, 2007), and stress that the direction of causality cannot be specified (it could be that active people choose to live in environments which support PA).

However, the characteristics of an area or neighbourhood could be influential, especially access to green space. The greenery of local neighbourhoods and other aesthetic considerations have been shown to correlate with levels of PA (Fox & Hillsdon, 2007). A number of expert views underline the importance for children's PA of simply being outdoors – whether that is a paved/road-based environment or a green space.

Jones et al. (2009) report (from the SPEEDY study) that children who spent more time outside the home were more active. Children tended to be active close to home, with 63% of all bouts of continuous PA occurring inside neighbourhoods.

Convenience is often strongly linked to proximity, either to leisure facilities and green spaces, or to travel destinations. A US study found that the number of leisure facilities in an area correlated with higher levels of PA (Gordon-Larsen et al. 2006, in Hillsdon et al. 2007). Environmental factors and proximity to places may be particularly important in respect to the opportunities for active travel (cycling and walking) (Panter et al. 2008).

In a study based on personal interviews, accelerometer recordings, global positioning systems (GPS), Geographical Information Systems (GIS) and site-based characterisation of local environments, Hillsdon et al. (2012) found that for most people, around half of all PA takes place approximately 1 kilometre from home, although there are marked variations by location and personal characteristics. This supports other work that finds weak correlations between the environmental characteristics of the area around the home and levels of objectively measured PA. The study also suggests that associations between PA and the environment appear to be specific to both the type of PA being undertaken and the environment in which it takes place.

The extent that a neighbourhood is walkable is also significant. The Foresight report states that people in highly walkable neighbourhoods are more physically active and have slightly lower body weights than those in less walkable areas (Foresight, 2007). However, the effect again depends on whether 'walkability' is considered in terms of people's own perception or objective measures.

Attitudes to personal safety are also potentially important influencers on levels of walking and cycling, although the evidence is complex and still being researched. The perception of safe routes for walking and cycling is reported to be associated with walking and cycling (see e.g. Panter et al. 2008). 'Walkability' based on perceptions can be more predictive of behavioural outcomes than objective measures (see Jones et al. 2007). 'Hard' measures of walkability (and bikeability) show mixed results in terms of their impact on active travel; for example, interventions involving footpaths and cycle paths show varying outcomes (see e.g. Panter et al. 2008).

Finally, cost of leisure can be a barrier to PA. It is a composite factor incorporating actual price levels, access to income, preferences, and perceptions of value for money.

Car culture

'Car Culture' expresses the way in which modern lifestyles are shaped by car ownership (which is now the norm). Car use is associated with convenience (linking in to 'consumer culture'). The car in this context is the quintessential labour saving device, and our relationship with it is based on co-dependency, to a point where we are locked in to car use. As Ivan Illich wrote in 1974: "Motorised vehicles create new distances which they alone can shrink."

Along with new technologies, the rise of 'car culture' is seen as central to sedentary trends (see e.g. Davies et al. 2007); for instance, risks of obesity rise in proportion to the amount of time spent in a car per day (see e.g. Fox and Hillsdon, 2007). In the context of the school run, parents drive children to school largely due to the time pressure of other schedules, and also through a perception that their children are safer in the car than walking – this in turn makes walking to school less safe for all.

Traffic-congested streets are also less safe (and critically are perceived to be so by parents) for children to be allowed to 'play out' in – thus removing a longstanding opportunity for children to achieve PA through active play. For recreational PA and organised sports, children often depend on their parents as 'chauffeurs' to drive them to sports venues: thus relying on a parent as gatekeeper, and on the parental car in order to undertake PA.

Social

Socio-demographics

For children aged nine years and younger, studies show that for girls decline in PA over time is greater than for boys (Craggs, et al. 2011). For older children and adolescents no consistent results were evident for the association between PA and gender. Maturation may be an important factor in age-related declines in PA. Differentials in individual maturity may directly or indirectly explain inter-individual differences in PA decline. Our expert interviewees were clear that among girls especially, levels of PA "plummet" after the transition to secondary school (age 12 and upwards: getting teen girls to undertake PA "is a total nightmare").

Uijtdewilligen et al. (2011) found a significant positive relationship between age and adolescent PA (the older the participants, the higher their PA level).

Younger children are less likely to be sedentary for long periods of time. The NHS Information Centre (2012) reports on data indicating that on weekdays little variation was found among younger children, with fewer than 10% of those aged two to nine years being sedentary for six or more hours per day, a particularly high level. The percentage rose steeply after this age.

In respect to socio-demographic groups, a Department for Transport commissioned segmentation model of transport choices based on survey data (Thornton et al. 2011), suggests that higher income groups tend to travel by car more often and travel more miles a year by car than lower income groups.

In respect to ethnicity (nine to ten year olds), McMinn et al. (2011) found that family and home factors that are significantly associated with children's PA were mostly consistent between different ethnic groups.

School

Provision of school-based sport and PE can be an important factor in determining PA amongst children. In regard to curriculum time spent on PE, across Years 1-13, 55% of all pupils participated in at least three hours of PE and out of hours school sport in 2009/10. This has increased by five percentage points from the 2008/09 survey. The figure is higher for just Years 1 – 11 (57% in 2009/10, an increase of six percentage points from 2008/09). There is a notable drop in participation levels by age group. Participation levels are highest in Years 4 – 6, and also reasonably high in Years 1 - 3 and Years 7 – 8. They reach 40% at secondary phase and then decline significantly in Years 12 and 13, to just 23% and 21% respectively.

The DfE Sport and PE Survey 2009/10 (Quick et al. 2010) shows differences in PE and school sport participation levels between girls and boys. Boys (58%) are more likely than girls (52%) to take part in

at least three hours of PE and school sport. There are small differences in participation levels between girls and boys in Years 1-7, but after Year 7 the gap grows bigger.

School may be an important factor in reducing the level of sedentary behaviour in children. At weekends, the proportion that were sedentary for six or more hours generally increased across all age groups (NHS Information Centre, 2012). The school day is important and weekends may be less active for children probably because the schedule of the school day is missing. There are also differences in weekday evening and weekend PA, with reports that some parents are happy for their children not to do PA after school, assuming (rightly or wrongly) they have been tired out by PA at school. After-school is a key time, with potential for meaningful amounts of PA among under 12s.

Family Activity Patterns

A study by Page et al. (2009) found that independent mobility (for 10-11 year olds) appears to be an important independent correlate of weekday PA for both boys and girls. Children who reported being allowed to visit destinations unsupervised locally and in the wider neighbourhood had higher levels of weekday PA compared to those who reported lower levels of independent mobility. There was not an overall significant association between independent mobility and weekend PA, perhaps because the majority of 10-11 year olds get their PA at weekends 'locally', or they are supervised by parents at weekends (perhaps travelling by car). PA and factors such as independent mobility are likely to be influenced by the neighbourhood characteristics and safety perceptions of that neighbourhood. However, the authors note that little is known about the level of independent mobility in young people.

Parental permission is required for children to walk or cycle to school, and the extent to which they play out unattended, while the fact that parents are needed to 'chauffeur' children to recreational sports events has already been mentioned. As an expert interviewee commented: *"Like HE it's about gatekeeping: do parents make time to take their children to clubs and sports?"*.

Another study (McMinn et al. 2012), in respect to 9-10 year olds, found that after-school moderate-to-vigorous PA (MVPA) was associated with being allowed to play out in the neighbourhood, restrictions on walking/cycling to friends' houses, restrictions on sedentary behaviour, and family social support. Weekend MVPA was associated with number of siblings, family encouragement and family social support.

Parental perceptions of safety have also been shown to be a strong determinant of children's levels of PA, particularly in relation to active travel. For instance, children of parents classified as having 'lower concerns' about local safety are reported to be more than five times as likely to walk or cycle to school (Kerr, 2006 in Panter et al. 2008). A more conceptual argument is that parental concerns about neighbourhood safety result in children being made to spend more leisure time indoors (e.g. COI, 2008), although meta-analyses have not been able to substantiate this link (see e.g. Panter et al. 2008).

There is strong evidence associating the activity levels of parents with those of children. HSE 2008 data compiled by the NHS Information Centre (2012) shows a relationship between children's and their parents' PA levels. More boys aged 2 to 10 met the PA recommendations for children if their parents also did so for adults. Likewise, more were in the low activity category if their parents were also in this group. For girls, parental activity made relatively little difference to the proportion meeting recommendations, but those who had parents with low activity levels were considerably more likely to be in the low activity category themselves.

Play is also clearly important, and family dynamics are key to that. Having siblings seems to correlate with more PA. Likewise parents' play skills (and time spent playing with their children) are seen as an important influence on how much PA a child takes and the physical skills they develop. An expert advisor commented: *"With under 5s in particular, a lot of our work would suggest that parents have lost the art of playing with their children"*.

Parenting

Several studies have identified parental variables that may modify risk factors for obesity by promoting PA and/or reducing sedentary behaviours in families of children aged two to six years (Skouteris et al. 2010). These include parents' cognitions and beliefs, parents' PA behaviours, and parenting styles. Parents can set patterns of behaviour for children and influence the availability of opportunities.

These variables are important in the pre-school years because the evidence is that parental beliefs, attitudes, perceptions and behaviours contribute to children's obesity (Skouteris et al. 2010).

The Lifecourse Tracker Survey (Williams et al. 2012) found that the intentions of parents of 2-11 year olds to increase their child's PA were strong, particularly amongst those reporting that their child does less than an hour's activity a day. Seventy per cent said they limit the amount of time their child spends watching TV/DVDs, or playing on the computer. There was little variation in reported behaviour by social grade or child's age. Intentions to increase PA were greater than intentions to improve their diet:

- 36% of parents said they intended to improve their child's diet over the next three months.
- 43% said they intended to get their child to be more active over the next three months (this rose to 56% amongst those who said their child spent under an hour being physically active yesterday, compared with 32% of children who were physically active for an hour or more).
- However, it should be noted here that parental intentions do not always lead to a change in behaviour, of either the child or the parent.

Basic knowledge of what sorts and how much PA are recommended may also be an issue. According to one expert interviewee: "*There's the problem of knowledge of what they should do, but there's also the question of how much [PA] they should be doing...and breaking this down for them, giving them examples and making it easier*".

Peers

Social norms are important because perceptions of what 'important others' are likely to think of a behaviour are seen as a major determinant of behavioural outcomes in social psychological models. Peer pressure is usually at its strongest among adolescents.

There is limited empirical evidence on the impact of social norms on activity, although qualitative work for Sport England with teenage girls shows that 'active girls' reported having sporty peer groups, while 'inactive girls' had inactive friends (TSA, 2006). Indirect modelling was also observed, with active girls reporting sports women as role models, which were lacking for the less active girls.

Jago et al. (2011c) examined the extent to which the PA modelling and PA actions of best friends are associated with the PA of 10 to 11 year olds. It was found that boys who have active friends spend more minutes in MVPA. Girls who frequently take part in PA with their best friend obtain higher levels of PA. For both boys and girls, taking part in PA with their best friend at home or in the local neighbourhood results in higher levels of PA overall.

PA is often seen as an opportunity for socialising, and several studies report that having a companion to take part with is a key driver of PA. In the Sport England study with teenagers, active girls stressed the value of their sporty friends. Companionship for young people also influences active travel; having friends nearby has been shown to increase the likelihood of walking or cycling (see Panter et al. 2008).

Media

While TV viewing has been shown to be a risk factor for obesity, the effect persists even when PA is removed from the equation, so the thesis that screen time displaces PA time, while valid, appears only part of the story (Livingstone, 2006).

A 2006 study featuring objective measures of activity found no significant association between hours of TV viewed and hours of PA undertaken (Ekelund et al. 2006 in Jebb et al. 2007). However, screen-time contributes to overall sedentary behaviours which have negative health impacts.

New technologies are associated with sedentary behaviours. Technological developments reduce the need for physical effort. For children, this is particularly important in relation to the amount of 'screen time' linked to home entertainment.

Individual

Skills

There is substantial practical and theoretical evidence based on the importance of physical skills or 'PA Literacy' in enabling PA among children, and determining participation in PA in later life (see e.g. Whitehead ed. 2010). The assumed mechanisms here are that basic PA skills (such as balancing, running, jumping, throwing and catching) are needed to play sports and games, and that having (or lacking) these skills impacts on young people's physical confidence. This in turn, influences the degree to which youngsters seek out or avoid opportunities where they perceive these skills to be required (in particular, adolescent girls' participation in sport).

According to an expert interview, a well-evidenced link can be traced from perceptions of physical competencies in primary school, to playing organised sports in secondary, which then predict levels of PA in adulthood. A specific example of how PA skills enable or prohibit adult PA is obviously available in terms of cycling (hence the long tradition of cycle proficiency and 'Bikeability' training in primary schools).

Habits

Children with relatively high levels of BMI are more likely to have sedentary habits. Uijtdewilligen et al. (2011) found strong evidence for a positive association between BMI and child sedentary behaviour. This is important because physical (in)activity and sedentary behaviours 'track' from childhood into adulthood. This means that children who are currently inactive and sedentary persist in such behaviours as they grow older.

Uijtdewilligen et al. (2011) also report moderate evidence for a significant positive relationship between planning and past PA, respectively, and PA in adolescents. Also, for children aged 10-13 studies show that previous PA is consistently positively associated with change in PA (Craggs et al. 2011).

Motivational factors are important in determining whether we exercise. The Foresight Map highlights the psychological construct of 'ambivalence', which describes how, for most people, exercise is not as appealing as eating. There is also evidence that people fall into habits of exercising (or not) in early adulthood and their perceptions are set from then on (e.g. Foster et al. 2005).

Recreational PA is also a habit, not just in terms of how it is scheduled in (consider e.g. regular commitments to after-school or weekend sports clubs) but also because exercise builds fitness (in another physiological feedback loop). A lack of fitness then prevents people from taking PA; as one expert interviewee commented: "*it's circular – obesity itself is a barrier to children do more PA: you can't just say to someone 'get on your bike and cycle all the way to school' They won't make it!*". This in turn is a good argument for getting people to undertake changes in PA in 'small steps' and setting children targets in moving up levels, rather than trying to reach the CMO's recommended amounts of MVPA in one go.

There is substantial evidence in travel research showing that journey patterns (especially for everyday journeys) tend to be habitual – having worked out our route, we then repeat it without much further consideration. This is very true of the school run (and the daily commutes it is often associated with); changing schools or moving house can provide a moment of disruption when the routes need to be reconsidered (e.g. Verplanken et al 2008).

Self-perception

Uijtdewilligen et al. (2011) find moderate evidence for a significant positive relationship between intention and PA in children.

For children aged 10-13 studies show that self-efficacy is consistently positively associated with change in PA (Craggs et al. 2011). For those aged 14 and over, higher perceived behavioural control and self-efficacy were consistently associated with smaller declines in PA. An individual's perceptions of their own level of sporting competence have been found to be a strong predictor of participation in sport, especially among adults. Research has shown that 70% of the variance in levels of sports participation can be predicted by asking people about their own levels of sporting ability (see Fox & Hillsdon, 2007).

The related dimension of confidence in one's own ability appears as a prominent barrier to girls' participation in sport and exercise (see e.g. TSA, 2006).

Perceived benefits of PA may also have an important influence on levels of participation; qualitative evidence suggests that the perceived benefits of activity for young people relate to personal appearance (and attractiveness to potential partners – see e.g. Foster et al. 2005; TSA, 2006).

Identity (or 'self-concept' as it can be labelled in social psychological theory) appears to be a key determinant of participation in PA. Numerous surveys (e.g. Allied Dunbar Fitness Survey in 1992) have found the public identifying 'I'm not a sporty person' as one of the top barriers to doing more sport or exercise (see e.g. Fox & Hillsdon, 2007).

One important aspect to consider in respect to the individual is the extent to which they recognise that they may be overweight or obese. Children (aged 8-15) do not have an accurate perception of their own weight (NHS Information Centre, 2012). While 60% of boys and 53% of girls thought that they were about the right weight, 30% of these respondents were actually overweight or obese (14% obese and 15% overweight). Also, 40% of obese children judged that they were about the right weight. A significant proportion of children aged 8-15 reported that they were trying to change their weight (35% of girls and 25% of boys). However, 28% of children who were obese, and 55% of children who were overweight, were not trying to change their weight.

2.3 Determinants of Healthy Eating

Evidence on determinants of HE in children is generally more plentiful and comprehensive than that for PA. That said, data is limited by the fact that eating behaviours are typically self-reported and therefore liable to endemic under-reporting. The different components in a 'healthy diet' (as outlined below) can each have a modest impact on weight, but more significant impacts may be achieved by multiple changes leading to a broad dietary shift (Jebb, 2005).

Material

Convenience food culture

The food industry, the government and the media have a direct impact on individuals' food choices, as well as having a more indirect influence via wider social norms and the 'obesogenic culture' (Lang & Rayner, 2007). 'Consumer culture' is to some extent contributing to the trend towards increased prevalence of obesity (Rayner, 2008). At the same time, our traditional 'food culture' is reported to be in decline as measured by time spent cooking.

In the context of consumer culture, it is possible to observe an ongoing trend towards convenience foods, with less cooking from scratch and more purchasing of ready meals, involving less forward planning and less preparation (Wardle, 2007). As with car culture, time use is a key dimension of consumer culture (see eg. Southerton 2006). However ready meals also appeal to lower income groups – often as a substitute 'treat' for those who cannot afford to eat out. According to the most recent sector report, the UK market for 'prepared meals' was worth £3.8 billion in 2012, and was forecast to grow by 28% by 2017 (Mintel 2013). As a kind of processed food, ready meals tend to have less nutritional value, and higher fat sugar and salt content (see eg. Howard et al 2012).

Consumer culture also drives (and is driven by) the preponderance of fast food outlets, which are notoriously associated with obesity (Schlosser, 2001). Lang and Rayner (2007) give the example of how energy-dense food and drink have become a source of entertainment, implying a sort of category shift from 'food culture' to 'consumer culture'.

Food supply

The impact of food supply on diet is long established: the conceptual distinction between availability (the supply of healthy food in an area), accessibility (the ability of local people to visit those food outlets) and affordability (the ability of local people to pay the prices asked for healthy food) is recognised across the evidence base (e.g. Foresight 2007, Dowler et al. 2007).

Children are more likely to eat foods that are available and easily accessible (Patrick and Nicklas, 2005). Rasmussen et al. (2006) report evidence for a positive association between child-reported home availability of fruit and vegetables and children's intake of fruit and vegetables.

Routine exposure to food shapes preferences and consumption. This depends upon parents because they are often responsible for making foods available to children and adolescents. It also more widely depends upon access to healthier foods. When foods are easily accessible and ready to be eaten, children are more likely to eat them. In this way the greater availability of energy dense foods is a factor in unhealthy eating.

Davies et al. (2010) report studies that readily available and easily accessible healthy foods within the home are likely to improve diet among youth and families. In particular, home availability is one of the strongest correlates of fruit and vegetable intake among adolescents. Home availability is mediated by parental social support for HE, family meals, and household food security.

The evidence on food availability in the local environment around the home can be contradictory. For example, fast food outlets have been shown to be clustered in areas of economic disadvantage, but at the level of individuals, proximity to a fast food outlet does not significantly increase the likelihood of eating fast food (Jones et al 2007). Car dependency can partly explain these findings.

An estimated 75% of all food eaten in the UK comes from the 'big four' supermarkets (Cabinet Office, 2008) - in turn requiring people to drive to shop. Supermarkets are more likely to promote processed foods, and those high in fat sugar and salt, than they are fresh ingredients – as processed foods are the most profitable (e.g. Dowler et al. 2007). Cheaper foods tend to be more energy dense and higher in fat, added sugar and salt (see e.g. Foresight, 2007). In a recent BMJ study, ready meals were found to be high in protein and fat (including saturated fat), and low in carbohydrates; only 4% met the WHO guidelines on salt (Howard et al 2012).

Portion size is important because children also tend to eat greater quantities when larger portions are provided (Patrick and Nicklas, 2005). There is a trend for larger portions to be provided in restaurants and take-away outlets. Patrick and Nicklas report on a study where a positive linear relationship was found between larger portions and intake by children aged four to six years. More broadly, Wansink et al. (2009) argue that other material influences are important for the volume of food consumed; for example factors such as package size, plate shape, lighting, and variety – as well as the social influence of the presence of others.

Social

Socio-demographics

There is substantial evidence that fruit and vegetable consumption decreases with increasing age (Rasmussen et al. 2006). However, this may be more related to the frequency of eating rather than the amount. Decreasing intake of fruit and vegetables with increasing age of children and adolescents seems to be more related to European societies than to the US.

A systematic review (Rasmussen et al. 2006) found that lower socio-economic status is associated with low, or less frequent, intake of fruit and vegetables, especially when considering family income, parental occupation, and parental education. Patrick and Nicklas (2005) also report that parental education is positively correlated with health consciousness in food choices.

Cost is reported in many surveys to be the main factor determining food choice (see e.g. Buttriss et al. 2004). Meanwhile, perceptions of high cost are reported to be a barrier to HE, especially for those on lower incomes (Jebb et al. 2007). It is noted that those on lower incomes are less able to experiment with different foods, as they cannot afford for the food to be deemed inedible. Experimentation is central to building children's familiarity with, and thus preference for, new foods, which in turn increases the diversity of dietary intake, a key element in HE (see e.g. Wardle, 2003 in Jebb et al. 2007). Low income also correlates with high ready meal consumption (see eg. Mintel 2013), for reasons including less potential for risk taking in what food is served to the family, and as a more affordable substitute for eating out.

Patrick and Nicklas (2005) report that longer working hours and family work-life structures mean that less time is available for food preparation and therefore an increased reliance upon convenience foods is more likely.

A UK study reported that children in lower socioeconomic groups had significantly lower daily intakes of many micronutrients, a higher percentage of energy from fat, and a tendency to consume more full fat milk and receive a greater proportion of energy and nutrients from snacks than children in higher socioeconomic groups (Ruxton et al. 1996, cited in Patrick and Nicklas, 2005). Similarly, Williams et al (2012) found that children living in the most deprived areas are less likely to eat 5 a day (17%) than those in the less deprived areas (24%), though levels of consumption in less deprived areas are still low.

Ethnicity and culture also play a role in respect to the types of foods served and methods of preparation (Patrick and Nicklas, 2005).

School

The supply of food within the school environment is clearly an important determinate of dietary intake. In a review of reviews, Davies et al. (2010) report a substantial level of evidence about the lack of availability of healthy foods in schools and in some local communities. The evidence is also clear that having a wider availability of healthier foods in schools, lowering their price, and making changes to the school meals service can result in increased fruit and vegetable consumption and reduced intake of saturated fat and salt. HE may be encouraged by school-based breakfast and lunch programs (Patrick and Nicklas, 2005). Meal programmes are more positively associated with fruit and vegetable intake, as opposed to paid-for meals.

However, the likelihood of children making healthy food choices is reduced when vending options (which tend to contain snack foods high in fat, salt and sugar) and 'a la carte' are available (Patrick and Nicklas, 2005; Rasmussen, et al. 2006). Work in the US has recognised the school related 'food environment' determinants of excessive weight gain in people who are 2–21 years old, and this has led to the development of a number of Community-based Childhood Obesity Prevention Environmental Nutrition Interventions (CCOPENIs) (Mayer, 2009).

The school environment is also important in respect to teachers and peers being a source of information/support for HE. This has sometimes been found lacking (Shepherd et al. 2002, cited in Davies et al. 2010). Also, teachers, in the same way as parents, act as role models.

Family activity patterns

Family structure is a factor in that children's fruit and vegetable consumption is lower among children from single-parent families relative to among children from two-parent families (Rasmussen et al. 2006). However, there is no association with family size.

Mealtime structure is an important factor related to children's eating patterns (Patrick and Nicklas, 2005). Mealtime structure includes the social and physical characteristics of mealtimes including whether families eat together. Whether a family eats together can have effects on food consumption patterns. Accompanied children are likely to consume more healthy foods and nutrients, eat more servings of the basic food groups. Rasmussen et al. (2006) found evidence for a positive relationship between shared family meals and children's consumption of fruit and/or vegetables.

Other family eating patterns may also be important, for example, the extent to which snacking (or 'grazing') takes place, the source of foods (e.g. eating out). The impact of these patterns on energy consumption is not clear-cut, but they may be associated with a higher intake of food high in fat, salt and sugar.

Parenting

Several studies have identified parental variables that may modify risk factors for obesity by promoting HE in families of children aged 2–6 years (Skouteris et al. 2010). These variables are important in the pre-school years because the evidence is that parental beliefs, attitudes, perceptions and behaviours contribute to children's obesity (Skouteris et al. 2010).

Parents play a direct role in children's eating patterns through their behaviours and attitudes (Patrick and Nicklas, 2005). Children's food preferences and consumption are related to those of their parents. This may be because parents have food in the home that they like, and this then becomes readily available to children. Parents' food-related knowledge is also important as their beliefs about which foods are healthy is related to children's intake. Similarities between parents' and children's food acceptance and preferences, intake, and willingness to try new foods is also established through the role parents play in modelling eating patterns and behaviour to children. In particular, studies have shown that children's intake of fruit and vegetables is positively related to parents' intake of fruit and vegetables. Fruit and vegetable consumption may also be related to parental support for eating fruit and vegetables/HE (Rasmussen et al. 2006). This was also found in many qualitative studies (Krolner et al. 2011).

If parents are unfamiliar with buying and cooking healthy food, this can present a substantial barrier; as parents on lower incomes can also not afford to serve up unfamiliar foods which run the risk of being rejected. An interviewee suggested that: *"Parental lack of confidence and lack of money are key barriers to children trying unfamiliar healthy foods. And among parents of the youngest children there's parental nervousness about trying new foods"*.

Parents act as 'gatekeepers', for instance setting the rules of a household and deciding what food is bought and served. While this dynamic affects both PA and HE, in the opinion of some expert interviewees, gatekeeping exerts a stronger influence over HE: *"Much of kids' diet is out of their control: it's the parents who decide what they eat. In PA it's a part of it, but we found that even young children were making choices about how to play"*.

Parents also play a direct role in children's eating patterns through their feeding styles, representing the caregiver's approach to maintain or modify children's behaviours. Work by Birch and Fisher (cited in Patrick and Nicklas, 2005) identified three child-feeding patterns:

- authoritarian, where eating is restricted or forced;
- permissive, where the child can eat according to their own desire;
- authoritative, where HE is encouraged alongside the offer of choices about eating options.

Feeding styles have been associated with both dietary intake and weight status. Authoritarian feeding can mean children become less sensitive to physiological cues of satiety and fixate on 'forbidden foods'. Permissive feeding can lead to lower consumption of all nutrients except fat. Authoritative feeding has been associated with greater fruit and vegetable availability, higher intake of fruit and vegetables, and lower intake of fast food. Rasmussen et al. (2006) similarly finds that the evidence clearly points to higher fruit and vegetable intake being associated with authoritative parenting styles.

Brown et al (2008) also highlight the widespread use of parental control practices (e.g. the extent to which overt or covert control is exercised over children's food intake) in relation to children's behaviour. Associations were found between parental control practices and aspects of the child's diet, in particular the potentially positive effects of covert control.

The Lifecourse Tracker Survey (2012) (Williams et al. 2012) supports the evidence that children's (2-11) nutritional behaviours are closely correlated with those of their parents. If a parent was not eating 5 a day, in nine out of ten cases the child was not either. Similar patterns were evident in relation to all measured food types. However, the survey showed that children were more likely than their parents to be eating high calorie/sugary foods daily and slightly less likely to be eating sufficient fruit and vegetables.

There were limits found in the survey to parents' intention to improve the diet of their children. Parents whose child eats high calorie/sugary foods regularly were less likely to intend to improve their child's diet than those who reported other negative eating habits for their child. The proportions of parents who said they intended to get their child to eat a healthier diet over the next three months were:

- 59% of those whose child does not eat fruit/veg every day;
- 47% of those whose child eats fatty foods (note small base, n=35) and/or drinks sugary soft drinks (note small base, n=43) more than four days a week;
- 36% of those whose child eats sugary foods more than four days a week.

Nearly four fifths (79%) of parents of children aged 2-11 disagreed that 'as long as a child is a healthy weight, parents needn't worry about what the child eats'. The same proportion (80%) reported that their child ate fewer than five portions of fruit and vegetables yesterday.

Peers

Children and adolescents are influenced by what their peers eat (Patrick and Nicklas, 2005). Observation of peers' eating behaviour can alter attitudes and intake of previously disliked food. The role of peer groups may be more significant in adolescents than younger children.

Studies have found that peer influence is very strong in terms of choice of branded foods, and in particular in determining schoolchildren's lunchbox contents (Stead et al. 2008).

Peer-related factors are less well investigated in quantitative studies (Rasmussen et al. 2006) relative to qualitative studies (Krolner et al. 2011). This evidence suggests peer pressure contributes to children eating unhealthy food. One study found that peers only influence fruit and vegetable consumption among 10-11-year-olds indirectly through promoting higher intake of unhealthy competitive food choices. In older age-groups (9-18) children have reported negative comments or being bullied if they brought healthy lunchboxes to school or ate fruit and vegetables in school.

Media

TV viewing is linked to children's food consumption patterns (Patrick and Nicklas, 2005). TV viewing has been shown to be a risk factor for obesity (Foresight, 2007). Hours of TV viewed in childhood correlate with obesity rates, and also increase the likelihood of obesity in adulthood. Rasmussen et al (2006) also find evidence that increasing hours of TV watching is associated with decreasing fruit and/or vegetable consumption. There is a dose-response effect in relation to TV viewing, with the increase in likelihood of adult obesity being proportionate to hours viewed in childhood.

Where TV viewing is part of the eating experience there is a likelihood of less fruit and vegetables and more convenience and high in fat, salt or sugar foods being eaten (Patrick and Nicklas, 2005). This may be related to TV food advertising. Food products that are most intensely advertised tend to be over-consumed. Food advertising provides prominent cues to buy and eat foods, and much of this food advertising is for foods high in fat, salt or sugar (see e.g. Jebb et al 2007).

In evidence from the US, it is reported that US children and adolescents have increasingly been targeted with food marketing and advertising (Davies et al. 2010). Davies et al. (2010) cite a study by the Kaiser Family Foundation on TV food advertising to children where it was found that children ages 8-12 see the most food ads on TV, an average of 21 ads per day or more than 7600 per year. Most were for sugary snacks, sugary cereals and fast food; none were for fruit and vegetables. Food marketing to children now extends to the internet, mobile phones, and video games.

Individual factors

Habits

For children, food preferences strongly determine food intake. Food preference and acceptance patterns develop early in life (Patrick and Nicklas, 2005). Food preferences developed during infancy remain relatively stable and are reflected in food choices made later in life.

Exposure to food is key to developing preferences and repeated exposure can overcome dislike of foods (Wardle, 2007). Thus "*The child brings a set of predispositions to early feeding interactions - a preference for sweet and salty tastes, a tendency to reject bitter and sour tastes, and a neophobic rejection of novel foods and flavours*" (Birch and Anzman 2010). Children who are reluctant to try new foods generally have lower intakes of fruit and vegetables. This is the 'familiarity effect' which is particularly apparent in children. This is a clear example of how habits are formed through repetition of rewarding behaviours; habitual behaviours are notably hard to disrupt. It fits with the model, whereby food preferences can be understood to be developed from i) exposure (past experience); ii) conditioning and cues iii) modelling (i.e. copying the preferences of others).

Skills

While the skills literature in HE among children is smaller than that on PA, children's skills and knowledge are still vital here. For instance, knowing what foods are healthy and in what proportions is instrumental in reaching recommended levels of intake, and in supporting everyday healthy choices.

Nutritional knowledge is positively associated with fruit and/or vegetable intake (Rasmussen et al. 2006). As noted in the section above on parenting, parents' knowledge and skills related to nutrition and cooking are important.

Building children's cooking know-how can help build confidence for cooking in later life, and help them acquire familiarity with fresh ingredients (as well as providing a fun experience). Conversely, there is a large literature on parents' food skills (or lack of), and many initiatives to build those skills (see e.g. Jamie's Ministry of Food). There are opportunities to help children and parents practise such skills together, and so play on the social dynamics in cooking and eating which are so influential (see e.g. Watt et al. 2012).

2.4 Understanding Audiences

One of the main findings to come out of the collaborative workshop held with DH staff, media and communications colleagues, and a selection of our expert interviewees was that the target audience needs to be well defined. The previous section reviewed the evidence on the determinants of physical activity and healthy eating behaviours, in relation to the audience of children aged 2 to 11. This section responds to the evidence that the factors and influences on those behaviours vary widely across the age range. For that reason this section looks at generic differences across the under 12 audience, according to their developmental stage. This evidence in turn has key implications for what interventions, tools and mechanisms are likely to work best, at which ages. This section addresses the primary audience of children under 12 first, then makes some salient points about parents which have arisen during the course of the review.

Children aged 2 to 11

Where interventions are aimed at changing the behaviours of children, then it is especially vital that any intervention tools are appropriate for the age or stage of development of the children in the target group. Developmental stage is in itself complex; in the child development literature it has been addressed from physical, intellectual, social and moral perspectives. Each of these perspectives suggests that children pass through a sequence of stages as they become more complex and mature organisms. Of significance here is that mechanisms of change, and the agency or source of motivation for that change, are different across these stages. What might work as an intervention for 2-6 year olds (and the ways in which the intervention might be delivered) would clearly be different to that for 9-11 year olds. Anyone who has worked with children is familiar with many of these differences.

Age is a strong determinant of stage but there is a wide range of rates of advancement between children so that even within age groups there are differences in the ways children operate and respond. In addition, progress through the stages is gradual such that it is hard to rule exactly when a child passes from one to another. Therefore grouping children by age is flawed - but at the same time the only practical means of getting a fix on some of the changes that we might expect.

Table 2 shows a raw attempt to demonstrate some of these differences with a view to supporting intervention design. It is derived from a synthesis of the academic literature on child development (e.g. Piaget, Nicholls, Kohlberg), plus comments from the expert interviewees and the workshop participants. It also draws upon best practice guidance from media and communications companies, grounded in market research with children under 12.

This table is a late addition to the outputs from the Review. Indeed, defining the audience was not a specific objective within the research brief, and this task was added by the research team in response to comments at the collaborative workshop. As such the table should be treated as an early attempt to capture some of the key variations in the under 12 audience. While the table is intended to support practical intervention design, given its exploratory nature we would recommend that more time were spent in bringing together defined age bands and their relevant characteristics for use by the intervention designers. Additional evidence should also be brought in to validate and extend the material here, especially that relating to lifestyle and media preferences. (This recommendation is made in detail in the final Section of this report.)

Table 2: Defined stages of development in the 2 to 11 audience of children

Age group	Main social agency	Child thinking	PA/HE Skills	Lifestyle	Cross-cutting approaches	PA approaches	HE approaches
Pre school 2-4 years	Family (90%)	Concrete thinking (here and now). Egocentric.	<i>PA:</i> Walking, jumping, climbing.	Open and honest. Dependent and properly childlike.	Fun and simple instant feedback	Skills practising, especially in social groups/ with family.	Increasing exposure to healthy foods, especially in social settings (ie. families).
Early primary 5-8 years	Family (70%) and school (30%)	Concrete thinking (here and now). Egocentric. Some social perspective-taking. Strategies include rewards and avoiding punishment.	<i>PA:</i> Same plus catching, throwing, kicking, dancing. <i>HE (by age nine, children should...):</i> be aware of some healthy foods and portion sizes (e.g. 5 a Day); know that food can be bought, or grown at home; understand people have different preferences; be aware of food labels; make some healthy recipes (with help); be aware of food safety procedures.	Boys and girls play more separately. Both like electronic games, but boys more (girls more chat). Boys increasingly competitive.	Fun and more complex instant feedback such as finishing first or scoring	Basic games playing – including points and rewards – plus active travel with parents.	Engage parents, and reconfigure home environment, including availability of healthy foods, but also children modelling parents' behaviour in this age range.
Late primary 9-11 years	Family (50%), school (30% and friendships (20%)	Concrete, plus the start of abstract and logical, thinking. Here and now still important but	<i>PA:</i> Same plus small sided games of football, dance, rules and tactics. <i>HE (by age nine,</i>	Increasing sense of self concept, and a rapidly growing world (much via media). Develop a liking for	Fun, doing well, beating others, completing tasks, feeling competent	Introduce competitive elements and teamwork (including in informal PA	Work via friendship networks (peers now toppling parental influence). Begin to link (body) image to

Age group	Main social agency	Child thinking	PA/HE Skills	Lifestyle	Cross-cutting approaches	PA approaches	HE approaches
		more socially aware. Pleasing others (parents and teachers). Status among friends.	<i>children should...</i>): be aware of a balanced diet and the need to eat different food groups; help shop and cook (inc. cost considerations); be aware how food advertising works; make use of food labels; demonstrate a range of food handling skills inc. preparing and storing; minimise food waste; demonstrate food safety behaviours.	what's 'in'. Girls vs Boys.		opportunities). Mobilise power of the peer group (eg. for girls' PA).	healthy eating.

Parents

A number of key points about parents' influence have been made in the Section above on Behaviours. It may be worth reiterating them briefly here, along with other insights gathered during the review.

- The gatekeeping role of parents is critical in this age range, although it begins to diminish somewhat with children aged nine and upwards. According to interviewees the gatekeeping role is, and remains, particularly strong in HE, although organised PA also depends in part on parental transport/time commitment.
- There may also be a class gradient at play here. We know that parents with lower incomes have less leeway to 'experiment' with unfamiliar healthy foods. It may also be the case that parents who work irregular hours, or do lots of part-time hours, are less available to drive their children to out of school PA sessions.
- While parents have a gatekeeping function for their children, they also have the potential to act as a first line of diagnosis for all kinds of health prevention. However, there is extensive evidence to show that parents tend to be very poor at recognising when their own children may be overweight or obese. For instance, one expert commented: *"Our social norm has been reset: it is now the norm to be overweight...people are less able to identify what a healthy weight person looks like...that's particularly strong with young people"*. There is also evidence that parents, when they are alerted to possible weight issues in their children, can often respond with denial, or outright resentment. Not only does this present problems to practitioners working face to face with children and families, but it potentially means that more remote communications targeting parents of overweight or obese children are likely to bounce off their target audience.
- At the same time as these general points about parental inability to diagnose overweight, there is specific evidence that parents' ability to be objective about their children's levels of HE and PA is also unreliable. For instance, one expert commented: *"80% of parents overestimate their children's levels of PA"*. While this is a problem for targeting parents with communications, it does suggest that interventions which involve an element of monitoring and feedback (e.g. using a pedometer or a food diary) could be very valuable. On the other hand, these tendencies mitigate against appropriate goal setting by parents on behalf of their children.
- Finally, in this context it is worth noting that qualitative research for Change4Life has emphasised that parents are more concerned by their children's overall happiness than they are about physical issues like weight. One interviewee described the finding that *"parents were more interested in their children being happy, fitting in, having friends and being satisfied with their lives, ahead of nutritional or physical activity outcomes"*.

3. Key Features of Effective Interventions

This section sets out principles of what works in obesity prevention for (and within) the 2-11 age range. It is a narrative synthesis of the evidence on the key features of effective interventions, structured around the three contexts of the individual, the social and the material. This section discusses specific governmental interventions where relevant, but the discussion is oriented towards elucidating key insights about the general approaches that have been demonstrated to be effective in obesity prevention and the promotion of PA and HE behaviours. The section therefore draws on a number of recent systematic reviews.

It should be noted that the available evidence base provides plentiful data on aspects of the delivery of interventions, and in particular the setting of the intervention, but it was found to be somewhat lacking in respect to the active ingredients of interventions that were found to bring about change. As will be seen, in attempting to identify the effective ‘mechanisms’ of interventions, we therefore draw on evidence that suggests a key role for behaviour change techniques (BCTs) in explaining intervention effectiveness.

Summary of key points

- Discussion of key features of interventions is informed by a conceptual framework which distinguishes context, intervention, mechanism and tool. It is important to consider mechanisms because these are the element(s) of the intervention that lead to the observed outcome. Subsequent sections discuss intervention packages and tools.
- The evidence points to key approaches and strategies that have been proven to be effective, but specific activating content is not well explained. For example, a major Cochrane review (Waters et al. 2011) was not able to substantiate which components of interventions were most effective.
- Systematic reviews are clear that obesity prevention interventions for children have been effective in reducing adiposity. Individualised interventions can also be effective on a range of different HE and PA behaviour change outcomes. However, behaviour change impact is less clear than impact upon adiposity, partly due to the range of outcome measures that interventions target.
- Some interventions have attempted to address a range of macro-level ‘environmental’ factors as part of the intervention. Individual changes are more likely to be sustained if the environment facilitates and supports options perceived to be both healthy and rewarding.
- Several studies have identified parental variables that may modify risk factors for obesity by promoting HE and/or PA and/or reducing sedentary behaviours.
- Evidence of success is strong in school settings. Curriculum based interventions are effective, but may not be sufficient alone, especially as they are likely to take a relatively small amount of a child’s time.
- Family-based interventions may be more likely to be effective if they are set in the home and include self-monitoring (using pedometers) and goal setting for specific lifestyle changes.
- The emphasis in the literature is on delivery contexts. What is missing is clarity over the ‘active ingredients’ of interventions, i.e. the change techniques which underpin their impact on PA and HE behaviours. Behaviour change techniques (BCTs) are a specific set of mechanisms found in interventions targeting change among individuals. BCTs are a key ingredient in successful PA and HE interventions.

3.1 Conceptual Framework

Before setting out the evidence on interventions, it is necessary to explain how these distinct elements fit within a broader conceptual framework.

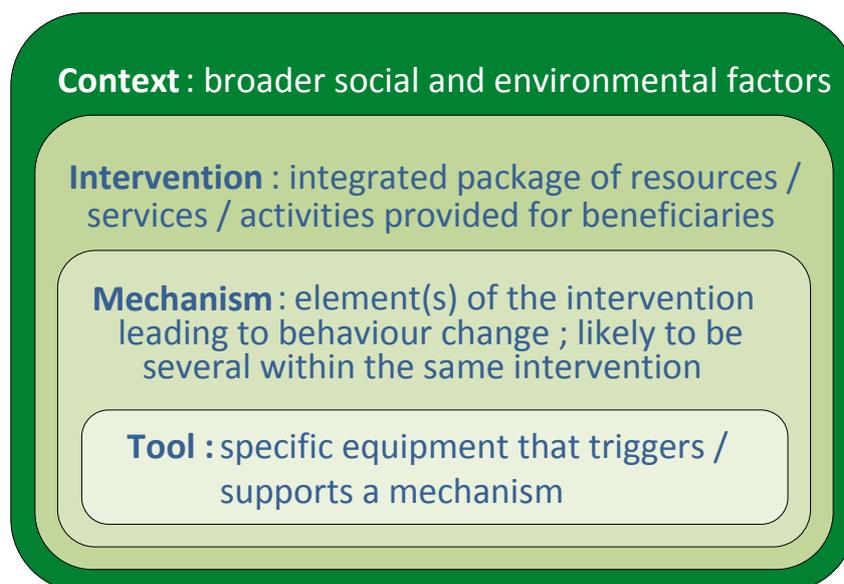
As noted in the introduction, one of the objectives of the study was to unpick effective interventions: to go beyond recommending the replication of ‘interventions x / y / z’ and to examine what it was about these interventions that seemed to lead to observed changes in behaviour.

In order to address this, the study team developed the conceptual framework illustrated in Figure 3.1 below. This framework, which draws substantively on the methodological work of Ray Pawson and others, examines causal relationships below the level of the intervention. It was formulated at the outset of the study, refined during the literature review and expert interviews and tested at the collaborative workshop.

We have developed the conceptual framework specifically for the purposes of this study. It has been used throughout the study, for instance to structure the evidence on determinants, and to enable analysis of effective interventions and the supporting guidance on 'what works'. Figure 3.1 below shows the four different dimensions of change which make up the conceptual framework:

- **Context:** this recognises that policy interventions do not take place in a vacuum; that the broader environment (e.g. economic, social, political, environmental factors) influences an intervention's formulation, design, implementation and effectiveness. The inclusion of context again highlights the need for interventions to be part of a multi-level systemic approach to tackling obesity.
- **Intervention:** seen here as a coordinated package of activities / services / resources provided to the beneficiary (the target for behaviour change). Interventions would include programmes such as MEND, VERB, Games4Life, etc. Causation is essentially tested through the impact of the intervention on key outcomes such as Body Mass Index reduction (ideally through an RCT). Yet, for the purposes of this study it was important that we probed deeper into the available evidence, such that a causal argument could be made at the level of the 'active ingredients' within an intervention (rather than at the surface level, e.g. that 'intervention X worked...').
- **Mechanism:** it is important that interventions are based on plausible mechanisms of change. Mechanisms were defined as the element(s) of the intervention that lead to the observed outcome – in this case behaviour change. There is strong overlap with the concept of 'Behaviour Change Techniques' developed by Abraham and Michie, discussed later. Mechanisms include change techniques and influences at the level of the individual such as goal setting, self-monitoring, rewards, etc.;
- **Tool:** a specific piece of equipment – such as an accelerometer, ball or recipe book. Mechanisms offer a way of examining how and why specific tools can stimulate or act as a practical vehicle for change, while not treating the tool itself as the causal agent. This approach allowed our review to provide examples of tools / kit / equipment that promote behaviour change, while not claiming that 'tool x will lead to effects y and z'.

Figure 3.1 Conceptual Framework



3.2 Evidence on general approaches and the influence of context

The key task of this review is to understand what works in obesity prevention and behaviour change for children aged 2-11 and their parents. However, there is a paucity of evidence on the mechanisms within interventions that are responsible for bringing about change. The evidence points to key approaches and strategies that have been proven to be effective, but specific activating content is not well explained.

For example, a major Cochrane review (Waters et al. 2011) of interventions for preventing obesity in children was not able to substantiate which components of interventions were most effective. However, they point to several promising approaches:

- a school curriculum that includes HE, PA and body image;
- increased sessions for PA and the development of fundamental movement skills throughout the school week;
- improvements in nutritional quality of the food supply in schools environments and cultural practices that support children eating healthier foods and being active throughout each day;
- support for teachers and other staff to implement health promotion strategies and activities (e.g. professional development, capacity building activities); and,
- parental support and home activities that encourage children to be more active, eat more nutritious foods and spend less time in screen based activities.

It is notable that the Cochrane review (ibid.) found that differentials in effectiveness of intervention could not be well explained by type of intervention (PA; dietary; PA and dietary combined), setting of intervention (education only; education plus other; non-education), or duration of intervention (more than 12 months; less than 12 months).

This is partly because studies of interventions are often experimental in design (e.g. randomised control trials). They are strong on attributing causation to a particular intervention but typically weaker on explaining how or why the intervention worked.

Notwithstanding a lack of transparency over which 'active ingredients' in an intervention are responsible for its effects, systematic reviews are clear that obesity prevention interventions for children have been effective in reducing adiposity. Most notably, a recent Cochrane review (Waters et al. 2011) of interventions for preventing obesity in children suggests that there is a strong body of evidence that interventions can be effective.

The interventions reviewed by Waters et al. (2011) cover educational, behavioural and health promotion interventions. A total of 55 controlled trials (randomised and non-randomised) were reviewed (6 of which were in the UK, 12 were in EU Member States, and 26 were in the US). The vast majority (39) involved interventions that targeted children 6-12 years old; 8 targeted 0-5, and 8 targeted 13-18 years. Also, most of the interventions (41) were implemented for 12 months or less; seven for one to two years, and seven more than two years. By far the most common setting for interventions was schools (43 studies). Other interventions were (or included) home-based (14 studies), community-based (six studies), or were set in a health service (two studies) or care setting (two studies).

The meta-analysis of 37 studies by Waters et al. (n = 27,946 children) revealed that the intervention group of children had a standardised mean difference in adiposity from pre- to post-intervention (measured as BMI or z BMI) of -0.15kg/m² (95% confidence level (CI): -0.21 to -0.09) by relative to the change in the control group.

Individualised interventions can also be effective on a range of different HE and PA behaviour change outcomes. However, behaviour change impact is less clear than impact upon adiposity, partly due to the range of outcome measures that interventions target. Measures for dietary change include nutrition knowledge, eating practices, food preparation practices, fruit and vegetable consumption, consumption of energy dense snack foods, intake of sweetened/carbonated drinks, intake of sweet foods, and intake of fat. For PA, indicators were self-efficacy, cardiovascular fitness, levels of PA, time spent in organised PA, and sedentary behaviour.

There is some suggestion in the evidence that PA and HE interventions may work better separately. Kriemler et al. (2010) and Atkin et al. (2011) argue that for behaviour change impacts, targeting PA alone may be more effective alone than in combination with diet or as part of obesity prevention programmes.

However, a HE component is important for adiposity reduction. In respect to adiposity reduction there may be limits to how effective PA interventions can be in isolation. An RCT study (165 overweight/obese 5.5 to 9.9-year-old children) of three different intervention types (dietary-modification program, PA skill development program, and a combination of the two) each involving a weekly two-hour face-to-face session for 10 weeks, homework activities, and a three-month relapse prevention program, found that that diet and activity programs in combination was not more efficacious than the activity and diet programs in isolation (Oakley et al. 2010). The dietary component resulted in approximately twice as great a reduction in BMI z-score, compared with the activity program in isolation. This is likely because weight loss was most effective when a parent-centred dietary component was combined with the PA skills development program for children. Dietary changes were targeted at parents who were the key agents of change.

The principles of effective interventions can be analysed in respect to the material, social and individual contexts which they are delivered in, and the factors within those contexts which they are targeting.

Material Context

Some interventions have attempted to address a range of macro-level 'environmental' factors as part of the intervention. Individual changes are more likely to be sustained if the environment facilitates and supports options perceived to be both healthy and rewarding (de Silva-Sanigorski, 2011). NICE guidance (2009) on promoting PA, active play and sport for pre-school and school-age children and young people in family, pre-school, school and community settings points to the importance of this and sets out several layers of action for stakeholders:

- national policy;
- high level policy and strategy;
- local strategic planning;
- local organisations: planning, delivery and training;
- local practitioner delivery.

This includes priority themes to 1) promote the benefits of PA and encourage participation, 2) ensure that high-level strategic policy planning for children and young people supports the PA agenda, 3) the planning and provision of spaces, facilities and opportunities, 4) the need for a skilled workforce, and 5) promoting physically active and sustainable travel.

EPODE is an intervention notable for its comprehensive approach to reducing childhood obesity. First launched in 2004 in ten French pilot communities, EPODE has since expanded to more than 500 communities worldwide (see Borys et al. 2012; Borys et al. 2011; Whitt-Glover & Kumanyika, 2009). The aim is to influence local environments, childhood settings and family norms to facilitate the adoption of healthy lifestyles in children (i.e. the enjoyment of HE, active play and recreation). Using social marketing, a Central Coordination Team (CCT) trains and coaches local project managers, whose role is to mobilise a wide diversity of local stakeholders - in schools, pre-schools, extracurricular organisations and social networks of associations.

Work in the US has recognised the 'food environment' determinants of excessive weight gain in people who are 2–21 years old, and this has led to the development of a number of Community-based Childhood Obesity Prevention Environmental Nutrition Interventions (CCOPENIs) (Mayer, 2009). These interventions attempt to alter the obesogenic behaviours at a population level. At the physical level, this may include the reduction of competitive foods in school (foods that compete with school-meals), increasing fruit and vegetables, low-fat dinners and non-caloric beverages in school cafeterias and vending machines, planting a garden, and initiating farmers markets in target communities. At the community level, interventions may decrease the cost of healthy foods through increased consumption in community outlets, community food coupons, and community food programs. At the political level CCOPENIs may involve implementing local school food policies that limit high-calorie soft drinks in community institutions and regulating the type of meals served in schools.

School regulations that prohibit less healthy food products can have negative consequences in that children may compensate for the lack of access to banned foods by buying more foods high in fat, salt or sugar (Jaime and Lock, 2009, cited in Davies, et al. 2010). Instead, school polices should encompass the wide range of in-school and out-of-school sources of food, rather than just focus on one type of food in school.

School policies that promote active travel to school can be effective. Daly-Smith et al. (2011) showed the value of additional days of children’s active commuting for meeting a criterion of 300+ minutes of moderate-to-vigorous PA (MVPA; 60+ mins/day x 5) during the school week. Every day of active commuting doubled the chances of meeting the MVPA criterion. In older girls active commuting is particularly effective.

Social Context

Parents

Several studies have identified parental variables that may modify risk factors for obesity by promoting HE and/or PA and/or reducing sedentary behaviours in families of children aged two to six years old (Skouteris et al. 2010). These can be summarised as shown in table below:

Parent cognitions and beliefs	Parental behaviours	General parenting
Nutrition and health knowledge	Parental eating – food preferences, food selection, food availability, regulation of energy intake and dieting	Parenting styles (e.g., authoritarian, authoritative, permissive)
Perceived child’s and own weight status	Parental PA	Parenting self-efficacy
Social norms around feeding and activity behaviours	Child feeding practices – restriction, monitoring, pressure to eat, using food as a reward, perceived responsibility, covert & overt control, provision of healthful foods	
	Meal-time practices (e.g., structured eating, eating at a table)	

These variables are important in the pre-school years because the evidence is that parental beliefs, attitudes, perceptions and behaviours contribute to children’s obesity (Skouteris et al. 2010). However, understanding of parental/family factors in the obesogenic environment is still rudimentary, and the effect of interventions on parental variables has also been less clear. A 2010 evidence review assessed the effect of interventions to change parent variables and found an overall positive impact on obesity prevention, although they add caution due to limitations of studies. In particular, the impact of parental role modelling and parent nutritional knowledge has yet to be determined due to limited methodologies. Changes in meal-time practices (e.g. structured eating, eating at a table, not watching television) have not been demonstrated to have any significant effect on child obesity. Evidence is more conclusive on the negative effect of restrictive feeding practices.

Parents as an agent of change may be particularly important in respect to the dietary behaviours of children. Family-based approaches may therefore be more effective in respect to this domain. This is perhaps to be expected given that determinants of HE are strongly linked to parents and family activity patterns.

Brown et al. (2008) highlight the widespread use of parental control practices (e.g. the extent to which overt or covert control is exercised over children’s food intake) in relation to children’s behaviour. However, they found no relationship between control practices and child BMI. However, associations were found between parental control practices and aspects of the child’s diet, in particular the potentially positive effects of covert control. Also important, different groups of parents use different

control practices, depending on age, whether they are a stay at home parent, and their education, which points to the influence of structural factors such as time and support.

There is some evidence that weight loss interventions for children may be more effective when a parent-centred dietary component is combined with the PA measures for children (Oakley et al. 2010).

As regards PA, parents can strongly influence children's PA behaviours through role-modelling and direct involvement. In respect to parenting style, Jago et al. (2011a), found that 'maternal permissive' parenting is associated with higher levels of PA than 'authoritative parenting', but associations differed by child gender and type of PA. 'Maternal logistic support' was associated with girls' PA, while 'paternal logistic support' was associated with boys' PA. There is also an association between parenting styles and children's television viewing (Jago et al. 2011c). A greater proportion of children with 'permissive mothers' watched more than four hours of TV per day, compared with children with 'authoritarian' or 'authoritative' mothers. The risk of watching more than four hours of TV per day was 3.3 times higher for children from low-restriction families.

However, a systematic review of 14 studies found no clear pattern to identify which family involvement methods resulted in PA behaviour change (O'Connor, 2009). This is largely due to heterogeneity of study design, study quality, and outcome measures used. Some messages of effective practice were identified. There was value in face-to-face interactions and/or telephone contact with parents that provide parent training, family counselling, or preventive messages. Contacting families via organised activities was also effective in engaging families. Sending material home to families in the form of newsletters or homework did not appear to be effective. Family participatory exercise programs were also not seen to be effective.

It is also important to consider that parents do not have an accurate perception of overweight and obesity in children (aged 4-15) and this varies according to the age of their child (HSE, 2011). Parents of children aged 11-15 were more likely to think their child was too heavy (13% for boys and 16% for girls) than parents of children aged 4-10 (4% for boys and 6% for girls). Overall, in 24% of cases where parents thought their child was about the right weight, the child was in fact overweight or obese. And 47% of parents with obese 4-15 year old children thought that their child was about the right weight. The comparable figure for parents with overweight children was 84%.

The same is true for identification of PA levels. Bentley et al. (2012), from in-depth telephone interviews with 32 parents of six to eight year old children, suggest that most parents described their child as being active or very active and indicated that they did not perceive a need for an increase in their child's PA. This matters because parental support for PA facilitates children participating in PA. Corder et al. (2010), in an assessment of awareness of PA levels among British school children aged nine to ten years old, found that most parents of inactive children wrongly consider their children to be sufficiently active; parents of children with a lower fat mass index appear to assume that their children are adequately active.

Setting

Waters et al. (2011) do not consider that setting of intervention offers a significant explanation for differentials in effectiveness of interventions. However, they suggest that for 0-5 year olds home-based or health care settings may be particularly beneficial. For 6-12 year olds education settings are more likely to be effective than multiple settings and non-education settings. The same was true for 13-18 year olds.

Early years

It has been argued (e.g. Birch & Ventura, 2009) that, given the limited success of school based interventions (in the US context) that interventions targeted towards very young children could usefully incorporate early years settings. However, evidence suggests that early years educational settings have limited effectiveness as intervention settings.

Hesketh & Campbell (2009) reviewed 23 studies of interventions targeted at 0-5 year olds and delivered through a variety of settings (preschool/childcare, home, group, primary care, and mixed settings). Approximately two-thirds involved multifaceted interventions and most were conducted in preschool/childcare (n = 9) or home settings (n = 8). Many in the preschool/childcare setting showed no

evidence of effect on behaviours that contribute to obesity. Many of these had a focus on increasing PA. One possible reason for lack of success could be that most of the pre-school/childcare-based interventions lacked a parental component.

Monasta et al. (2011) similarly conducted a review of seven different RCTs (four in preschool settings, one with an exclusive educational component, two with an exclusive PA component and one with both) and found that none of the interventions had an effect in preventing overweight and obesity. In some cases, small effects were observed in variables such as dietary and/or PA/sedentary behaviours, but overall behaviour change was limited.

There are some examples of successful interventions for 0-5 year olds in early years settings. The Australian Romp and Chomp intervention has been shown to reduce obesity in 0-5 year olds by improving dietary patterns through community capacity building in early years settings (de Silva-Sanigorski et al. 2011). The Romp and Chomp intervention focuses upon capacity building and skills development within the childcare environment, especially targeting care workers and health professionals. Activities involved promotional materials such as posters and postcards, media coverage, awareness raising and demonstrations with parents, health professionals and early childhood workers, and presentations at community forums and child care settings.

Romp and Chomp was successful in creating more health-promoting early years environments. A quasi-experimental questionnaire-based investigation of the intervention (n = 28; comparison group = 223) showed that children spent less time in screen-based activities and there were more rules related to HE. There were also more care provider practices that supported children's positive meal experiences, including: fewer unhealthy food items allowed; a higher chance of staff being trained in nutrition and PA; and a lower chance of having set minimum times for outside and organised active play, and of rewarding children with food. However, while HE improved, there was no improvement in the level of organised active play and free inside play. At the same time though, children spent less time in sedentary activities.

An earlier paper from the same team (de Groot et al. 2010) focused on Romp and Chomp's capacity building among organisations, settings and services. Capacity building (defined as the development of knowledge, skills, commitment, structures, systems and leadership to enable effective health promotion) increased in respect to the establishment of sustainable partnerships, use of specialist advice, and integration of activities into on-going formal training for early childhood workers. However, challenges were found in respect to budgetary constraints, staff turnover, unclear governance structures, lack of on-going high-level leadership and inadequate communication between the partnering organisations. The authors recommend that a capacity building intervention would be more effective with the addition of on-going activities and commitments to address these shortcomings.

Overall, the intervention confirms the importance of the care provider's role in modelling and sharing eating experiences with preschool children, communicating with parents, and changing the norms and culture in the setting related to positive food practices (de Silva-Sanigorski et al. 2011).

School

Evidence of success is strong in school settings. Interventions based in primary schools have been shown to be relatively effective. Interventions are increasingly required to take account of the wider obesogenic environment and schools are considered a good setting for changing the environment related to PA and/or nutrition, to thus increase the likelihood of healthy behaviour (De Bourdeaudhuij et al. 2011). A World Health Organisation (WHO, 2009) review of interventions also found that school-based interventions show consistent improvement in knowledge and attitudes, behaviour, and physical and clinical outcomes.

Lakshman et al. (2010) cite evidence from systematic reviews that school-based intervention programmes which combine the promotion of healthy dietary habits and PA may be effective in preventing childhood obesity through behaviour change. This contrasts with a review of 11 studies of school-based interventions targeting dietary and PA behaviour in primary and secondary school children in Europe. In younger children (6–12 years old), there was inconclusive evidence that multi-component school interventions have a positive impact on child obesity in the European context (De Bourdeaudhuij et al. 2011)

Mixed success may be related to the intervention dose and duration (Lakshman et al. 2010). This was a feature of the Stockholm Obesity Prevention Programme (STOPP) which aimed to reduce the intake of fat and sugar in schools (ban on sweets, buns and sweetened drinks). A cluster-randomised, controlled study of the efficacy of STOPP in reducing the prevalence of overweight in 6 to 10 year old children found that the prevalence of overweight and obesity in 6 to 10 year old children were reduced (Marcus et al. 2009). This was mainly due to the effect on eating habits at home and at school, as opposed to increased levels of PA.

Other evidence suggests that school settings are specifically effective for PA interventions. A review of 20 studies (11 RCTs and 9 CTs) found that 16 reported effects on a PA outcome, and 11 on a fitness-related outcome (Kriemler et al. 2011). The effects were consistently positive for PA in school, out of school and for overall PA. Success factors included having a multi-component mandatory programme, with the involvement of specialists and supported by families.

In terms of particular interventions in schools, the Let's Get Cooking initiative designed by the Children's Food Trust proved to be an effective way of developing cooking skills and encouraging HE (Children's Food Trust, 2011). The Let's Get Cooking initiative involves setting up and running cooking clubs in schools. These are run by parents, school cooks, teachers, teaching assistants and volunteers from the school community. Children and adults are shown how to cook healthy food from basic ingredients, mainly using recipes provided by Let's Get Cooking. The recipe is available to take home and participants are encouraged to try the recipes again at home. A skills progression chart guides activities and tracks progress. There have been around 1.7 million participants between 2007 and 2011. As a result of the clubs: 92% of participants report using their new cooking skills at home (this was maintained at three month follow-up); 58% of participants report eating more healthily than before (this reduced to 45% at three month follow-up). A full Let's Get Cooking club, set up from scratch in a school without existing after-school cooking activities costs £5,000 to equip, train the club coordinators and run for three years. This represents an average cost of £34 per participant.

In another example, a card game 'Top Grub' was used as part of the 'HE' curriculum in a primary school (9-11 year olds). This educational intervention aimed to increase nutrition knowledge and develop positive attitudes to HE. The card game, based on the 'Top Trumps'® game featured nutritional values for foods and the cards were used to deliver the 'HE' curriculum. Thirty-eight state primary schools comprising 2,519 children in years five and six (aged 9-11 years) were recruited in a pragmatic cluster randomised controlled trial (Larksham et al. 2010). Twelve intervention and 13 control schools (comprising 1,133 children) completed the trial. Mean total nutrition knowledge score increased by 1.1 in intervention schools (baseline to follow-up at nine weeks: 28.3 to 29.2) and 0.3 in control schools (27.3 to 27.6). Total nutrition knowledge score at follow-up, adjusted for baseline score, deprivation, and school size, was higher in intervention than in control schools (mean difference = 1.1; 95% CI: 0.05 to 2.16; $p = 0.042$). At follow-up, more children in the intervention schools said they 'are currently eating a healthy diet' (39.6%) or 'would try to eat a healthy diet' (35.7%) than in control schools (34.4% and 31.7% respectively; chi-square test $p < 0.001$). Most children (75.5%) enjoyed playing the game and teachers considered it a useful resource. However, the study authors note that increasing nutrition knowledge may be an important initial step, but ensuring translation to behaviour change would perhaps require a more intensive intervention.

Other evidence supports the finding that nutrition knowledge can effectively be improved amongst children (Larksham et al. 2010). For example in the US, the Food and Agriculture Organisation's global school-based nutrition education initiative 'Feeding Minds, Fighting Hunger', the 'Michigan Model Nutrition Curriculum', and the nutrition education program 'Colour My Pyramid' were all found to be effective. Improved knowledge can lead to behaviour change in some instances. In the UK, a 'Traffic Light Nutrition Tool' showed that children's refusing behaviour for 'red food' items increased.

Behaviour change in relation to HE clearly depends on access to healthy food for children. School dinners are often cited as an important dimension of this. However, the provision of free school meals in primary schools may not increase nutritional intake because vegetables are likely not to be eaten, although this was found to be more often the case for a school in a relatively deprived area (Gatenby, 2011). This means that more needs to be done to provide menus that are both healthy and enjoyable for children, so as to ensure that food is eaten.

The school setting can also be important for children's involvement in school-based sport, both organised and unorganised. According to the PE and Sport Survey 2009/2010 (Quick, et al. 2010) there has been an increase in the average number of minutes that pupils in Years 1-11 take part in PE each week. In 2004/05 the average number of minutes was 107, compared to 123 in the latest survey. There has been an increase in the proportion of pupils in Years 1-11 participating in at least 120 minutes of curriculum PE (from 44% to 84%). The survey found that across Years 1-13, 55% of pupils participated in at least three hours of high quality PE and out of hours school sport during the 2009/10 academic year. This is an increase of five percentage points compared to 2008/2009. Participation levels are highest in Years 4 – 6, and also reasonably high in Years 1 – 3 and Years 7 – 8. They are at their lowest in Years 12 and 13, and this age group has also seen the smallest improvements. However, there is perhaps scope to improve opportunities still more. In a study of the role of School-Sports Partnerships (SSP) in embedding high quality practice in Physical, Education and School Sport (eight interviews with SSP coordinators), Flintoff et al. (2011) found that there was a need to provide activities other than traditional sport for engaging previously inactive young people.

A number of school sport interventions have seen positive results in increasing PA amongst pupils. The Change4Life School Sports Clubs Programme targeted those that were not choosing to play every week or that were not positive about sport. Amongst this group, those choosing to play sport every week increased by 166% and those positive about sport increased by 89% (SPAEAR, 2011). For the participants overall, at the end of 2010/11, 90% of participants (almost 55,000 young people) were Choosing to play sport every week and had a positive attitude towards sport (an increase of 40% from the point of joining a Change4Life School Sport Club). The average age of participants was 13.3 years. The impact was most significant for 8 to 12 year olds. The clubs typically ran for two or three terms and took place immediately after school and/or at lunchtime. They had on average 22 members of whom six were previously 'non-sporty' and three were Young Leaders. It was supported by one or two new coaches.

Similarly, the £32 million BIG Lottery Fund and Sport England Programme, Sportivate, provided 14-25 year olds not currently choosing to take part in sport in their own time access to six-week courses in a range of sports. The majority of teenagers and young adults (77.2%, n=1913) that took part in Sportivate sessions suggested that they were very likely to continue to take part in sport in the next three months, a further 18.5% (n=458) were likely to continue taking part in sport over that period (Sport England, 2012). The remaining people (4.2%, n=103) felt that they were not likely to continue to take part in sport in the next three months. A tracking survey was sent to people 90 days from the last sports session. The indications are that these good intentions seem to have been turned into tangible behaviour change. More than three quarters (88.9%, n=860) of the people who responded to the tracking study suggested they have been sustained in sport. Very few (11.1%, n=107) have not continued to take part in sport since taking part in Sportivate.

GreatFun2Run, a school-based healthy lifestyles intervention, led to positive changes in PA levels and body composition immediately post-intervention. The programme aimed to increase children's activity levels through developing and promoting running skills. It consisted of a CD-rom learning and teaching resource for teachers, an interactive website for pupils, teachers and parents, two PA events (one mile school runs/walks), a local media campaign, and a summer activity wall planner and record. A study of 7-11 year olds in four intervention and four control schools (N = 421) showed that while the intervention initially produced positive changes in PA levels and body composition, these changes were not sustained once the intervention ended (follow-up at 18-20 months) (Gorley et al. 2011).

Encouraging sport in school may not require formalised sessions or special equipment. A study of seven to eight year olds in two primary schools using accelerometer measures of PA showed that opportunities to engage in free play with the stimulus of toys or even cardboard boxes result in higher activity levels than without them. The children in the study spent a higher proportion of time in activity of a moderate-vigorous intensity in all the play sessions with toys and boxes (61%) than they did in PE (38%), school break (47%) or lunch-time (36%) (Morris et al. 2012).

Curriculum based interventions are effective, but may not be sufficient alone, especially as they are likely to take a relatively small amount of a child's time. Educational components should be combined with other environmental components (e.g. organised physical activities during breaks, or before and after school; improved availability of PA opportunities in and around the school environment; increased

physical education lesson time; improved availability or accessibility of healthy food options; and restricted availability and accessibility of unhealthy food option that focus on both HE and PA) (De Bourdeaudhuij et al. 2011).

De Bourdeaudhuij found that for primary school children there was evidence that education-only interventions had no significant effect on BMI or other obesity measures. Kriemler et al. (2011) make a similar argument, suggesting that there is value in such multi-component interventions (comprising both environmental and educational elements). However, findings are mixed on whether this is the case for both adolescents and younger children.

Also, a barrier to curriculum-based approaches is that nutrition education and increased PA can be compromised by the limitations of time in the school curriculum. Doak et al. (2006) (cited in Davies et al. 2010) found that concern may arise amongst parents, faculty and staff that the additional burden of a school-based PA programme may take away from the school curriculum and negatively impact academic performance.

Family support is also important, and extension into the home may enhance effectiveness. This has been noted in respect to PA in particular. Families may be important mediators for PA outside the school and for positive attitudes towards PA in general. However, the influence of the family on health behaviour may become less important for adolescents (Kriemler et al. 2011).

After school

Given that the majority of young peoples' PA occurs outside of school there is a need for interventions in these settings. School-based programmes appear less successful in improving activity outside of school hours (Atkin et al. 2011). In a review of nine studies (mostly USA based) on the effectiveness of interventions to promote PA in young people conducted in the hours immediately after school, Atkin et al. (2011) found that only three studies reported an increase or smaller decrease in PA amongst intervention participants compared with controls, and these studies also suffered from methodological limitations. Effects were also small in scale. Few clear moderators of effectiveness emerged but effective interventions were located primarily in the school setting, whilst non-effective interventions more likely took place in combinations of school, home or the community.

The YMCA's Y-Active programme was delivered in school settings and was a multi-component outreach children's program delivered by a team of trained YMCA sports coaches and play workers. It consisted of a breakfast club, physical education, lunchtime fitness classes, after-school play club, and after-school sports. Evidence is limited but a small case study in one London school suggested that pupils demonstrated and developed specific sporting competencies and increased their perceived efficacy in exercise and sports (Stathi & Sebire, 2011). Many pupils believed that their fitness had increased as a result of their increased opportunities. Psychological well-being improved through feelings of vitality and relaxation. There was a positive effect of Y-Active on the pupils' attitudes toward PA. Key to the success of Y-Active was the delivery style of the YMCA coaches which involved focus on fun and enjoyment, an empathetic approach where pupils were listened to and their needs were accommodated, provision of positive self-referenced mutual respect, strong focus on pupils' empowerment, and balancing structure, discipline and autonomy within activities. Overall, the activities were associated with fun. The authors argue that this delivery style is associated with the creation of autonomous social environments, which leads to the satisfaction of the need for autonomy, competence, and relatedness. This contrasts with more controlled social environments linked to pressure to comply, obligation, or guilt.

Family and Home-based

The family or home environment is claimed to be an important setting in which PA can be increased. A review of reviews suggests that the evidence of impact on PA is limited, but that family-based interventions may be more likely to be effective if they are set in the home and include self-monitoring (using pedometers) and goal setting for specific lifestyle changes (Van Sluijs et al. 2011). Recent evidence (based on six family-based RCTs) shows that significant positive effects on PA occurred in three family-based studies, such as 2,327 more steps per day or 3.9 hours of additional PA per week. There were no distinctive aspects of these interventions to explain effectiveness.

There is evidence that diet and PA advice (through commercial group membership and commercial magazine and/or website) can benefit young people (Pallister et al. 2009). A survey of 2,812 people accessing Slimming World advice revealed that they disseminated HE practices and messages to others. Thirty two percent of all respondents who followed the dietary programme (n = 2,197) reported buying and cooking food for themselves and for the whole family. Those with children at home (n = 982) reported that 14% followed the dietary programme.

Weight Watchers evidence submitted to NICE (Hellman, 2012) also recommends that it be recognised that interventions targeted at supporting adult parents to manage their own weight, could have a positive familial impact. The Weight Watchers family programme specifically developed to address childhood obesity focuses on healthy behaviours not weight and is targeted at parents of overweight/obese children (aged 2 to 16 years) – applying to all family members whether siblings have weight issues or not. It is delivered to parents through 10 weekly sessions. There has been some formal evaluation of the programme in the US and this shows positive results.

Community and commercial

There is evidence that encouraging parents to bring their adolescent children into commercial weight management groups in community settings can help build the support network to facilitate lifestyle and behaviour change (Stubbs et al. 2012). A Slimming World programme for 11-15 years focused on behaviour change, in particular a gradual shift in healthier food choices, decreased sedentary behaviours and increased participation in active pastimes was emphasised. Participants attended weekly groups with a parent or guardian who was normally responsible for their meals. Tailored literature was used to encourage small changes to eating and activity habits, and a package of guidance was developed for healthcare professionals, Slimming World consultants and the young person member to monitor targets and progress.

Mean BMI change was -2.5 (SD = 2.0) and mean BMI z-score change was -0.5. Self-reported eating and activity behaviours from 79 survey respondents showed that a decrease in the avoidance of moderate activity and intense PA accounted for 11% and 8%, respectively, of the variance in BMI change. Eating more selectively and eating more fruit and vegetables was also significant in accounting for the variance in BMI and weight change.

Slimming World weight management groups also take a family-based approach, supporting young people aged 11–15 years. Nearly 10,000 young people each year have attended a group with a parent or guardian. One study focused upon the adults attending with the young club members (Avery et al. 2012). Questionnaires were completed by 22 programme facilitators representing data for 128 young members (all were clinically overweight). The majority of young members attended the group with their mother (84.4%). Sixty-two percent of supporting family members were already members themselves. The majority of those adults who were not already a member joined with the young person to obtain weight management support for themselves as well.

The Scottish Childhood Overweight Treatment Trial (SCOTT) demonstrates the effectiveness of individualised behavioural change counselling in reducing BMI z-score relative to standard dietetic care among overweight children (Hughes et al. 2008). SCOTT is delivered by paediatric dieticians on a one-to-one basis with five hours contact time over 26 weeks. The family-centred approach involved the child taking control of his or her own lifestyle changes. Behavioural change techniques were used to enhance the child's motivation for making lifestyle changes. This comprised exploring pros and cons of change, identifying barriers to change, problem-solving barriers, goal-setting, rewards, self-monitoring, social support, and preventing relapse. Children were encouraged to alter their diet by using a modified traffic-light approach, increase their PA, and restrict their sedentary behaviour to no more than two hours per day or the equivalent of 14 hours per week. An RCT involving 134 overweight children showed no significant effect relative to standard care on BMI z score from baseline to 6 months and 12 months. BMI z-score decreased significantly in both groups from baseline to 6 and 12 months. However, in respect to objectively measured PA and sedentary behaviour there were significant between-group differences from baseline to six months in favour of the intervention group.

Individual Context

There is evidence that an individual's age impacts on the effectiveness of interventions. Waters et al. (2011) found that interventions that targeted 0-5 year olds were the most effective in terms of reduction in adiposity (-0.26kg/m²) (95% CI:-0.53 to 0.00). For 6-12 year olds, the mean effect was -0.15kg/m² (95% CI -0.23 to -0.08), and for 13-18 year olds it was lower at -0.09kg/m² (95% CI -0.20 to 0.03).

While changes in adiposity were the primary outcome measurement in the studies reviewed by Waters et al. (ibid.), behaviour change outcomes on activity levels and dietary intake were considered as secondary. When considering these behavioural measures there was little impact for 0-5 year olds.

For children aged 6 to 12 years there was clear indication of the effectiveness of interventions. Twenty studies (out of 27) found positive dietary outcomes. For PA, 21 studies from 33 found positive change.

For 13 to 18 year olds dietary related behaviour change was found in only three from six studies (lower intake of fat and sweetened drinks). For PA five studies from eight reported positive change in levels of PA.

3.3 What Works? Identifying mechanisms

A core element of the brief for this study was to 'dig down' into effective interventions, to see how far it is possible to identify in more detail what it is that makes them successful. This is a fundamental part of the review. Primarily it enables us to go beyond simple recommendations about replication ('scheme x works, therefore roll it out') and instead inform consideration of what the 'active ingredients' are likely to be, in order to draw out transferable insights for designing interventions.

In order to support this, the conceptual scheme for the review (see Section 3.1), employed the concept of 'mechanisms'. Mechanisms here are taken to mean the element(s) of the intervention that lead to the observed outcome. There are very close parallels with efforts in the behaviour change literature to provide more precise descriptions of the components of effective interventions. In particular our approach builds on the growing evidence around Behaviour Change Techniques (BCTs).

Behaviour Change Techniques (BCTs)

This overview of the cross-cutting evidence on effective interventions shows that the emphasis in the literature is on delivery contexts, and to a lesser extent, other audience dimensions such as variation by age of child. As has been commented above, what is missing is clarity over the 'active ingredients' of interventions, i.e. the change techniques which underpin their impact on PA and HE behaviours.

Behaviour change techniques (BCTs) are a specific set of mechanisms found in interventions targeting change among individuals. In a major review and meta-analysis on the question of the components of interventions that work most effectively, Michie et al. (2009) provided robust evidence that BCTs are a key ingredient in successful PA and HE interventions. Since that first paper set out a 'taxonomy' of BCTs, Susan Michie and colleagues have gone on to refine and extend the classification and definitions of the BCTs, and have begun to apply the BCT analytical approach to other areas of health behaviour.

In a key follow-up paper developing the BCT taxonomy, Michie et al. (2011) explained that studies of interventions to prevent and treat obesity have failed adequately to identify the content of interventions in terms of the mechanisms through which they achieve change. For instance, studies typically describe interventions in broad terms, such as 'behavioural counselling', 'Cognitive Behavioural Therapy' or 'motivational strategies'. Also, studies may only specify a mode of intervention delivery such as 'face to face' or 'nurse delivered', or describe it in terms of number of intervention sessions. This problem is compounded by the fact that systematic reviews of the effects of PA and HE interventions on behaviour or health outcomes often conclude that both the interventions as well as the effect sizes are extremely heterogeneous.

In order to address the issue, Michie and colleagues investigated the role of BCTs and found that they are a key ingredient in successful interventions. In their original 2009 paper, Abraham and Michie developed a taxonomy including 26 BCTs, derived from a meta-analysis of 250 PA and HE interventions (Michie et al. 2009). The BCTs specify the intervention elements using consistent terms; examples include 'providing information on consequences', 'prompting specific goal setting', 'agreeing a

behavioural contract', and 'providing feedback'. While the BCTs are identified by deduction from the evaluations of effective interventions, given that the interventions are aimed at individuals and predominantly based on 'therapeutic' models of delivery, the BCTs they include tend to relate to dominant social-psychological models of behaviour grounded in self-regulation, such as Control Theory, and Social Cognitive Theory. In these theories, behaviour change is principally explained as the result of a process of goal setting, monitoring and on-going feedback.

Since setting out the initial taxonomy, Susan Michie and colleagues have refined and extended it, such that in a 2011 paper, a further regression analysis is performed across 122 interventions, resulting in the extension of the taxonomy to include 40 BCTs (rechristened 'the CALO-RE taxonomy' – Michie et al. 2011). In terms of the effectiveness of BCTs, the authors address whether certain BCTs designed to promote PA and HE have improved outcomes related to obesity. They found that interventions with BCTs were more effective than those without. Pooling the data across the 122 evaluations (N = 44,747) using a random-effects model produced an overall effect size of 0.31 (95% confidence interval [CI] = 0.26 to 0.36) compared to control interventions without BCTs.

There are typically multiple BCTs within interventions: the 2011 analysis found an average of six BCTs per intervention. Meta-regression techniques were used to identify the most effective elements of interventions in terms of their mechanisms. The most effective interventions were those which included the BCT 'prompt self-monitoring', in combination with at least one of four other BCTs ('prompt intention formation', 'prompt specific goal setting', 'prompt reviewing of goals', and 'provide feedback') (pooled effect sizes for HE: 0.54 vs. 0.24; PA: 0.38 vs. 0.27; all interventions: 0.42 vs. 0.26). Furthermore, the analysis concluded that intervention content (i.e. the mechanisms included) was more important in explaining effectiveness than other contextual or delivery aspects such as target audience, duration, mode of intervention, or setting.

In other work, Foley et al. (2012) suggest that the self-monitoring technique can also take account of sedentary behaviour as well as instances of PA. This behaviour can be measured by 'use-of-time', which retrospectively records free-living activities in a structured, chronologically ordered manner over a dedicated and bounded time period. Metabolic equivalent (MET) values can be attached to activities so that use-of-time tools can be used to assess daily energy expenditure. Tools may include the Previous Day PA Recall, the Three-Day PA Recall, the PA Interview, the Computerised Activity Recall, the Activity Gram, and the Multimedia Activity Recall for Children and Adolescents.

This body of evidence shows that BCTs are more effective when multiple BCTs work in combination. However, while multiple BCTs are needed, it is not the case that a prescriptive set of BCTs make a better intervention in themselves. BCTs are wrapped up within an intervention package which is the means through which they are operationalised, and this is characterised by specific contextual factors such as target audience, duration, setting, and deliverer. As suggested in our conceptual framework (see 0 above), 'tools' support and trigger mechanisms. In this way, BCTs are often operationalised by particular 'tools'. For example, in order for self-monitoring to occur, a tool such as a pedometer or a food diary is required.

Susan Michie's work on BCTs represents a significant advance for researchers and practitioners alike seeking to understand and develop effective obesity prevention interventions. Considerable evidence, derived from robust evaluations, supports the taxonomy, and its links back to behavioural theory enhance both the transparency and transferability of effective techniques. However, the major limitation to this body of evidence from the perspective of a study of 'what works' for 2 to 11 year olds is that the entire evidence base is derived from analysis of interventions with adults. Indeed, when we interviewed Susan Michie and colleagues as part of this study, they confirmed that they are not aware of any analysis of interventions for under 18s which has used the BCT taxonomy to structure its findings.

For her part, Susan Michie recommended we build on her work on BCTs for adults, and "extrapolate" for under 18s, based on a sound knowledge of developmental stages in childhood. We attempt this extrapolation in the Full Report and Recommendations on this study, drawing on the evidence base for adults set out here.

Nine mechanisms for 2 to 11 year olds

All the interventions analysed in Michie et al. (2011) were undertaken with adults aged 18 and over. Despite our approaching the lead researchers, and various colleagues, it appears that no one has yet performed an equivalent analysis to identify BCTs for programmes targeting under 18s. In the absence of such evidence, the lead researcher on BCTs, Susan Michie, advised us to “extrapolate”. This is what we attempt in this section, performing an extrapolation informed by the understanding of developmental stages set out in Section 0 of this report.

We present a set of nine mechanisms for 2 to 11 year olds, including some which echo Michie’s broad categories of BCT, plus some new ones which we have developed specifically for children (especially at the younger age range). Although these are informed by the evidence in the review, and have been developed with expert advice, this set of mechanisms remains hypothetical until further research is done to identify the active ingredients in PA and HE interventions for children.

Given the hypothetical nature of this suggested classification of mechanisms for effective PA and HE interventions with under 12s, it is hard to say anything substantive about the relative importance of each mechanism. In the adult BCT taxonomy, Abraham and Michie undertook further analysis to show that, on average, the interventions under review each incorporated 6 of the 26 BCTs. This is an important learning, and suggests that effective interventions for under 12s should also include multiple mechanisms (our case study interventions bear this out).

Given the lack of evidence supporting our proposed mechanisms for under 12s, it is not possible to generate a hierarchy of mechanisms for under 12s based on regression analysis. However, we can suggest an approximate ranking of these mechanisms for under 12s, based on the prevalence of each mechanism across the effective interventions reviewed in this study (thus the highest ranking mechanisms are the most ubiquitous), in combination with the relative applicability of each mechanism to the different age ranges across the audience of 2 to 11 year olds (thus the most widely relevant are ranked most highly). By this method, the following hypothetical ranking of mechanisms for PA and HE interventions with 2 to 11s is suggested:

1. Fun

- Sheer and immediate pleasure – the main purpose of children’s activity (cf. learning as play) and an intrinsic reward from participation
- *“The only way for young children is to appeal to the ‘here and now’”.*
- *“Our entire campaign was based upon re-positioning PA as something that’s fun and cool”.*

2. Rewards

- Ideally immediate, deliberately short-term (so as not to encourage dependence, or lead to boredom), and best if linked to relevant content or messages.
- Extrinsic to begin with, although intrinsic benefits should become increasingly apparent through the course of the intervention.

3. Social Support

- Social support for children comes in many ways – encouragement, organising, providing, showing, listening – all of which are critical.
- Given the observations in this review that the determinants of PA and HE for children are mostly social, and that interventions should concentrate on reaching children in social groups, it could be concluded that almost all interventions for under 12s should involve some social support.
- *“Social support is really important; under 12 it tends to be from parents, among adolescents it’s more likely to be peers”.*

4. Skills

- Especially ‘physical literacy’ skills, plus a bit of cooking/food skills – especially if learnt from/with their parents.
- The parental role is key here, as gatekeeper, play partner or behavioural role model.
- *“Critical is building confidence and competence. If kids think they can do something well they will join in and continue. If not they will be shy and embarrassed. Simple fact”.*

5. Self Monitoring

- Linked to goal setting, so really only suitable for older children in this age range.
- Only relevant once kids have a sense of self and are interested in their own performance, and even then unlikely to work for all children.
- *“Goal setting appeals more to the achievement orientated and the pre-motivated; it’s not for everyone”.*
- However, a strategic approach can focus on task completion and show children that they can do things better now than before, and that in turn builds confidence and competence – this from about age eight onwards.

6. Social Comparison

- Effectively for children this means competition – and thus really only for older children in this age range (and more for boys than girls – although there are also qualitative differences in the kind of competition which can prove motivating).
- Can operate at individual or group (e.g. school, neighbourhood, nation) levels.
- Care should be taken that the competition doesn’t become stressful (or children will drop out), and that it doesn’t exclude, or label ‘losers’.

7. ‘Goal’ Setting

- Only suitable for the oldest children in this age range: requires an ability to project a sense of self, and to realise ‘targets’ for personal development.
- A question still remains about who sets the goals; most likely the teacher/parent does but the child needs to be old enough to ‘own’ them.
- *“Goal setting and self-monitoring can help at the upper end of this age group. They do like goal setting and seeing how they are doing - but it has to be enjoyable and show them that they can achieve”.*

8. ‘How To’ Info & Advice

- (Formal or informal) information is often seen as prerequisite of certain behaviours, not least given information’s role in shaping attitudes. However, this is a very rational and ‘adult’ way of attempting to change behaviours – and one that has been found to be less than effective with many adults!
- *“Kids like to know as they get older but it is not a great motivator - unless they can identify with it in a simple way”.*

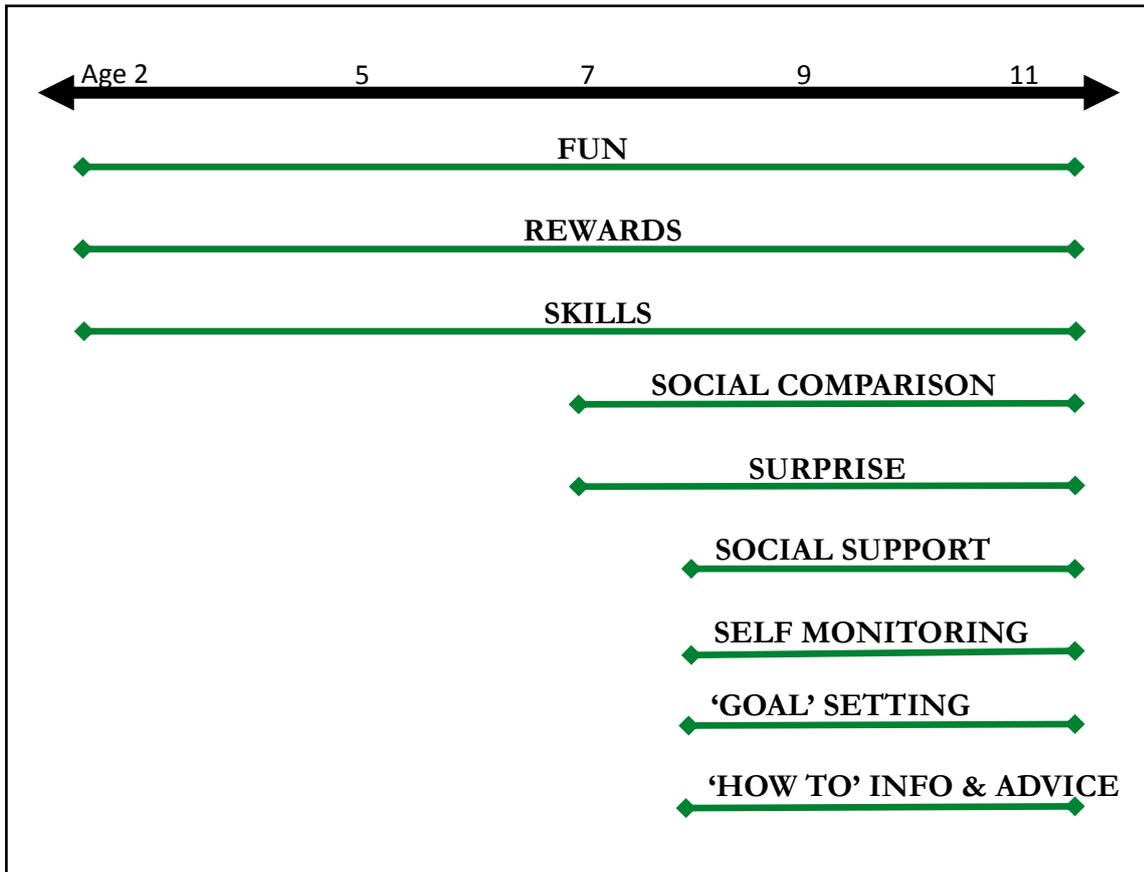
9. Surprise

- ‘Disconfirming data’, i.e. the surprise people get on seeing their own performance or attributes objectively for the first time (“this is the main way pedometers work” - the attraction being instant feedback, not on-going use, once the initial shock’s been received).
- This in turn can bring less rational habits under conscious scrutiny, such that people may make plans to change them. It may be that for children this kind of feedback needs to be kept simple, and certainly handled sensitively, with social support on hand.

Further detail on these effective mechanisms is provided at the level of the case study interventions (Section 4): both in terms of how mechanisms are combined in an intervention, and which combinations appear to be associated with intervention effectiveness. The case-by-case analysis should also provide greater colour on each mechanism, helping practitioners understand better how each mechanism works, as well as giving them practical ideas for activities which can implement a particular mechanism within their intervention.

The figure below takes the nine recommended mechanisms for PA and HE interventions for under 12s, and maps them on the 2 to 11 age range. In doing so, it takes the findings on mechanisms and presents them in a simple format, such that intervention designers can ensure that, once they have chosen their specific target audience, they can easily identify the suitable mechanisms for increasing PA or HE behaviours among that audience. This helps to demonstrate that practitioners should ‘start with the mechanism’. Once that has been identified they should then consider the tools to use.

Figure 3.2 Timeline of Effective Mechanisms for PA and HE Interventions for 2 to 11 year olds



4. Case Study Interventions

The previous section addressed the key feature of effective interventions and was oriented towards elucidating key insights about the general approaches that have been demonstrated to be effective in obesity prevention and the promotion of PA and HE behaviours. It mentioned some specific intervention packages, but was more general in content.

This section is about specific interventions. As described earlier, interventions refer to a coordinated package of activities / services / resources provided to the beneficiary (the target for behaviour change). This section features nine case study interventions. Each case study is structured according to a consistent template: background, content, outcomes, mechanisms, tools, insights.

In discussing mechanisms, the analysis of case studies attempts to elucidate the element(s) of the intervention that lead to the observed outcomes. The mechanisms identified are a representation of those set out in the respective studies consulted on each intervention. Where possible these have been interpreted using the concept of BCTs.

Section 4.10 following the case studies includes a table with detail on these effective mechanisms at the level of the case study interventions: both in terms of how mechanisms are combined in an intervention, and which combinations appear to be associated with intervention effectiveness. The case-by-case analysis should also provide greater colour on each mechanism, helping practitioners understand better how each mechanism works, as well as giving them practical ideas for activities which can implement a particular mechanism within their intervention.

The case studies were selected from a longer list of interventions identified through literature searches and suggestions from the DH, and also the Centre for Disease Control and Prevention (CDC) in the US. The shortlist of nine represents a mix of UK and US interventions and interventions covering PA, HE, and PA/HE combined. The selection also meets the following criteria:

- They are proven to be effective on the basis of good evidence;
- They target children within the 2-11 age range;

They contain identifiable 'mechanisms' which is the basis for deriving messages of effective practice from the case studies. Table 3 below provides an overview of the case study interventions:

Table 3: Summary Table of Characteristics of Nine Case Study Interventions

Intervention name	Country	Age range	Intervention type	Setting	Brief description	Duration of intervention	Key impacts	Evidence
Active8 Eatwell	Northern Ireland	9-10	HE, elements of PA	School	Social marketing and curriculum based scheme aimed at primary school children aged nine and ten. It highlights the importance of diet, nutrition, hydration and PA. Delivered in schools, based on a resource pack for teachers that includes an Eatwell plate and rewards for pupils.	6 weeks	<p>Increased awareness that a minimum of 60 minutes per day PA is guideline level</p> <p>Increased awareness of 5-a-day guidelines</p> <p>Increase in average fruit and vegetable consumption</p> <p>69% increase in the number of days per week that pupils achieved minimum 60 minutes of PA</p>	<p>Coleman & Moore (2010)</p> <p>Randomised control trial involving 47 intervention schools</p> <p>Measurements at baseline, immediately post-intervention and at four to six weeks post-intervention</p>
Beat the Street	UK and international	9-13	PA	School (with community links)	Uses swipe cards and sensors on lamp-posts ('Beatboxes') to encourage walking to school. Pupils' journeys are recorded and can be reviewed on a website. Individuals and schools compete: the individual / school with the most miles are rewarded with prizes and donations to a charity of their choice; the level of donation depends upon the distance walked.	4 weeks	<p>Prior to the scheme, around 63% of children had walked to school in the past week; this increased to just over 80% by the end of the scheme.</p>	<p>Intelligent Health (2013)</p> <p>Evaluation comparing baseline data and data two weeks post intervention</p>
Color Me Healthy	US	4-5	Both	School (with home extension)	Targeted at children (and their families) in child care and preschool settings, designed to improve fruit and vegetable intake and increase PA. The curriculum is designed to be fun and is highly visual and interactive, using colour, music, dance and imaginary play.	12 school lessons over around 6 weeks	<p>Consumption of fruit snack increased by approximately 31.2% and vegetable snack by approximately 24.2% between baseline and one week post intervention.</p> <p>Consumption continued to increase three months post</p>	<p>Witt & Dunn (2012)</p> <p>Randomised control trial involving 17 intervention classes</p> <p>Measurements at one week prior to</p>

Intervention name	Country	Age range	Intervention type	Setting	Brief description	Duration of intervention	Key impacts	Evidence
					The programme is delivered by child care staff and consists of 12 lessons which provide opportunities to try foods and undertake PA. Parents are engaged through newsletters, a website and other materials.		intervention (fruit by 20.8% and vegetable snack by 33.1%)	intervention, one week post intervention and three months post intervention
Food Dudes	UK and Ireland	4-11	HE	School (with home extension)	Intensive school-based first phase with regular inputs of watching of Food Dudes super-hero characters) and eating fruit and vegetables at lunch time (for which rewards are given). Followed by less intensive home-based second phase, which includes distribution of a home-pack for HE at home.	16 days	During intervention, consumption of fruit more than doubled from 36 to 79%, while that of vegetables increased from 44% to 66%. At follow-up, consumption was a little lower than at intervention (61 % for fruit and 59 % for vegetables) but still higher than that of baseline.	Horne et al. (2004) Randomised control trial with 749 participants Measurements at baseline, intervention and four-month follow-up
Hip Hop to Health Jnr.	US	3-7	Both	School (with home extension)	HE and exercise curriculum-based intervention delivered by teachers or early childhood educators targeted at black preschool children. Each week focuses on a particular theme - such as portion sizes, food groups, switching to low-fat milk, exercise, ideas for activities instead of TV, healthy snacks, and five a day. Parents receive a weekly newsletter to reinforce each theme.	28 lessons over 14 weeks	Children engaged in 7.46 min/day more MVPA than control group, and had 27.8 min/day less total screen time. There were no significant differences between groups in energy intake, dietary fat, dietary fibre, or consumption of fruit, 100% fruit juice, or vegetables. There were no significant differences in BMI or BMI z-score.	Fitzgibbon et al. (2011) Randomised control trial involving nine intervention schools Measurements at baseline and immediately post intervention
MEND	UK and international	2-4 / 5-7 / 7-13 /	Both	Community	Family based obesity prevention / treatment intervention delivered by non-specialists in community	Nine weeks and up to two years	At 12 months, children reduced their waist and BMI z-scores by 0.47 and 0.23	Sacher et al. (2010) Randomised control

Intervention name	Country	Age range	Intervention type	Setting	Brief description	Duration of intervention	Key impacts	Evidence
		13-16			settings to children in four different age groups. Programmes vary, but typically combine parent workshops, active play and PA sessions for children. MEND is embedded into a two-year weight management strategy with tapering support; typically begins with weekly sessions for 10 weeks.		respectively, and benefits in cardiovascular fitness, PA levels, and self-esteem were sustained.	trial involving 54 children Measurements at baseline and 6 or 12 months from baseline
VERB	US	9-13	PA	Not specific	Large-scale social marketing campaign that used a range of media – television, print, community events, website, text – and equipment (e.g. VERB yellow balls) to promote PA as fun and ‘cool’. VERB targeted ‘tweenagers’ directly, segmented by broad ethnic groups, using different media and partner / community based organisations.	4 years	Children’s self-reported PA on the day before survey was significantly positively correlated with levels of campaign exposure.	Huhman et al. (2010) Telephone survey of three nationally representative cohorts of children aged 9 to 13 years and their parents. Cohorts were studies in 2002, 2004 and 2006.
Walk Once a Week	UK	4-11	PA	School	Involves school classes recording their daily journey on a wall chart. At the end of each month every child that has walked at least once each week, is rewarded with a badge. The badges are designed to be collectable and the scheme is promoted by a mascot, ‘Strider’. Backed by wider awareness raising work within schools and parental engagement.	Not specific	19 per cent of respondents who walk to school said that they started to walk to school due to WoW.	Wavehill Consulting (2009) Evaluation involved a hands-up and stand-up survey of 23,450 children in 961 classes and assemblies
Zamzee	US	9-15	PA	Not specific	Uses an accelerometer and website to provide “a game that	Not specific	An average 59% higher rate of MVPA compared to the	HopeLab

Intervention name	Country	Age range	Intervention type	Setting	Brief description	Duration of intervention	Key impacts	Evidence
					gets kids moving". Users install Zamzee software and create a personal account that supports goal setting, tracking progress - and rewards where PA is converted into the website currency, the 'Zamz', which can be exchanged for goods in the real world (e.g. gift cards / charity donations).		control group. There was no lessening of impact over the six month period.	Randomised control trial involving 448 11-14 year olds Measurements at baseline and six month post baseline

4.1 Active8 Eatwell

Background

This initiative of Sport Northern Ireland and the Food Standards Agency was a pilot developed from Activ8 which positioned sport as a mechanism to reduce obesity by raising awareness of PA levels (Coleman & Moore, 2010).

Active8 Eatwell is a social marketing scheme aimed at primary school children aged nine and ten. It highlights the importance of PA, diet, nutrition, and hydration, and aims to instigate long-term behaviour change.

Content

Active8 Eatwell is a complete package of teaching tools linked to the Northern Ireland curriculum (FSA Northern Ireland, 2012).

The intervention provided 47 schools with a comprehensive teaching resource for teachers and coaches to deliver PA, HE, and lifestyle messages. The package is designed to help teachers equip children with the knowledge, understanding, skills and attitudes they need to make better choices.

Resource packs are given to teachers containing materials for pupils; these used cartoon character modelled on the Ben 10 character. Pupils who participate receive rewards. The Eatwell plate gives a visual representation of the types and proportions of foods needed for a healthy and well balanced diet.

Outcomes

An evaluation (Coleman & Moore, 2010) involving the 47 participating schools and a control group of schools measured outcomes at baseline, immediately post-intervention and at four to six weeks post-intervention. There were positive results amongst pupils:

- Increased awareness (from 53% baseline to 92% post intervention) that a minimum of 60 minutes per day PA is guideline level;
- Increased awareness of the range of activities that constitute PA;
- Increased awareness of daily recommended levels of water consumption (27% baseline to 75% post intervention);
- Increase in average daily water consumption (4.5 glasses baseline to 6 glasses post intervention);
- Increased awareness of the five food groups (57% baseline to 89% post intervention);
- Increased awareness of the Eatwell plate (50% baseline to 98% post intervention);
- Increased awareness of 5-a-day guidelines (71% baseline to 85% post intervention);
- Increase in average fruit and vegetable consumption (exceeding 5-a-day at post intervention);
- Increasing awareness of food labels;
- 69% increase in the number of days per week that pupils achieved minimum 60 minutes of PA (2.25 days baseline to 3.8 immediate post-intervention).

Mechanisms

Active8 Eatwell is principally based on the provision of information/training within the school setting. This is combined with the provision of extrinsic rewards to children.

The Eatwell plate works as a form of self-monitoring on food consumption.

Tools & Format

- Pupils receive rewards including Active8 Eatwell branded gym bags and water bottles.
- The Eatwell plate gives a visual representation of the types and proportions of foods needed for a healthy and well balanced diet (FSA Northern Ireland). The size of the segments for each of the food groups is consistent with Government recommendations

for a diet that would provide all the nutrients required for a healthy adult or child (over the age of two). The Plate is available as an online pdf download. (See Figure 5.6 below.)

Insights

- Critical success factors in delivering social marketing campaigns include offering food tasting sessions (Coleman & Moore, 2010).
- There was value in not delivering the message as anti-obesity, or highlighting potential negative outcomes. Coercive means of communication should also be avoided (Coleman & Moore, 2010).
- A strong social marketing brand was also seen as important to help sustainable intervention (Coleman & Moore, 2010).

4.2 Beat the Street

Background

Beat the Street was an international walk-to-school competition for children aged 9 to 13. It ran for four weeks in the autumn of 2012, organised by Intelligent Health, who use digital networks to create PA opportunities in towns and cities; this particular project was funded by the Coca Cola Foundation. In total, around 2,500 children took part from 13 urban schools in England (London and Reading), Canada and China.

Content

Children were issued with a Beat the Street card that they could swipe across sensors ('Beatboxes') placed along walking routes. Those who lived too far away to walk were encouraged to get off the bus/out of the car a little early so that they could swipe their card and walk the rest of the way. Sensors were attached to lampposts, public transport links and school gates, marking walking routes around 1km in length. 'Beatboxes' were worth one, two or three points, depending on their distance from school.

Information from the Beat the Street cards was uploaded to an online system, where children could check their progress, and that of their school and country. Prizes were awarded to the best individual, school and country – the 'winner' being the individual or group who completed the highest percentage of all possible walks.

Outcomes

Intelligent Health (2013) published their evaluation of the scheme in 2013, comparing baseline data and information collected two weeks after the intervention. This found that:

- **Participation** was high across all the countries – around two thirds of children invited to take part in the scheme did so; everyone who registered tried out their Beat the Street card at least once, and 81% more than five times. Participation rates were slightly lower in England than elsewhere, partly due to structural differences in the way the scheme was offered. In England around half of those children invited to take part, did so and, of those, a further half swiped their card more than five times.
- The biggest impact of the intervention was on **occasional walking**. Prior to the scheme, around 63% of children had walked to school in the past week; this increased to just over 80% by the end of the scheme. Interestingly, patterns were very similar across all three countries.
- There was a smaller impact on **regular walking** as a result of the intervention. The numbers of children whose usual means of getting to school was walking increased (non-significantly) from 59% to 65%. This increase appeared to come from a switch in behaviour from those who used the bus/ train, or cycled, rather than any reduction in the number who regularly drove to school (which remained at 16%).
- Most of the use of swipe cards took place **close to school** – at those boxes either on the school gates, or very close to schools. Just under half of English children swiped

their cards further away than this at least five times, indicating that around half of children weren't walking very far at all. Children in Canada were more likely to swipe their cards further away from school – probably because, unlike in England, there were proactive initiatives in place to encourage this.

- There were no major changes in children's **awareness of, or attitude to, walking** – this was mainly because the levels of awareness of the benefits of walking, plus positive attitudes towards it were already quite high at the start of the study; there was little scope for improvement. There was some reduction in negative attitudes towards walking, such as thinking it was geeky, uncool or for those who could not afford other forms of transport.
- A third of children said that they had **made new friends** by walking to or from school during the competition.
- There were **no gender or ethnic differences** in the impact of the competition – the intervention worked equally well for a variety of children.

Mechanisms

Intelligent Health identifies the underlying mechanism for Beat the Street as competition – getting children to compete as individuals, as a school, and as a country. Prizes were available to the winning individual, and a donation was made to a charity of the school's choice. No evidence was gathered on how motivating children found this to be. It would be particularly interesting to know whether children were particularly motivated by competing for their school or country, particularly since the chances of winning the individual prize (only one was offered) were so low.

The online platform for Beat the Street, which allows children to monitor their progress, contains an element of self-monitoring towards goals. Again, no information was collected on how motivating children found this – there is some question over whether techniques such as these are cognitively appropriate for younger children.

Peer modelling, and the normalising of walking to school, is another mechanism potentially used by Beat the Street. This is important, as one of the significant barriers to walking to school for children was whether their friends walked to school (12% mentioned this). There is therefore scope for interventions such as this to 'snowball' in their success rates as walking becomes normalised, and negative perceptions decrease (Intelligent Health, 2013). This same effect may also be seen among parents, as more parents see walking to school as a safe and convenient thing to do, so these attitudes will affect others. Around a third of parents from Beat the Street schools said that the intervention had enabled them to see walking in a more positive light (Intelligent Health, 2013).

Tools

As an organisation, Intelligent Health focuses on using technology to map and encourage walking and cycling. In Beat the Street cards are swiped on digital 'Beatboxes'. This is linked to an online platform, which allows children to track the progress of themselves, their school and their country.

Insights

- Canada was much more successful at engaging children with the scheme than England. Intelligent Health suggest that this might be due to Canadian schools being small primary schools, compared to the large secondary schools in England and China. It's possible that it's easier to effect broad behaviour change in a smaller, more integrated school; equally this could be due to younger children being easier to motivate; or it could be linked to the higher level of parental engagement in small primary schools.
- It's interesting that there were no gender differences in the impact of this intervention – it suggests that competition and technology can be equally motivating for boys and girls.
- Beat the Street may have used a number of mechanisms to work, however more research would be needed in order to disaggregate exactly how (and if) the different levels of competition worked; how important peer modelling was; and how appropriate self-monitoring was across this age range.

4.3 Colour Me Healthy

Background

Colour Me Healthy is targeted at four and five year old children (and their families) in child care and preschool settings. The content is delivered by child care providers. It has been in operation since 2002 and is designed to improve fruit and vegetable intake and increase PA by increasing exposure to nutrition education and opportunities for PA (The Center for Training and Research Translation).

The developmentally appropriate curriculum of Colour Me Healthy is designed to be fun and is highly visual and interactive, using colour, music, dance and imaginary play to provide opportunities for PA and to teach children about fruits and vegetables (Color Me Healthy) .

Color Me Healthy is a partnership between North Carolina Cooperative Extension and North Carolina Division of Public Health (Physical Activity & Nutrition Branch). Dissemination of the programme was funded by the Supplemental Nutrition Assistance Program – Education (SNAP-Ed) and implemented in low-income under-resourced childcare centres participating in the Child and Adult Care Food Program (CACFP) and the Expanded Food and Nutrition Education Programs (EFNEP).

Content

The programme has four key elements (The Center for Training and Research Translation):

1. The intervention uses a train-the-trainer approach to support child care providers to deliver the programme through their teachers. During this training, participants spend time modelling the 'circle time' activities in order to help them become familiar and comfortable using the activities with the children. The Color Me Healthy Training Manual provides guidance on planning and conducting training. Each child care provider also receives a copy of the toolkit to use in their classrooms at the conclusion of the training.
2. Trained teachers use the Color Me Healthy Kit to teach the lessons. Lesson plans outline the props and the action steps needed to complete each lesson. All of the props and other materials are provided in the Kit.
3. The programme consists of 12 lessons which are taught during 'circle time', a part of the day when children gather to learn and interact. They integrate developmentally appropriate learning activities. Several of the lessons provide opportunities for children to try fruits and vegetables. For example, in the "Brown Paper Bag Mystery" lesson, children have to use touch and smell to guess what fruit and vegetables are in the bag. Teaching includes six imaginary trips that allow the children to use their imagination to travel to different places and events (Witt and Dunn, 2012). In the 'Climb Every Mountain' trip children imagine activities, such as setting up the camp, going for a hike, going for a canoe ride, and making and eating a healthful vegetable stew. These imaginary trips allow children to be physically active and role play eating nutritious food (Witt and Dunn, 2012). Other content comprises four sets of picture cards; three classroom posters; a CD with seven original songs which children sing and dance to (to reinforce messages); and a hand stamp to reward participation. Teachers are asked to create a reinforcing classroom environment, for example, using classroom posters, and ideas for bulletin boards.
4. Parent engagement through 14 reproducible parent newsletters and two colour posters designed for parents (provided in the Kit). The Colour Me Healthy web site also provides information to parents, including copies of the parent newsletters and the songs available for free download. A section of the web site is tailored for parents or others interested in HE and PA for young children.

In terms of resources required, it is suggested that child care providers receive a minimum of four hours of hands-on training in Color Me Healthy prior to implementation in the classroom. Trainings are most effective with small numbers of providers (less than 25). English language Kits are available at cost (\$80 per kit for orders under 100 kits; \$65 per kit for orders over 100 kits). CDs are available for \$10 per CD for orders under 100, and \$5 per CD for orders of 100 or more. Other costs are mileage reimbursement for travel to conduct trainings, venue for training, refreshments at training, and training supplies (The Center for Training and Research Translation).

Outcomes

The efficacy of Color Me Healthy was evaluated as an RCT, with random assignment at the child care centre level (Witt & Dunn, 2012). Seventeen preschool classrooms were randomly assigned to one of two groups, with the second group of seven classrooms acting as a control group. The control group did not incorporate nutrition curriculum into their lesson plans. The curriculum was implemented for six weeks. Children were given fruit and vegetable snacks one week before CMH was initiated, one week after the program was completed, and three months after the program was completed. 263 children in 17 preschool classrooms participated in the evaluation. In total, 70 intervention children and 52 comparison children received vegetable snacks at all three time periods. Data were analysed using repeated-measures analysis of variance and hierarchical linear modelling.

Intervention group children increased their consumption of fruit snack by approximately 31.2% and vegetable snack by approximately 24.2% between baseline and one week after the completion of the study. Consumption continued to increase three months after the completion of the curriculum (fruit by 20.8% and vegetable snack by 33.1%) ($p < 0.001$). Hierarchical linear modelling did not reveal child, classroom, or teacher variables that predicted fruit snack and vegetable snack consumption at post-intervention assessments. Parent engagement was limited; of the six parent-child activities, on average, 3.4 were completed and returned to the classroom. 22% of the children completed and returned all six parent-child activities.

Also, eight-week follow-up surveys were completed by child care providers ($n = 486$). Of those participants, 92% perceived an increase in PA of the children in their care, while 92% indicated that the program increased the children's knowledge about movement. In addition, 93% perceived that using the program increased the children's knowledge about HE, while 79% indicated that the children were more willing to try new foods and 82% reported that the curriculum had improved fruit and vegetable recognition.

Mechanisms

According to the Center for Training and Research Translation, Color Me Health primarily addresses the individual and interpersonal levels of the socioecologic model and constructs from the social cognitive theory including: behavioural capability, outcome expectancy, outcome expectation, observational learning, reinforcement, social support and reciprocal determinism.

Tools

The Color Me Healthy Kit includes the following:

- Teacher's Guide;
- 4 sets of picture cards;
- 3 color classroom posters;
- CD with seven original songs;
- 14 reproducible parent newsletters;
- 2 color posters designed for parents;

The Color Me Healthy web site also supports content provision:

- Copies of parent newsletters;
- Color Me Healthy songs available for free download;
- Information for families on HE and PA;
- Color Me Healthy recipes;
- Information for public health professionals;
- The Color Me Healthy Training Manual;
- Manual available for staff who will be training child care providers.

Insights

Witt & Dunn (2012) offer the following learning points:

- The curriculum is thoroughly designed and informed by evidence on developmental factors in children.
- The Kit has been found to be very effective. It is professionally designed, full-colour, and empowers child care providers. Offering the training directly to child care providers enhances the likelihood that the programme will be implemented as intended.
- There was a very high adoption rate from child care providers. This was important because the intervention was designed for dissemination and proactive engagement. This is perhaps because the programme is easy to implement at a relatively low cost and there is high acceptability of the curriculum.
- There was a lack of parental awareness, engagement and active participation.
- In some cases, child care centres were less able to deliver the programme due to issues such as schedules or space restrictions.

4.4 Food Dudes

Background

The Food Dudes HE Programme is a combined school (4-11 year olds) and home intervention focusing on fruit and vegetable intake.

It was developed by psychologists at Bangor University, Wales. At present in the UK, there are 146 schools participating across Bedfordshire, Coventry, Dudley, Walsall, Wolverhampton and Yorkshire (Food Dudes, 2009).

Wolverhampton City Primary Care Trust (PCT) and The Worshipful Company of Fruiterers, with the support of the School Food Trust, have funded the pilot of Food Dudes and over three-years the programme is aiming to reach 20,000 primary school children. The total budget is £575,000.

A sister project, the Fit n' Fun Dudes, focuses on PA and has been funded by the Wales Office of Research and Development for Health and Social Care.

Content

The aims of the Food Dudes HE Programme are set out on the Food Dudes website, as follows:

- Encourages children to eat fruit and vegetables both at school and at home;
- Helps children develop a liking for fruit and vegetables;
- Encourages children to reduce their snack food consumption;
- Encourages children to become proud to think of themselves as healthy eaters;
- Changes the 'culture' of a school to one that strongly supports HE.

The programme consists of a 16-day intensive school-based first phase with regular inputs of watching of Food Dudes videos and eating fruit and vegetables at lunch time for which extrinsic rewards are given.

Each day children are read a letter and/or watch a specially designed DVD episode (lasting six minutes) featuring the Food Dudes super-hero characters. These are two boys and two girls aged 12–13 years. The characters work as role models; they demonstrate eating healthy foods and conflict with anti-HE antagonist characters (the 'Junk Punks'). They also urge the children, in speech and in song, to keep the 'Life Force' strong by eating healthy foods. The videos include an animation sequence, a Food Dude theme tune and a range of celebrity endorsements and accompanying sound bites.

Children are given one portion of fruit and one portion of vegetables to eat at lunch time in the school canteen, and those who do eat them are given rewards. The idea is that repeated tasting leads to enjoyment of the foods.

A less intensive home-based phase involves distribution of a home-pack for HE at home, and also encouragement to bring fruit and vegetables to school. This aims to involve the parents and to

encourage self-monitoring of consumption at home. Children are encouraged to bring their own fruit and vegetables to school every day in special Food Dudes containers. Classroom Wall Charts record consumption levels, and are used for distributing further rewards and Food Dudes certificates.

Outcomes

A key early study by Horne et al. (2004) showed very positive outcomes of Food Dudes. It employed weighed measures and direct observations of behaviour as the principle measures of food consumption and dietary change. The study had 749 participants aged 5 to 11, with measures at baseline, intervention and four-month follow-up.

The evaluation design was that over a five-month period, children in an experimental and a control school were presented with fruit and vegetables at lunchtime (5-7 year olds also received a fruit snack at mid-morning). At lunch children could, as part of their meal, select a portion of cooked vegetables weighing approximately 60 g, and a whole fruit weighing approximately 80 g. On a daily basis, the amount of each portion of fruit and vegetables that each child consumed at lunchtime was visually estimated and rated on a five-point scale (either 0, 25, 50, 75 or 100%) by independent raters.

For both control group and intervention group, the study began with a 12-day baseline phase followed by a 16-day intervention phase, and then by a four-month maintenance phase. The control group had the same availability of food, but were not exposed to the Food Dudes intervention.

Measurements of the amount of fruit and vegetables consumed each time showed that more was eaten as a result of the intervention. During intervention, consumption of fruit more than doubled from 36 to 79%, while that of vegetables increased from 44% to 66%. At follow-up, consumption was a little lower than at intervention (61 % for fruit and 59 % for vegetables) but still higher than that of baseline. The largest increases in consumption were obtained by children who ate the least during the baseline phase. Just over a quarter of the children who ate just 11% of their vegetables in baseline were eating 43% at follow-up.

The intervention model has also been effective in nursery settings. In a later study, Horne et al. (2011) investigated an intervention modelled on Food Dudes, which aimed to increase fruit and vegetable consumption of 20 pre-schoolers (two to four years old) in a day nursery setting. Following in-house videos of two cartoon characters, 16 foods (eight fruit and eight vegetables) were presented to children, and in different segments of the study these were either rewarded (target food) or not (non-target). The amount of each fruit and vegetable consumed daily by each child was measured by observation.

The interventions produced large and significant increases in target fruit and vegetable consumption. In both the fruit intervention and the vegetable intervention there was a three-fold increase in consumption of target foods and these increases were fully maintained at follow up more than six months after all rewards were withdrawn. Also, consumption increased for foods that were not rewarded. It was only necessary to target half the foods directly with the intervention in order for tasting and liking to develop for all foods.

The intervention model has also been effective for lunch box meals from home. One particular piece of research in Ireland investigated Food Dudes in the context of 4 to 11 year old children bringing their own food to school in lunchboxes (Horne et al. 2009). The results were similarly positive; at 12-month follow-up measurement, parents in the intervention school provided more, and their children consumed significantly more, lunchbox fruit, vegetables and juice relative to baseline and to the control school.

Teachers have viewed the Food Dudes model positively. Qualitative evidence from six teachers also shows that Food Dudes has raised children's awareness of HE (Upton, 2009). Teachers felt the rewards were a particularly positive aspect of the intervention. The key challenge for teachers was finding the time to implement the programme.

The intervention model has also been applied to PA as opposed to HE. Horne et al. (2009) and Hardman et al. (2011) have studied a PA intervention (Fit n' Fun Dudes) which also added a pedometer for monitoring progress towards set targets. This element was added to the role-modelling and rewards contingencies. Again the outcomes were positive and demonstrate the efficacy of a peer modelling, rewards and pedometer-feedback intervention. The study by Horne et al. (2009) was conducted in two primary schools in Wales (47 children from the experimental school and 53 children from a matched

control school). Pedometer measures were taken from children at baseline, intervention (baseline two for the control school) and 12-week follow-up. Steps per day at intervention phase and follow-up were significantly higher compared to baseline. For boys, there were no significant differences at follow-up measurement between activity levels of intervention and control boys. This was not true of girls, who continued to produce additional steps per day. It is possible that girls are more responsive to reinforcers such as self-reporting in diaries.

The study by Hardman et al. (2011) included 386 participants from three primary schools, which were randomly assigned to either full intervention (peer-modelling, pedometer goals, leading to rewards), no-rewards intervention, and control group (pedometers only). PA was measured through pedometers at baseline, intervention and at the end of a 14 week 'taper' phase. The full intervention school showed the largest increase in PA during intervention relative to baseline (+2456 steps per day). The increase in the no-rewards school was smaller (+1033 steps per day). There was no significant change in the control group. The key point though is that at 14-week follow-up, while the intervention group returned to baseline levels, the no-rewards group continued to increase (+2030 steps per day). This means that peer-modelling and pedometer goal setting alone produced better results over time. This suggests that tangible rewards are not required to promote longer-term increases in children's PA. This contrasts with some of the findings of Horne et al. (2009).

In regard to the European School Fruit Scheme which tackles the issue of falling consumption of fruit and vegetables among children, Food Dudes was commended as an effective 'accompanying measure' in a Commission publication (European Commission 2012). The Commission noted that the teaching and rewards inherent to Food Dudes was essential for a sustainable increase in children's fruit and vegetable consumption.

Mechanisms

The Food Dudes intervention is explicitly informed by the use of the '3R's': role modelling plus rewards leads to repeated tasting. This is derived from the literature on the determinants of children's food preferences (Horne et al. 2011).

The rationale is that the combination of peer modelling and the reward contingency motivates the children to overcome reluctance to try healthy food and, through repeated tasting, they develop a lasting liking of these foods. Extrinsic rewards are gradually withdrawn as children come to find the foods intrinsically rewarding, and the behaviour is reinforced by peers' support (Horne et al. 2011). The programme claims to create a culture, at school and at home, that strongly supports the eating of fruit and vegetables and this environment leads children to think of themselves as "healthy eaters" (Food Dudes, 2009). The combination of these biological (repeated tasting) and psychological (role-models, rewards) factors maintain behaviour change over time.

There is evidence that it is the combination of mechanisms in Food Dudes that makes it effective. Importantly, the two key mechanisms in Food Dudes were found to be more effective in combination than either of the two components used alone.

Greenhalgh (2009) looked specifically at the effects of positive and negative peer modelling on children's consumption of novel food. The study involved 79 three to seven year olds being given novel food for snacks with both negative and positive modelling on different occasions. It was found that negative peer modelling has potent effects on consumption of novel foods; positive peer modelling did not reverse the effects of negative modelling. Positive peer influence can increase the likelihood of consumption of a novel food.

The value of combined mechanisms was also found in the PA intervention evaluation by Horne et al. (2009). The intervention used three key mechanisms (peer modelling, rewards and pedometer feedback) as a means of increasing PA in 9-11 year olds. Two of these, the peer-modelling and rewards mechanisms, were modelled on the Food Dude HE Programme. The study by Horne et al. (2009) reports on the first application of this approach to PA, adding the pedometer as a feedback mechanism. A pedometer provided the means of monitoring progress towards set activity goals.

The evidence from Food Dudes and Fit n' Fun Dudes has brought to the fore the debate about the extent to which removing rewards has a detrimental effect on food preferences in the longer term.

Horne et al. (2009) showed the importance of rewards in contributing to longer-term PA increase, but Hardman et al. (2011) found the opposite; that tangible rewards are not required to promote longer-term increases in children's PA. A theoretical interpretation from cognitive evaluation theory is that extrinsic rewards decrease an individual's intrinsic motivation to perform a task due to their effects on reducing autonomy and facilitating a more external perceived locus of control. However, Hardman et al. (2011) do not have enough evidence to substantiate this. Horne et al (2009) argue that the issue may depend on the nature of the reward.

Another issue is the relative effectiveness of exposure-based interventions. Horne et al. (2011) argue that this may be an important determinant of food preferences but that simply presenting healthy food repeatedly to children, in the absence of any other motivational intervention, is ineffective.

Tools

The Food Dudes and Fit n' Fun Dudes interventions use a variety of materials and tools.

- The DVD series featuring the 'Dudes' characters;
- Food items for tasting;
- Rewards (including juggling balls, pencils, erasers, pencil cases, rulers, certificates, stickers, pedometers, badges);
- Interactive wall charts (tracking progress towards a goal);
- Letters to children (to provide encouragement and praise);
- Two 'homepacks' (to encourage home consumption and to help parents become actively involved in the programme).

The pilot intervention for promotion of PA also used a pedometer for monitoring progress. Rewards were distributed when daily pedometer step counts increased by 1,500 steps per day relative to baselines. Children who had not reached their targets were encouraged to keep trying. The intervention was immediately followed by a maintenance phase where no rewards were given but pedometers and self-recording of steps via Fit N Fun Dudes diaries were in place. Children were also prompted to reach targets via personalised letters from the Fit n' Fun Dudes. Fit n' Fun Dude certificates were awarded to children who completed their diaries at the end of the phase.

Insights

- The intervention demonstrates the effectiveness of peer-modelling, reward contingency, and repeated tasting. The combination of these elements was seen as key to success.
- Food Dudes research (Horne et al. 2004) suggests that it is critical that the children achieve taste exposures. Repeated tasting means that children come to find fruit and vegetables rewarding in their own right. Extrinsic rewards can be gradually faded out from the programme as the intrinsically rewarding properties of the foods themselves begin to take their effect. Children were found to still be eating above the reward threshold amount even in post-intervention phase.
- Peer modelling videos and rewards influenced children to repeatedly taste the foods that many of them had previously shunned. The study by Horne et al. (2004) suggests that television can be used to positively influence children's diets, especially when children's enthusiasm for video hero figures and celebrities and their desire to emulate them may be harnessed to provide a potent counter influence to food mass-marketing.

4.5 Hip Hop to Health Jnr.

Background

Hip Hop to Health Jnr. is a HE and exercise curriculum-based intervention for children aged three to seven years. More specifically, it is a weight control intervention delivered by teachers or early childhood educators targeted at black preschool children. The preschool years are targeted because these offer an opportunity to interrupt the trajectory toward obesity in black children (Fitzgibbon et al. 2011).

Content

The Hip Hop to Health Jnr. curriculum is 14 weeks in length (although four, six and eight week programmes are also offered), with two sessions a week. Each week focuses on a particular theme and objective, including the food pyramid, portion sizes, food groups, switching to low-fat milk, healthy exercise, ideas for activities instead of TV, healthy snacks, and five-a-day. Each session includes a 20-minute lesson together with a 20-minute PA session. Several tools are used to aid delivery (see tools section). Parents receive a weekly newsletter to parallel curriculum content and reinforce curriculum themes. This includes a 15-minute homework assignment. For example, in 'Five-a-Day' week, parents were asked to keep track of their and their children's fruit and vegetable intake for one week. Parents received a small monetary incentive for homework completion.

Outcomes

The Hip Hop to Health Jnr. Obesity Prevention Effectiveness Trial (Fitzgibbon et al. 2011) is a group-randomised controlled trial assessing the feasibility and effectiveness of an adapted version of Hip Hop to Health Jnr. The trial targets three to five year old children enrolled in 18 Head Start programs administered through the Chicago Public School system.

A total of 618 children participated. Children in nine schools were randomised to the intervention group. Children in the nine schools received a general health intervention. 590 parents and guardians also participated in the study. There were 323 children with valid accelerometer records at baseline, 580 children with screen time data at baseline, and 508 children with valid diet records at baseline. At baseline there were no significant differences between control and intervention groups in terms of gender, BMI, BMI z-score, PA, time spent watching television, and consumption of fat (% kcal), fruit, 100% fruit juice, or vegetables. Baseline BMI and BMI z-score were not associated with the child's age, with minutes of MVPA per day or with television viewing or screen time. Activity, television and screen viewing, and diet were also not significantly different among obese and non-obese children.

The trial has so far only measured data immediately post-intervention. At baseline and post intervention, 543 children had screen time data, 190 had valid accelerometer records, and 440 children had valid diet records.

The intervention remained effective post-intervention. Children in the intervention group engaged in more MVPA than children in the control schools (difference between adjusted group means = 7.46 min/day, $P = 0.02$). The difference was significant whether MVPA was expressed as min/day or as min/h (in both cases, $P = 0.02$ for difference between groups). Mean accelerometer counts per minute were higher in the intervention group, but the difference was not statistically significant (672.6 vs. 640.1 counts per min, $P = 0.06$). Children in the intervention group had significantly less total screen time than children in the control group (-27.8 min/day, $P = 0.05$), although there was no significant difference between groups in television viewing. However, there were no significant differences between groups in energy intake, dietary fat, dietary fibre, or consumption of fruit, 100% fruit juice, or vegetables. There were no significant differences in BMI, BMI z-score, but this was expected given that the trial was prevention focused.

The results were significant but post-intervention activity levels were still below recommendations of 120 min of MVPA daily. The same was true of screen time. The mean screen time in the intervention group was 4.7 h/day compared to the US recommended two hours of total screen time per day for children.

In an earlier study (Fitzgibbon et al. 2004) two-year follow-up data is available. This study was a randomised controlled trial conducted between September 1999 and June 2002 in 12 Head Start preschool programs in Chicago. The design mirrors the latter study described above. This trial showed effectiveness in reducing subsequent increases in BMI in preschool children. Children had significantly smaller increases in BMI compared with control children at one-year follow-up. The increase in mean BMI in intervention children was 0.02 kg/m², whereas mean BMI increased by 0.64 kg/m² in control children ($P = .002$). Change in BMI z-score also differed significantly between groups (-0.06 vs 0.13, $P = .024$). At Year two post-intervention, the mean increase in BMI was 0.65 kg/m² higher in control group children, or 1.14 and 0.48 kg/m², respectively ($P = .008$). The difference in change in BMI score was 20.14, or 0.02 and 0.16, respectively ($P = .021$). Intake of total fat and dietary fibre per 1000 kcal,

exercise frequency and intensity, and hours of TV viewing were not significantly different between groups at any study stage.

Mechanisms

Fitzgibbon et al. (2011) describes the conceptual framework of Hip to Health Jnr. as based on social cognitive theory and self-determination theory. The former places emphasis upon modelling behaviour in order to encourage children to try new foods as well as engage in new activities. In the same way as Food Dudes, this places importance upon repeated exposure to new foods. Self-determination theory distinguishes between behaviours that an individual performs freely and those that an individual feels coerced to do. It also targets psychological needs such as feeling competent, being part of a group and having friends.

Tools

The key tools used in Hip Hop to Health Jnr. are as follows:

- A specially produced CD with program songs and raps and two fully scripted 20-minute exercise routines;
- Each parent also received the same CD that the teacher used in the classroom so that the nutrition concepts and importance of PA could be reinforced in the home;
- 'Pyramid Puppets' (colourful, friendly, handheld puppets) representing the seven food groups of the food pyramid were used to lead the children in various activities and adventures;
- In the PA sessions, the teachers used multiple games and approaches, such as aerobic "trips to the zoo" where children pretended to be different animals;
- Weekly parent newsletters.

Insights

- This intervention demonstrates the efficacy of an intervention tailored to a particular minority ethnic group.
- An obesity prevention program can effectively and feasibly be taught by classroom teachers (Fitzgibbon et al. 2011). However, teachers require both intensive initial training and on-going individualised supervision.
- Teachers were more comfortable delivering the didactic nutrition information than they were delivering the PA sessions. This is because children were initially resistant to engaging in activity for a full 20 minutes and became distracted, and many of the teachers were not well-equipped given their own physical limitations (Fitzgibbon et al. 2011).
- The trial did not deliver dietary change. This may be related to parental support and the intervention could usefully include a stronger parental intervention component. Providing a home-based component as an adjunct to the school-based element can improve both outcomes and sustainability (Fitzgibbon et al. 2011).

4.6 MEND

Background

MEND is a family based intervention delivered by non-specialists in community settings to children in four different age groups (Swain, 2009). It is primarily treatment for the older age ranges, and prevention for the two to four age range.

MEND provides practical, accessible advice working in partnership with local organisations. MEND healthy lifestyle programmes aim to prevent obesity that results from inactivity or poor diet, and also to treat those above a healthy weight (MEND Central)

Content

Since its launch in 2005, 10,000 children and families have participated in the course. Criteria for participation is that children are clinically overweight or obese (on or above the 91st BMI centile) without evident serious co-morbidities (Swain, 2009).

Programmes combine parent workshops (HE, portion control, regular eating, healthy snacking, interpreting food labels, a supermarket tour, cooking techniques, and food tasting sessions) with active play and PA sessions for children. Parents and children participate separately in different sessions and then together (Swain, 2009). Behaviour change sessions focus on teaching parents and children to apply techniques such as stimulus control, goal setting, reinforcement, and response prevention. MEND promotes behaviour change by addressing education, skills training, and motivational enhancement (Sacher et al. 2010).

The programmes are embedded into a two-year weight management strategy with tapering support. The aim is neither 'diet' nor rapid weight loss but rather incremental and lasting improvements in families' dietary intake and fitness levels (Swain, 2009).

One programme of interventions is targeted at two to four year olds ('Mini MEND') and in contrast to other programmes of MEND it is a preventative measure, targeting those at risk of overweight or obesity (Hardy et al. 2010). It covers fussy eating, portion sizes, managing sedentary activities, and positive parenting. It uses an evidence-based exposure-based technique to promote acceptance and increased intake of fruit and vegetables (Skouteris et al. 2010), offers active play activities to children, and interactive education and skill development sessions based on group-based parent-training principles (Skouteris et al. 2010). Sessions are designed to be interactive and involve interactive stories, rhymes and songs to help children engage with key messages. A 90 minute session is delivered once a week for 10 weeks. The cost of mini-MEND has been estimated at £199 per family, adding up to a total cost of over £5000 for training and resources for one programme, not including salaries (Hardy et al. 2010).

The programmes for older children (split into programmes for 5-7 year olds, 7-13 year olds, and 13-16 year olds) are delivered over 10 weeks with one weekly 1 hour 45 minute session for 5-7 year olds and two hour sessions twice a week for older children.

The MEND programme has inspired similar models of delivery. A pilot programme, Fighting Fit Tots, was developed within a local Sure Start area in Lambeth, and included parent and toddler PA sessions followed by parent workshops facilitated by nutritionists and health visitors (Wolman et al. 2008).

The Move It Challenge is another aspect of MEND. It aims to encourage PA (including walking and house cleaning as well as sports) for 7-11 year olds regardless of weight. The intervention is school based but parents are encouraged to get involved.

Outcomes

MEND is evidence-based and meets all NICE guidelines on the management of overweight and obesity (Swain, 2009). Robust evidence includes an RCT with an intervention group of 54 children on a nine-week programme measuring waist circumference (primary outcome), BMI, body composition, PA level, sedentary activities, cardiovascular fitness, and self-esteem (Sacher et al 2010). 83% of the intervention group were seen at either 6 or 12 months from baseline. Outcomes were very positive. At 12 months, children in the intervention group had reduced their waist and BMI z-scores by 0.47 ($P < 0.0001$) and 0.23 ($P < 0.0001$), respectively, and benefits in cardiovascular fitness, PA levels, and self-esteem were sustained. These outcomes compare very favourably to findings from other RCTs of similar interventions, particularly in terms of waist circumference and BMI.

Findings from a small single location trial of a 'mini-MEND' (two to four year olds) programme identified some short-term outcomes, such as parent self-reported ability to manage their child's behaviour more effectively, give their child a wider range of fruit and vegetables, and read and interpret food labels properly (Hardy et al. 2010). An RCT of a Mini-MEND has been established (Skouteris et al. 2009) but results are not available at the time of writing.

Studies of similar 'family-based behavioural treatments' have shown mixed success. While not a study of a MEND intervention specifically, Croker et al's (2012) study of a 'family-based behavioural treatment' (FBBT) for childhood obesity offers useful insights and also questions the positive outcomes found in other studies, especially of FBBTs in the US. The authors of this RCT attempt to examine effectiveness in a UK setting; the aim was to examine the impact of a six month FBBT programme carried out in a hospital setting on overweight and obese 8-12 year olds. The findings were that while there were BMI standard deviation score (SDS) changes ($p < 0.01$) for the treatment and control groups of -0.11 (0.16) and -0.10 (1.6), the between-group treatment effects for BMI, body composition, blood pressure and psychosocial outcomes were not significant. There was no overall change in BMI or BMI SDS from 0-12 months for the treatment group.

The results contrast with other studies of FBBTs and also a prior Cochrane review which found a significant pooled treatment effect of -0.06 BMI SDS from behavioural interventions compared to usual care. This may be partly due to divergences in use or BMI indicators. However, the MEND study of Sacher et al. (2010) is not comparable because it does not employ an intention-to-treat (ITT) analyses, something Croker et al. (2012) argue can inflate intervention group outcomes. Another reason for these findings is the high prevalence of overweight in the parents and high level of psychosocial difficulties in the children.

Mechanisms

Sacher et al. (2010) describe MEND as engaging families by addressing the three components necessary for individual-level behavioural change: education; skills training; and motivational enhancement, while also taking account of other systems of influence within the family context. Sacher et al. (2008) suggest that MEND incorporates the psychological principles of learning theory, habit development, parenting skills, group work and social learning. The behaviour change sessions in the programmes aim to establish a health-promoting home environment and focus on teaching parents and children to apply techniques such as stimulus control, goal setting, reinforcement, and response prevention. They also cover how to deal with role modelling, setting boundaries and problem-solving (Swain, 2009). An important component of the programme is having SMART goals and rewards.

Tools

- The **MEND website**, where parents can register for programmes, has a BMI calculator and also allows teachers and health professionals to order the 'Your Life, Your Choice' pack, an educational resource (lesson plans, worksheets, DVD clips etc.) to support the Citizenship and PSHE elements of the National Curriculum for Key Stage 3 students (11-14 year olds) and the Healthy School Standards. The aim is to help 11-14 year olds make responsible healthy lifestyle choices.
- There are structured **weekly nutrition targets**, hand-outs and child-size portion measuring pots and wallet-sized cards featuring label reading tips (Swain, 2009).
- The **Move It Challenge** involves children earning points in return for activity (MEND Move It, 2011). The key tool is a Points Wheel which is used to track self-reported activity over a week. Children are able to use the Wheel to choose the activity they did (e.g. rollerblading, trampolining, cycling etc.) on a particular day of the week and the time spent doing it (10, 15 or 30 minutes). Points are calculated and added into a table, and at the end of the week an award is given as to what level was achieved (1 to 6). The Wheel and a Tracker table are available as an interactive online tool or as printable downloads. Children are given stickers to denote the level they achieved. There is also a similar school class challenge. Teacher resources support the Challenge.

Insights

- MEND works with the whole family context and explicitly intervenes in respect to parenting factors (Swain, 2009);
- MEND uses appropriate goals setting, specifically SMART (specific, measurable, attainable, relevant, timely) goals for participants (Swain, 2009);
- It explicitly promotes behaviour change through a focus on education and skills and a focus on behavioural techniques for families to apply (Sacher et al. 2010);

- An important aspect of MEND programmes have been their acceptability - an RCT found an 86% attendance rate, suggesting considerable acceptability by families (Sacher et al. 2010);
- The programmes have also benefited from being standardised, meaning that they can be delivered by community practitioners with no previous expertise in the management of paediatric obesity (Sacher et al. 2010);
- The Fighting Fit Tots pilot (modelled on MEND) found poor uptake and attendance due to poor parental perception of child weight status - a key lesson is that weight-based inclusion criteria should not be used (Wolman et al. 2008).

4.7 VERB

Launched in 2002 by the Centres for Disease Control and Prevention (CDC), the VERB social marketing campaign aimed to encourage children aged 9 to 13 years to be physically active every day.

The campaign ran for four years from 2002-2005 (preceded by one year of campaign development) and sought to inspire children to be active, emphasising free-time play in their gardens and local parks. A key principle was to sell PA as a 'fun and cool' way to spend time (Huhman, 2010).

Congress initially allocated \$125 million to CDC in 2001 to launch the campaign; cumulative congressional appropriation was \$339 million. The idea was to create a campaign that would '*help children develop habits to foster good health over a lifetime*' and to use '*methods that are employed by the best kids' marketers*'. With this in mind, CDC commissioned professionals with commercial marketing experience in advertising, public relations, branding, and marketing to youth. They also contracted separately for the general 'tween' market and for marketing to each of four minority ethnic audiences in the US (i.e. African Americans, Asian Americans, American Indians, and Hispanics) (Wong et al. 2008).

Content

The campaign messages were delivered to tweens directly, using kid's language and media channels, and not through their parents or teachers. The age of 9-13 was targeted because this was seen as the age at which behavioural patterns are established.

The brand positioning was that PA is fun and cool, not competitive; accessible for all children, from inactive children to elite athletes; and something appealing and easy to do (Ashbury, 2008). The tag line was 'it's what you do!'. The approach was to encourage play, and the strategy was to encourage tweens to explore what they like to do, discover new ways to be physically active, and pursue a variety of physical activities including participation in both free-time play and organised sports.

Parents and teachers were VERB's secondary audience, but instead of asking adults to be messengers for VERB, they were asked to encourage, support, recognise, and reward tweens for being physically active. Targeting tweens meant that there was lower recognition amongst adults and also that there was a delay in building support for VERB among partner organisations and professional colleagues (Wong et al. 2008).

However, Price et al. (2010) report that parents' awareness of VERB (unaided, aided, overall) increased significantly during each successive year of the campaign. In 2005, parents aware of VERB were significantly more likely than parents who were not aware to have positive attitudes about PA for all children and believe in the importance of PA for their own child. Awareness was also a predictor of whether parents were physically active with their child during the seven days before the survey. However, baseline measures were also an explanatory factor in these variables, meaning that existing attitudes and behaviours were important.

The marketing approach included the following elements (Huhman, 2010):

- Paid television advertising, mainly on cable channels popular with children aged 9 to 13 years old (this delivered an estimated 119 gross rating points (GRPs) per week for television in the first year and about 108 GRPs per week in the second through fourth years of the campaign);

- Advertising in magazines targeted to this age group (average of 80 GRPs per month across the entire campaign);
- An interactive website for the target audience with regularly refreshed content. An 'Activity Finder' facility was launched on the VERB website, alongside a large range of online games which had been developed to attract tweens;
- Text messages sent to the target audience reminding them to play - during a three-month promotion in summer 2005, 19,486 children signed up to have a text message sent (Wong et al. 2008);
- School focused measures in years' two to four of the campaign, mainly through participation of schools in classroom-based activity promotions - there were four major promotions, each reaching children in 2000 to 3000 elementary or middle schools;
- Vans wrapped with bright VERB logos canvassed in local communities and staff set up play areas and street games at the local venues;
- VERB'S advertising partner, Nickelodeon, directed traffic to the VERB Web site and partnerships with media outlets (e.g. Disney) increased the visibility and appeal of VERB;
- National organisations (e.g. National Recreation and Parks Association and Girl Scouts) helped to deliver the message that PA could be 'cool' and 'fun'. Partnerships with local stakeholders also helped to address the environmental determinants of PA.

Outcomes

The latest study on VERB (Huhman et al. 2010) examined the associations between exposure to VERB and PA sessions (free time and organised), and psychosocial outcomes (outcome expectations, self-efficacy, and social influences). The method comprised a telephone survey of three nationally representative cohorts of children aged 9 to 13 years and their parents. Cohorts were studied in 2002, 2004 and 2006.

In regard to the exposure of the campaign, in 2006, 28% of children aged 9 to 13 years had unprompted recall of VERB, and 47% recalled VERB after prompting (75% recall in total). Visits to the VERB Web site increased over the four years. In 2006, more than one million children were registered on the site. The foundations for high campaign recognition were laid in the first year when awareness of the VERB brand was 67% among the target audience. Also, unprompted awareness was just 17 % in this first year, rising to 28 % subsequently.

In regard to PA outcomes for children aged 10 to 13 years, in 2004, 2005 and 2006 children's self-reported PA on the day before the interview was significantly positively correlated with levels of campaign exposure. However, reports of free-time PA in the previous week was only significantly associated with campaign exposure in 2004 and 2005, not in 2006. Organised PA was not significantly associated with campaign exposure in any of the three cohort years. Overall, the effects of the campaign after two years were considerably stronger than the effects found after year one. This suggests that the second year of advertising was critical to sustaining the momentum of year one.

There were also significant dose-response associations between exposure and psychosocial outcomes for children aged 10 to 13 years, including belief in benefits of being physically active (outcome expectations), self-efficacy to be physically active, and social influences on their PA.

Longitudinal analysis of cohort one (those targeted in 2002 and now 13 -17 years old) found positive dose-response associations in 2006 for free-time PA and outcome expectations. Other outcomes lessened in 2006 compared to previous years of the campaign, and as with cohorts two and three, organised PA was not significantly associated with the campaign. Effects therefore lessened as children aged out of the campaign target age range, but the findings suggest that some of the changes made in PA levels of children exposed to VERB were being sustained into their early adolescent years.

Providing communities with a higher dose of marketing activities and sustaining those activities over time was found to produce more positive outcomes (Berkowitz, 2008). A comparison of outcomes in six communities that received additional VERB marketing activities (50% more advertising and special campaign activities) with a control group, reported higher levels of awareness and understanding of

VERB messages, greater self-efficacy, more sessions of free-time PA per week, and were more active on the day before being surveyed.

Cost / cost-effectiveness

At an aggregate level, Congressional appropriations were \$68.4 million in 2002, \$51.3 million in 2003, \$36 million in 2004, and \$59 million in 2005 (Wong et al. 2008).

Mechanisms

The programme strategy was informed by two theoretical models: the Theory of Planned Behaviour and Social Cognitive Theory. Drawing on these theories the campaign messages sought to promote the benefits of PA ('it's social, fun, and cool'), self-efficacy (try new activities, you don't have to be a pro to be active), and social influences (many of your peers are having fun being active).

Based on these theories, CDC produced its own 'logic model' for VERB, which linked the key determinants of PA based in the two theories to the outcome measures on which the campaign would be evaluated. Bauman et al. (2008) found that increased awareness and understanding were the key proximal effects that led to behaviour change in VERB. This suggests that the sequence of effects bypassed attitudes and outcome expectations. Tweens who understood the message were more likely to engage directly in more PA, than were those who did not understand the message. Understanding the message was a necessary mediator of campaign effects.

Tools

- School-based promotions delivered particular packages of materials. For example, 'VERB Crossover' a three-week school program that guided children to combine basketball with another activity, included kit of inflatable vinyl basketballs, teacher guides, parent letters, two posters, a dry erase, laminated bracket poster for competitions, a classroom interactive tool, award certificates, and prizes such as terry cloth wristbands and rubber band bracelets (Huhman et al. 2010).
- Also, six community-based promotions were implemented, with 20,000 ready-to-use kits delivered to youth organisations.
- The VERB Web site had the facility for children to play virtual playmates, get virtual tutoring on sports skills like soccer and tennis moves, and record their PA to receive prizes and incentives.
- Particular campaigns used tools to integrate advertising, marketing, and website activities to reach the target audience. For example, the YELLOWBALL, a national activity promotion, involved distribution of 500,000 large yellow balls printed with the VERB logo to encourage play with the balls, to go to VERB's tween website to blog about how they played, and then pass the balls on to friends or family members to encourage other children to play. Participants could also create videos of yellow ball playing (Wong et al. 2008).

Insights

There were a number of key learning points from the marketing campaign (Wong et al. 2008):

- The value of the brand: evidence suggested that VERB resonated with tweens, who are at a transitional stage in their lives as they simultaneously try to discover their own identities and be accepted by their peers. The brand success owed much to its broad appeal and its emphasis upon encouragement to explore individual interests and to play and have fun with other children (Ashbury et al. 2008).
- Integrity and consistency of brand message: all partners and stakeholders had to incorporate brand attributes into whatever VERB activities they implemented. All communications were 'on brand'. Attempts by organisations or communities to create their own materials were carefully managed by CDC and the marketing agency.
- Avoidance of mixed messages: the campaign was first launched with messages of both PA and pro-social messages. This was found to be confusing and was sending a mixed message to tweens to be both physically active and sedentary.

- Marketing budget: funding for media time and new advertising materials (as opposed to donated media time) provided an essential level of control and creativity. This strengthened the reach and the message.
- Incorporating the many dimensions of PA: aspects such as making social connections, increasing self-esteem, acquiring expertise, being inspired, having fun, being creative, and being in control were all attributes that were emphasised as selling points.
- Addressing the determinants: in presenting the evaluation results, the authors at CDC noted that: “improving children’s PA will require multiple approaches, including more physical education in schools, programs that address transportation and other barriers to being active, public and private efforts to increase access to safe places for children to be active, and marketing PA in cool and fun ways directly to children.” (Huhman et al. 2007: p39). In so doing they acknowledge the limitations of marketing campaigns in changing levels of PA, and reach a conclusion which is similar to one of the Foresight reviews, which found that “persuasive public message campaigns” are one of the few potential means for tackling the apparent increase in sedentary behaviours, but that they must be accompanied by “environments and incentives for alternative activities that involve more PA” (Fox & Hillsdon 2007: p119).
- Audience segmentation: VERB had a two-level strategy for its marketing, one level designed to reach a general audience of tweens, and second level specifically to reach four racial or ethnic audiences. This was justified due to demographic, language, and media-use habits that differ between ethnic populations (Huhman et al. 2010). A qualitative evaluation found that tweens and parents in the target groups found the advertising messages relevant, motivating, and appealing. The survey found that there was no difference in different ethnic groups understanding of the campaign message (Huhman et al. 2008).
- The value of experimental marketing (a live event or experience that gives the target audience the opportunity to see a product and experience it for themselves): this articulated the notion of ‘play’ in VERB, whereby events were used to get children to play in their local community spaces (Heitzler, 2008).

4.8 Walk Once a Week

Background

Walk Once a Week is one of the programmes within the Travel Actively programme and is led by Living Streets.

As part of Travel Actively, Living Streets and Sustrans have implemented several schemes to encourage children and young people to walk to and from school. Key initiatives have been funded through the Travel Actively Programme, funded by the Big Lottery Fund running between 2008 and 2012 and managed by the Active Travel Consortium, led by Sustrans and also including British Cycling, Campaign for Better Transport, CTC, Living Streets, London Cycling Campaign, National Heart Forum, National Obesity Forum, The Ramblers and Walk England. It aims to encourage walking and cycling behaviour change through practical support and information. Around 50 projects have been running in communities and schools, with target groups including BME groups, people with disabilities, people with mental health problems, the elderly and the young.

Content

Walk Once a Week (WoW) is part of Living Streets’ Walk to School campaign. Running since 2005 and now engaging around 300,000 primary school pupils in 1,895 schools, WoW involves school classes recording their daily journey on a wall chart. At the end of each month every child that has walked at least once each week, is rewarded with a badge (Wavehill Consulting, 2009). WoW incurs a cost to participant schools as they must buy wall charts and badges. Average cost for a school is £320 per year or between £2.31 and £3.38 per pupil per year (Wavehill Consulting, 2009).

It is also worth noting the ‘Step up’ project by Living Streets, which is another Travel Actively project that targets children. This targets secondary school pupils walking to school by increasing their interest

in their local area and providing the skills required to campaign for improvements. Free Your Feet, a national challenge week in summer 2011 aimed to increase the number of pupils walking to/from school and to increase the amount of time spent walking.

Other strands of Travel Actively are as follows, but do not directly target children (Sustrans, 2011):

- **Active Travel (Sustrans):** promoting walking and cycling for everyday journeys through information and advice and activities such as bike loans, health walks, cycle rides, workplace events, cycle training, and bike maintenance classes. The project has used volunteer Active Travel Champions.
- **Get Walking Keep Walking (Rambblers):** encouraging inactive people living in urban areas to walk regularly and independently in their area. The 12-week programme involved information and motivation together with led walks.
- **Walking Works (Living Streets):** encouraging walking, especially to work, through a range of support materials.
- **Community Cycling Champions (CTC):** encouraging less active people to start cycling by facilitating community grants to help eliminate barriers related to cycle training, bike maintenance, access to bikes, and organised bike rides.
- **Fitter for Walking (Living Streets):** the rationale is that every day walking could be encouraged by improving local surroundings (Adams et al. 2012). Project coordinators are used to recruit local community groups and to conduct community street audits. Participants are invited to make a pledge to walk more often and Living Streets Awards are given to neighbourhoods, groups and individuals.
- **Travel smart (Sustrans):** a personalised travel planning (PTP) scheme designed to reduce car use and encourage walking and cycling. It aims to enable people to make changes to their daily travel choices and does this through the Individualised Travel Marketing (ITM) process. Using a customer segmentation model (regular users of sustainable travel modes; non-regular users who are interested in finding out about sustainable travel; and those who are not interested in taking part), 'interested customers' can order materials and services. Non-interested users are offered home advice sessions.

Outcomes

- **WoW (Living Streets):** The evaluation of WoW (Wavehill Consulting, 2009) involved a hands-up and stand-up survey of 23,450 children in 961 classes and assemblies in 2009 (69% of these were in London). Nineteen per cent of respondents who walk to school said that they started to walk to school due to WoW. Twenty three per cent of children surveyed walk with their parents. In 2009, a total of over 3.5 million badges were distributed (85% of these were in London).
- **Step up (Living Streets):** 2010 internal monitoring data (Sustrans, 2011) shows that pupils walking none of their journey to and from school fell by 14% from the week before the challenge to the week after the challenge.

Mechanisms

In WoW classes record their daily journey on a wall chart. Badges are given as rewards on this basis. We therefore see the combination of self-monitoring with extrinsic rewards.

Tools

- **WoW (Living Streets)** uses wall charts or postcards for children to record their daily walking on a school class basis. They receive a badge for walking at least once a week. The badges are designed as part of a pupil art competition. Wall charts and badges are based on an Around the World theme. A character, Strider, visits a new country each month. A starter resource pack is available to order. Organisers are encouraged to run a launch event.
- **Free Your Feet (Step-up)** uses a DVD (containing information about the benefits of walking to/from school), a PowerPoint presentation, and a poster. A key element was the

use of record cards for pupils to document how much walking they did. Cards were entered into a prize draw at the end of the week. An evaluation (Duncombe et al. 2012) found that students recalled the record card but most did not complete it (mainly because they lost it or forgot to do it). It is suggested that a reward for completing the record could be a good incentive.

Insights

- WoW is easy to implement by schools (no training, manuals or mentoring) (Wavehill Consulting, 2009).
- The simple concept of WoW readily engages children (Wavehill Consulting, 2009).

4.9 Zamzee

Background

Zamzee was established in 2010 by HopeLab, a non-profit technology research organisation. Zamzee is a social enterprise with the objective of increasing PA amongst children and families (Zamzee, 2010). The Zamzee accelerometer unit is sold for around \$30. Other income streams come through commercial sponsors of some challenges who provide reward goods free of charge.

Content

Zamzee is marketed as a game for children, as “a game that gets kids moving”. It targets children aged 9 to 15 years old, with the rationale that this is when activity can decline and when life habits may form.

Importantly, the meter measures intensity of activity, not just steps. It has a three-axis accelerometer which measures both the time and intensity of PA. The meter unit clips onto shoes, shirts or pockets.

Users can install Zamzee software and create a personal account. The meter is plugged directly into a USB port for download of activity data. This shows tracked movement (daily or to the minute). Parents can use Family View to view the activity of all their kids.

Users' personal account features goals, challenges, and level markers. Goals are in place in the form of special accomplishments, such as beating a daily average, and challenges, such as time-based story adventures. Children are also encouraged to progress through a hierarchy of levels and earn badges for doing so.

A points system is used to add enhance motivation and distribute rewards. Points are collectable on completion of challenges. A five-minute walk typically earns about 20 Points. Points translate into the website currency, 'Zamz'. Parents are also invited to transfer points into real monetary rewards for children. It takes about 1,000 Points to earn a \$5 'Goalz' award.

Outcomes

HopeLab conducted their own RCT of Zamzee with 11-14 year olds (mean 12.7 – SD 0.8) recruited from six urban, suburban, and rural US middle schools ($n = 448$)² (54% female and 46% male; 45% white, 25% Hispanic, 14% African American, 12% multi-ethnic, and 3% Asian). Participants were randomised to either a passive control group or to an intervention group that used the motivational website. Both groups carried the Zamzee unit during waking hours for six months.

MVPA levels were assessed continuously over six-month follow-up. Lipid, metabolic, and inflammatory biomarkers were assessed at baseline and six-month follow-up (four sites). BMI and leukocyte gene expression were also assessed at baseline and six-month follow-up.

The intervention group showed an average 59% higher rate of MVPA compared to the control group (mean = 118 min/week \pm SE 3 vs. 74 \pm 5 for controls; $p < .0001$). There was no lessening of impact over the six month period. These effects correspond to approximately 1,120 min MVPA and 8,800 kcal expended per participant over six months.

² Provided to the research team by HopeLab.

The intervention group also achieved CDC recommended 60 min MVPA/day at a rate 4.5 times that of controls (3.1% ± 0.3% of days vs. 0.7% ± 0.4%; p < .0001). A pilot study prior to launch of Zamzee also found that it enhanced MVPA by ~30% (p < .0001).

Zamzee was also found to be effective with overweight children (BMI>25). Compared to the control group, this group saw a 27% increase in MPVA.

Within the biomarker sub-study (n=186), involving pre- and post-study blood sampling, the intervention group showed more favorable pre- to post-study changes in LDL cholesterol, total cholesterol, and blood sugar levels, However, non-significant effects were observed for CRP and BMI.

Mechanisms

Zamzee combines individualised feedback, progress monitoring and goal setting, tangible incentives, and intrinsic motivation features to promote a long-term increase in PA (HopeLab).

The results of the RCT point to the importance of the motivational elements within the intervention, particularly the rewards. HopeLab emphasise extrinsic and intrinsic rewards to initiate and sustain behaviour (HopeLab, 2012). It is suggested that intrinsic rewards provide positive experiences related to PA. Children are said to develop a sense of competence, autonomy, mastery, purpose and relatedness.

Tools

- The Zamzee unit, which is a three-axis accelerometer that clips easily onto clothes;
- A motivational website with personalised features;
- Users' personal account features goals, challenges, and level markers;
- Badges for reaching level markers;
- 'Zamz' are collected and can be exchanged for rewards. Rewards include things like iPods, 'Angry Birds' back packs, games, toys, gift cards, and charitable donations.

Insights

- The motivational website is the key element (not accelerometer alone) in increasing children's PA. The points system is particularly effective in enhancing motivation. The website brings individualised feedback, progress monitoring and goal setting.
- Success is also attributed to the combination of extrinsic and intrinsic rewards. The rewards are expected to give way to intrinsic rewards that become apparent through having carried out PA.
- The game is very social; children can compete with each other and communicate through the website. It can also be played as a family.
- The rewards appear relevant and desirable for children. They can be quite significant in monetary terms. Zamzee is able to do this through corporate sponsorship arrangements.

4.10 Hypothesised mechanisms within case study interventions

Section 3 set out an approximate ranking of mechanisms for under 12s, based on the prevalence of each mechanism across the effective interventions reviewed in this study (thus the highest ranking mechanisms are the most ubiquitous), in combination with the relative applicability of each mechanism to the different age ranges across the audience of 2 to 11 year olds (thus the most widely relevant are ranked most highly). The following hypothetical ranking of mechanisms for PA and HE interventions with 2 to 11s is suggested:

1. Fun
2. Rewards
3. Social Support
4. Skills
5. Self Monitoring
6. Social Comparison
7. 'Goal' Setting
8. 'How To' Info & Advice
9. Surprise

Further detail on these effective mechanisms is provided at the level of the case study interventions: both in terms of how mechanisms are combined in an intervention, and which combinations appear to be associated with intervention effectiveness. The case-by-case analysis should also provide greater colour on each mechanism, helping practitioners understand better how each mechanism works, as well as giving them practical ideas for activities which can implement a particular mechanism within their intervention.

The results of this assessment of case study intervention by mechanism are presented in Table 4 below; shaded boxes identify a particular mechanism present within an intervention, while darker shading is used to indicate a stronger emphasis on that mechanism. The Table confirms the importance of Fun, Rewards and Social Support as mechanisms. Each of the nine selected interventions contains these mechanisms – albeit delivered in different forms and with stronger or weaker emphasis – suggesting that interventions designed with Fun, Rewards and Social Support in mind will have an increased chance of success in preventing obesity.

Table 4 Hypothesised mechanisms within case study interventions

	[Interventions]								
[Mechanisms]	Active8 Eatwell	Beat the Street	Color Me Healthy	Food Dudes	Hip Hop to Health Jr.	MEND	VERB	Walk Once a Week	Zamzee
FUN	Uses cartoon characters and play based approach to teaching	Frames walking as fun; Beatboxes / cards have appealing branding	Focus on play and having fun; use of songs (e.g. Heartbeat Beat) and games	DVDs use of 'Food Dudes' and 'Junk Punks'; also songs	Program songs (e.g. 'Bake Don't Fry') / raps / puppets used to convey messages	Sessions for younger groups involve stories and songs	PA framed throughout as being fun – emphasis on play	Frames walking as fun; use of 'Strider' character	Website is designed to frame PA as fun; avatars / games / graphics used
REWARDS	Extrinsic rewards to encourage tasting; intrinsic thereafter	Offers prizes and charity donations; depends on distance walked	Small rewards used, e.g. handstamps for children	Extrinsic at first to encourage tasting; intrinsic thereafter	Monetary incentive for parents on completion of homework	Children get stickers as rewards for PA	Website provided some incentives / prizes	Use of collectable badges (designed through art competition)	Rewards are a key feature – extrinsic at first; intrinsic thereafter
SKILLS						Focus mainly HE for parents, PA for parents and children	Equipment (e.g. Yellow ball) used to promote play and skills		
SURPRISE						Tools to show (e.g.) sugar in a packet of sweets			Children / their parents learn more about PA levels
SOCIAL COMPARISON		Competitive between individuals and schools		Use of peer modelling and role models (Food Dudes)		Group sessions used; whole family intervention	Many of the messages were about peers' PA	WoW badges are collectable, enabling comparison with peers	Children can compete / compare with peers
'GOAL' SETTING		Relative goals set through competition		Some goal setting to achieve certificates		More focused on parents		Focused on the 'once a week' goal	Central to achieving rewards
SELF MONITORING	Eatwell plate acts as a tool to support	Website where children can track their		Use of wall charts in school; done		Children can monitor levels of PA through		Use of class wall charts (forthcoming)	A core part of the website, tracking

	[Interventions]								
[Mechanisms]	Active8 Eatwell	Beat the Street	Color Me Healthy	Food Dudes	Hip Hop to Health Jnr.	MEND	VERB	Walk Once a Week	Zamzee
	self-monitoring	progress (and others')		by parents through the Home Pack		'Move It Challenge'		interactive whiteboard software)	progress to rewards
SOCIAL SUPPORT	School / class based	Targets parental norms re. walking to school; also builds peer networks (walking groups)	Delivered in 'circle time' to groups	School / class based; strong use of peer modelling	Parental involvement a strong feature	Group sessions run in local community settings	Encouraged user generated games / exchange of ideas	Both promote walking in groups	Family involvement encouraged (eg. via Family View online pages)
'HOW TO' INFO & ADVICE	Provision of information for children	Some tips on increasing walking distance	More for parents to support the curriculum (backed by website)	Provides advice on HE	Concentration on tips and ideas (for children and parents)	Focus on equipping parents with skills to make healthy choices		Some tips on increasing walking distance	Users able to exchange tips on reaching goals

5. Tools Fact Files

This final section features a set of ‘fact files’ on particular tools. As described earlier in the report, tools are a component of the conceptual framework informing the review. ‘Tools’ refer to specific pieces of equipment and function through a particular ‘format’, such as being online, a phone app, or paper-based. Tools play a particular role within the operation of a mechanism. They do not effect obesity prevention or behaviour change in themselves; they support or trigger a mechanism. For example, a food diary tool may work well because of its role as a means of a person recording their food intake; a pedometer may work well because it is linked to incentives or a game.

This shortlist of tools was identified from a long list of tools located through literature searches, interviews, and suggestions by the Department of Health. The final selection of tools was based on practical considerations related to their potential use with 2-11 year olds, and the extent to which they were seen as innovative. The tools are not necessarily ‘proven’ to be effective since evidence is generally not available at the level of tools. Most of the information presented in the fact files below is of a practical nature and includes interpretive insights from the research team.

Each case study is structured according to a consistent template: description, examples, and considerations. The eight fact files are as follows:

Summary of tools

Tool	Examples	Intervention type
Pedometers and accelerometers	Nike+ Fuelband Striiv Play	PA
Stickers, badges, prizes	Walk Once a Week/ Walk on Wednesdays Free your Feet Beat the Street	PA and HE
Portion sizing	Eatwell Plate Food Models and Photographs Interactive Portion Size Assessment System	HE
Food diaries	MyNetDiary The Eatery	HE
Energy balancers	Energy Balancer App Find Your Balance Challenge	PA
Lifestyle info	Blink Take Two Campaign	PA and HE
Menu planners	Be Food Smart Food a fact of life	HE
PA equipment	VERB Yellow Ball	PA

Section 5.9 following the tool fact files provides a summary of the tools and identifies the primary mechanisms associated with them and the most suitable age groups to which they can be applied.

5.1 Pedometers and Accelerometers

Description

Pedometers and accelerometers are small, portable instruments which, at their most basic level, measure the number of steps an individual takes. Modern versions of these have become increasingly sophisticated, measuring sleep, intensity of activity and linking to apps and websites. The principle

behind both is that immediate visual feedback on individuals' exercise helps increase their awareness of how their day-to-day behaviours and choices affect their levels of PA. They can encourage individuals to value and increase the walking that is incidental to their normal everyday activities (Rettie, 2012).

The two use different mechanisms. Pedometers work by bouncing a horizontal arm up and down each time someone takes a step; detecting vertical motion and hip movement. They are relatively cheap, costing between £5 and £40. Conversely, accelerometers use a piezoelectric strain gauge to measure vertical motion. The different mechanisms mean that accelerometers are more accurate, able to be worn in a non-vertical position, and can measure intensity of exercise. They often now link with GPS, allowing them to trace routes and calculate the pace of travel. They are more expensive, costing from \$30 (Zamzee) to £129 (Nike+ FuelBand).

Accelerometers can be split into three categories, most of which are aimed at adults:

- *Fitness trackers*, for example Jawbone's Up, Nike+ FuelBand and Fitbit One. These will all also link to smartphone or tablet apps, can track steps, distance travelled, calories burned and stairs climbed.
- *Play-linked accelerometers*, for example Striiv Play (for adults) and Zamzee (for families and children). As well as allowing sophisticated tracking and monitoring of activity, these also introduce an element of play and competition.
- *Phone-based*, such as bActive. These utilise the in-built accelerometers now present in most phones. This means that there is no need for activation, or additional specialist equipment.

Examples

Nike+ Fuelband: This is an accelerometer embedded in a wristband. It measures individuals' movement in a 'universal metric of activity', NikeFuel. This allows different activities (e.g. basketball, walking, dancing) to be compared to each other. An accelerometer in the wristband monitor monitors activity and matches movement patterns to a Nike proprietary index. The band syncs wirelessly to PCs and a mobile app, allowing users to:

- View progress using charts and graphs;
- Play and share accomplishments with friends;
- Unlock awards, trophies and surprises;
- Set daily activity goals, where progress is marked by an LED display on the band lighting up from red to green to track progress towards the target.

Striiv Play: This is a small accelerometer, costing \$70, which links movement to games. Trophies can be earned for real-life achievements such as burning off a cupcake; walking the equivalent length of the Golden Gate Bridge; or climbing the equivalent number of stairs as Mount Everest. It also links to an online gaming platform – Myland, where users can complete challenges to earn points to spend on goods in the fantasy world.

Considerations for use

Considerations over the use of pedometers and accelerometers, particularly with a younger audience, centre around the mechanisms they use to effect behaviour change; the effect of increased numbers of steps on BMI; and access to smartphones.

Much of the research done on the effectiveness of pedometers and accelerometers considers adolescents and adults, and raises two key motivating mechanisms. The first is self-monitoring and feedback, which Tudor-Locke and Lutes (2009) found to be much more effective when linked to a formal process of recording values (e.g. a chart or calendar). This links well to the sophisticated visual graphing, and instant feedback, offered by most of the modern accelerometers. Requiring participants to submit their readings in some form was also found to enhance accountability, with follow-up support an essential motivator. Again, modern accelerometers will seek to exploit this mechanism through the social sharing aspects of the devices. An RCT of *bActive*, for example, showed that feedback that included the average activity levels of others was marginally more effective at increasing walking among 23-40 year old males than feedback containing only the individual's data (Rettie, 2012).

Issues arise over whether the self-monitoring element of accelerometer and pedometer use is effective for 2-11s, particularly those at the lower end of the age range. Duncan et al (2012) investigated pedometers as part of an integrated curriculum intervention to enhance PA among the 10-11s. Goal-setting, rather than just self-monitoring, was used as the main motivator, with children asked to complete a four-week virtual walk from John O’Groats to Lands’ End. Steps per day were significantly higher during and post intervention, compared to baseline. However, average daily step counts declined throughout the intervention, and up to the follow-up measurement. Children classified as ‘normal’ weight were significantly more active than those classified as ‘overweight/obese’. This was in direct contrast to evidence from adults, which suggests that overweight adults are more likely to complete programmes (Tudor-Locke and Lutes, 2009).

The gaming element of accelerometers such as Zamzee builds on the goal-setting mechanisms used in Duncan’s (2012) study, and evidence suggests that having access to the motivational website (rather than just the accelerometer) led to a 27% increase in MPVA (HopeLab, 2012). Unlike the John O’Groats to Lands’ End intervention, there was no lessening of impact over six months; this could be related to the varied and incremental nature of Zamzee goal-setting, guarding against the ‘novelty’ wearing off. The Zamzee trial looked at 11-14 year olds, and did not distinguish between girls and boys. We therefore cannot be sure whether these kinds of complex games are appropriate for younger audiences, or if they are as appealing to both genders.

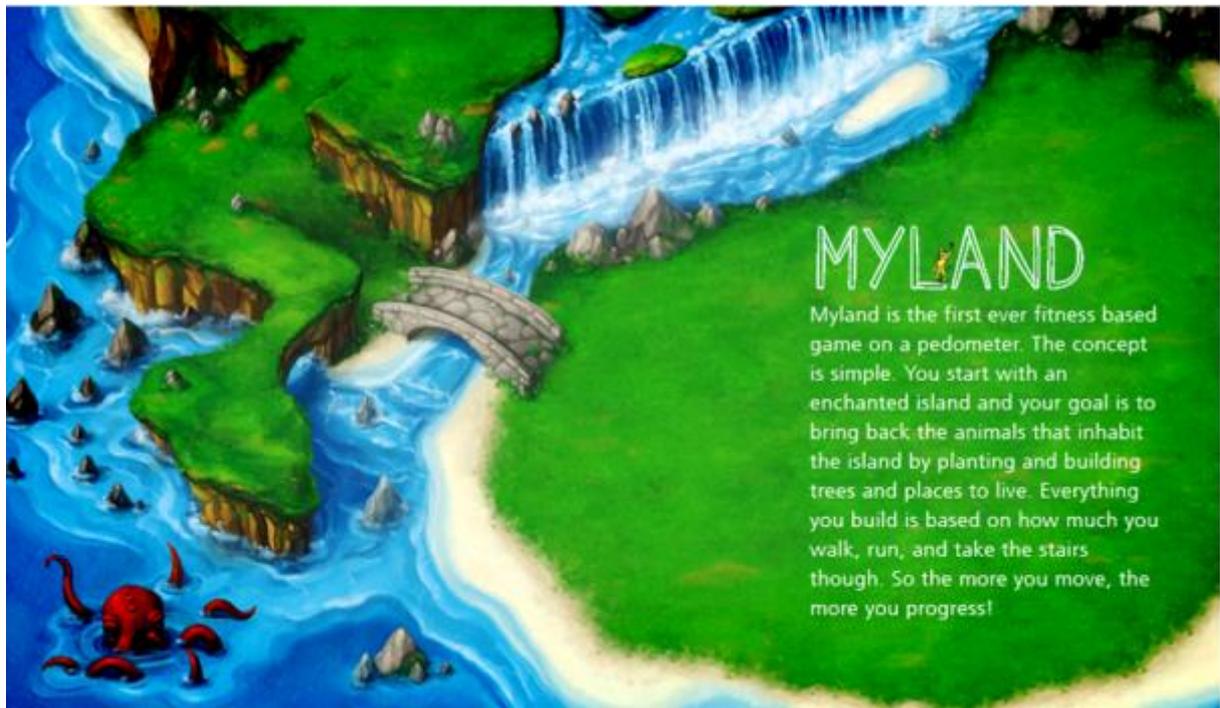
Issues are also raised over the ability of pedometers and accelerometers to effect a change in BMI. In both Duncan et al’s (2012) study and Tudor-Locke and Lutes’ (2009) review, there was no noted correlation between increased steps/day and BMI; although a systematic review by Bravata et al (2007) did find significant declines in BMI, though long-term durability was undetermined.

A final consideration lies in the fact that many of the accelerometers are linked to smartphone apps, which are crucial for goal-setting and motivational feedback. Many children will not have access to smartphones. Ownership of these only outstrips ownership of other phones from age 12 onwards, with only 10% of eight year olds owning one (though we may expect this to increase) (Ofcom, 2012).

Figure 5.1 Nike+FuelBand and smartphone app



Figure 5.2 Striiv Play's Myland game



5.2 Stickers, Badges and Prizes

Description

These are relatively low-tech motivators. Whilst present in many of the more sophisticated examples of other tools (e.g. Striiv Play), they can also be used on their own. Schemes involving stickers and prizes as awards are often quite cheap. Walk Once a Week costs schools around £320 a year to participate, while Free Your Feet is around £170, plus £50 for a shopping voucher.

Examples

Walk Once a Week/ Walk on Wednesdays (WoW): This is a scheme run by Living Streets. It tries to get primary-school kids, and their parents, to walk to school at least once a week. Kids fill in charts in their classrooms, and get collectable badges each month if they've walked to school at least once a week. The badges are designed in a nationwide competition, and are highly collectible.

Free Your Feet (FYF): This is also run by Living Streets, but aimed at secondary schools. Again, the idea is to encourage pupils to walk more, and to generally raise awareness. Each student who walks completes a postcard, collected at the end of each week. All students who complete a postcard are entered into a prize draw to win a voucher. The aim is to encourage pupils to *start* walking, so entry into the prize draw is not dependent on distance/time walked.

Beat the Street: A walk to school campaign, run by Intelligent Health. Each participant is given an electronic card which they tap on 'beat boxes' on the way into school. For each 'beat box' touched, they earn a point. Points go towards raising money for a charity of their school's choice. An online comparison allows students to compare themselves against other students; as well as seeing how well their school is doing overall.

Considerations

- That the rewards are valued is absolutely central to success. 'The evaluation showed that one of the most important mechanisms in the WoW scheme was that the badges were seen as collectable and something to be prized' (Tony Armstrong, 2012, personal correspondence).
- The value attached to rewards may vary significantly by age, and gender. Evaluation of FYF found that most students didn't complete the postcard, and were unmotivated by a shopping voucher as a prize.
- Having tangible, personal rewards is not necessarily crucial. Beat the Street allowed kids to collect points, contributing towards the schools' overall total. These could be converted into donations to a charity of the schools' choice, but the kids themselves received nothing specific.
- Care should be taken to distinguish between extrinsic and intrinsic rewards. Extrinsic rewards include small prizes that help initiate PA or HE; intrinsic rewards are positive experiences which sustain motivation over time.
- The relative balance between extrinsic and intrinsic rewards should be considered. Can one overshadow the other? Are the two of differing importance as children age?
- Should interventions always be based on rewards, not sanctions? Evidence would suggest that rewards are a better motivator and, indeed, that fines can actually facilitate negative behaviours, by removing guilt (Gneezy and Rustichini, 2000).

Figure 5.3 All the WoW badges



Figure 5.4 Free Your Feet Campaign poster



Figure 5.5 Beat the Street Website (www.beatthestreet.me) [Accessed 23 January 2013]



5.3 Portion Sizing

Description

Portion sizing considers both the quantity of food that children should be consuming, and the relative amounts of different types of food. Implicit is also education around food groups, what constitutes them, and why they are good (or bad) for individuals. Tools are generally low-tech, involving posters and guides, and are often delivered as part of a broader HE strategy. They can be both reflective, asking individuals to consider what they have just eaten; and formative, getting people to consider changing how much, and what, they eat. They can be aimed at both young people and their parents.

Examples

FSA's Eatwell Plate: The Eatwell plate makes HE easier to understand by giving a visual representation of the types and proportions of foods needed for a healthy and well balanced diet³. It is based on the five food groups:

- Bread, rice, potatoes, pasta and other starchy foods;
- Fruit and vegetables;
- Milk and dairy foods;
- Meat, fish, eggs, beans and other non-dairy sources of protein;
- Food and drinks high in fat and/or sugar.

It is a stand-alone tool, but is also used as part of broader interventions, for example in Northern Ireland's Activ8 Eatwell programme. This is a primary school-based programme to develop understanding of the links between PA and HE.

³ Based on Government recommendations for the diet that would provide all the nutrients required for a healthy adult or child (over the age of two)

Figure 5.6 Food Standards Agency, The Eatwell Plate



Food Models and Photographs: Food photographs can be used to illustrate increasing portion size, with children identifying the size of their portion based on a scale of different images. Food models can also be used - these are a series of shapes, varying in size, to be used for portion size estimation.

Interactive Portion Size Assessment System (IPSAS): This is a computer programme developed at Newcastle University to assist children in estimating portion size. It uses photographs based on child portions. Children select the portion size served, and any food left over. Results are recorded and stored, to allow easy export to a database (Foster, 2008).

Figure 5.7 Food Photographs (Foster et al, 2008: 177)

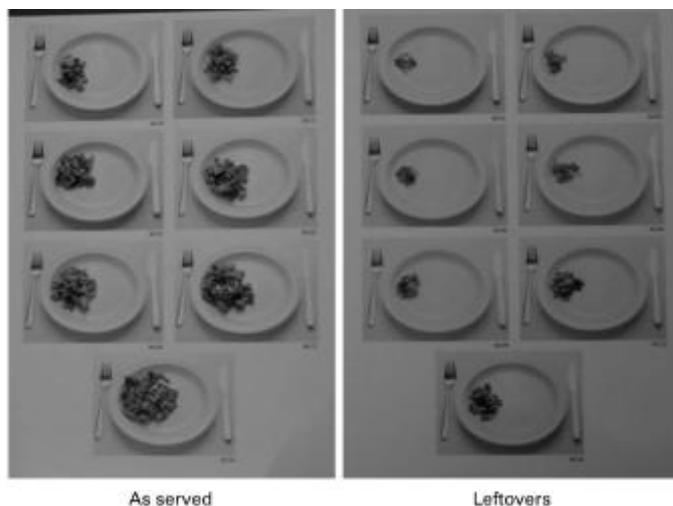


Figure 5.8 Food Models (Foster et al, 2008: 177)



Figure 5.9 Example screen from IPSAS (Foster et al, 2008: 177)



Considerations

- Evidence on the effectiveness of portion control plates for healthy individuals is limited. Although a study by Pedersen, Kang and Kline (2007) showed that a portion control tool was effective in inducing weight loss, this was in individuals with Type II Diabetes.
- A recent study (DiSantis et al 2013) tested the effects of dishware size (ie, plates and bowls) on children's self-served portion sizes and intakes in a naturalistic setting. An effect on portion size in calorie intake was reported. This reflects work done with adults (e.g. Wansink et al 2005).
- Recognition of food groups and portion sizes is not necessarily enough to change behaviour.
- Children's ability to accurately assess their portion size can vary according to the tool. IPSAS and food photographs have high levels of accuracy, but estimates using food models were poor (Foster et al. 2007).
- Children and adolescents may have a preference for capturing food intake using technological methods, such as mobile phones, rather than pens and paper (Boushey et al. 2009).

- Children tend to be better at estimating the amount of food served to them, than the amount they have consumed (Foster et al. 2007).
- Knowledge of the five food groups is not high; education is needed before children can balance their portions. At the beginning of the Activ8 Eatwell programme, only 60% of children recognised that there were five main food groups (Coleman and Moore, 2010).
- Successful strategies should involve both young children and adults; educating children in school can lead to them going home and informing their parents.
- Appropriate portion sizes will vary significantly across the age range 2-11, and possibly for girls and boys at different ages. This needs to be highlighted in any intervention.
- Passive methods of measurement are also possible. For example, the 'smart card' system, originally developed in the UK to pay for pupils' meals, now can also monitor food choices (Lambert et al. 2005).

5.4 Food Diaries

Description

Seven day (or more) weighed food intake diaries were considered to be the gold standard method for measuring dietary intake in research, and are still used as a reference against which other dietary methods are assessed (MRC 2013). Food diaries can also be used by individuals for self-monitoring and feedback. These are increasingly electronic, and based around self-monitoring, allowing people to track their own habits. Photos and social comparisons are used to increase reliability of reporting, a key issue with paper versions. Forward planning is a central feature, encouraging people to plan ahead for the week, then reflect back on how well they've done. Some also incorporate tracking and analysis, shedding light on individual habits and 'trigger points' for unhealthy eating. The vast majority are targeted at adults.

Examples

MyNetDiary: This is a smartphone-based app (costing £2.49), which allows its users to track their daily calorie intake and exercise. As with many apps it has access to a food database. This lists nutrition facts, and assigns an overall 'food score' to each item, providing an easy means for individuals to judge the quality of the foods they eat.

The app also indicates how many calories were burned during the day's PA, and how many calories are left to consume in the day, based on an individual's height and weight.

The Eatery: This is a free smartphone-based app from Massive Health. Unlike most food diaries, it explicitly sets out to *not* be about counting calories. Instead, it uses the pressures exerted on individuals when they share information about their habits with peers. Users snap photos of their food, which friends can then rate. Tracking systems give feedback on individuals' habits, identifying trigger points and habits – a technique used widely by apps, including Slimming World and Weight Watchers.

Considerations

- Food diaries are associated with significant under-reporting (Livingstone et al. 1990), and are not particularly accurate. This is not necessarily an issue when the main objective is to motivate.
- The immediacy of measurement increases accuracy, as it does not rely on individual memory. Apps also facilitate long-term tracking, meaning weekly variations in diet can be monitored.
- Diaries rely heavily on self-monitoring, which will be less cognitively appropriate for younger children.
- The effectiveness of social support/networking features is well evidenced in adults (e.g. Leahey et al. 2011), and could be more cognitively appropriate for younger children than self-monitoring.

- Care would need to be taken to ensure that social support, if it was from peers, was supportive, and directed beneficially. Children will not automatically support healthier choices, as might be the case with adults.
- Combinations of different social support/ networking features are likely to be more successful. Breton et al's (2011) review of apps mentioned *MyNetDiary's* combination of support features (providing means to connect with an expert; allowing interaction with others; having an online messaging board; and connecting to social media) as being a particular strength.
- Apps which move away from explicit 'calorie counting', such as *the Eatery*, may attract a newer demographic.
- It is important to consider the level of control children have over their own diet, and in what way parents are engaged in this process.
- Young children may not have access to a smartphone. Current evidence suggests only 10% of eight year olds have access to one (Ofcom, 2012).
- Smartphone applications have an extremely high turnover, with new examples appearing all the time. Any decision to design an app must consider the likelihood that it may rapidly be replaced by a novel, more exciting app.

Figure 5.10 The Eatery App, iPhone screenshots (iTunes store, 2012)

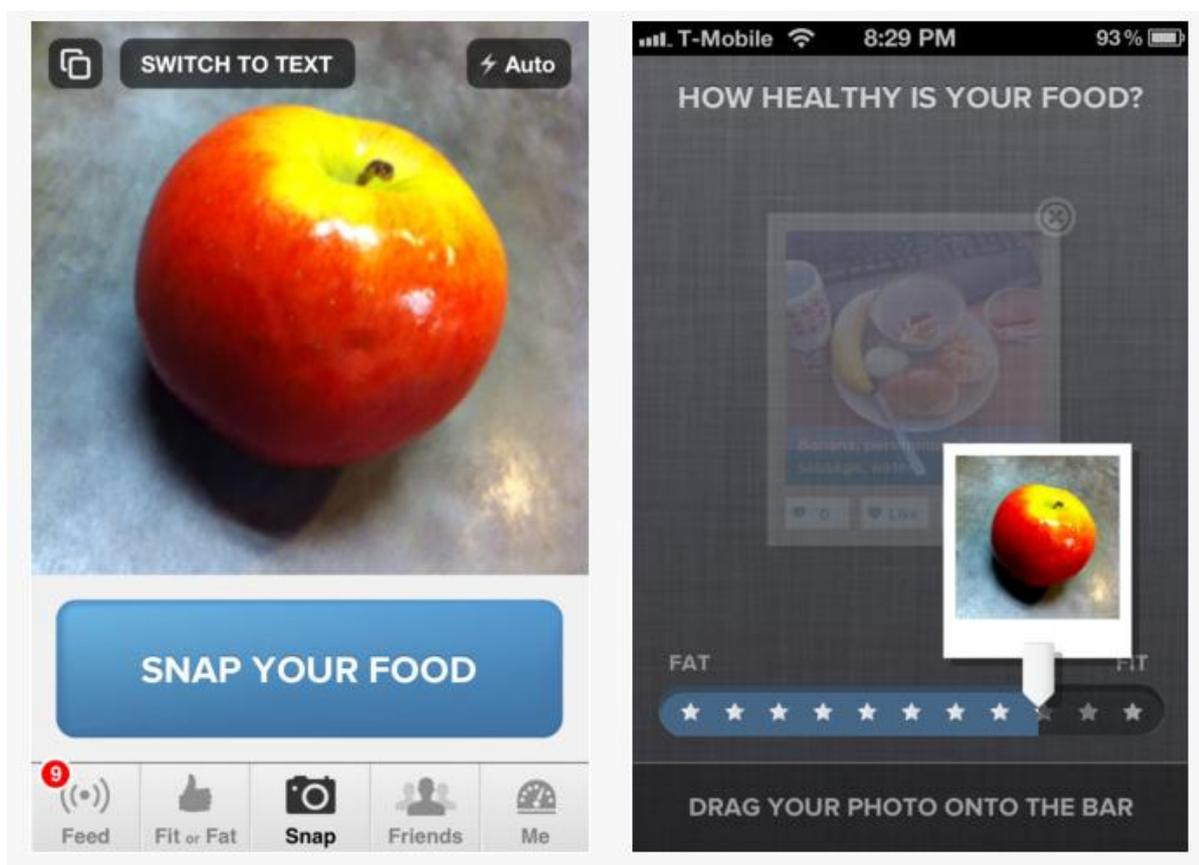
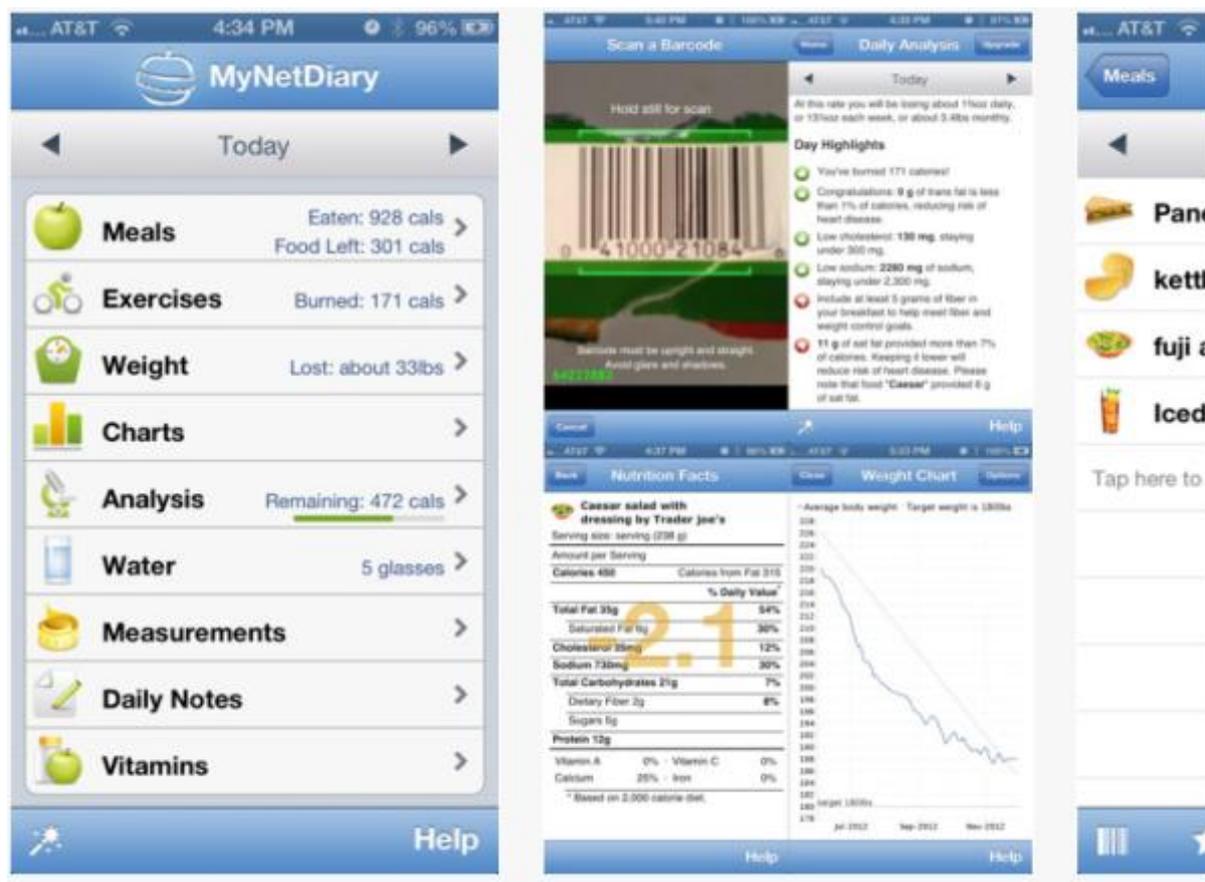


Figure 5.11 MyNetDiary, iPhone screenshots (iTunes, 2013)



5.5 Energy Balancers

Description

Energy balancers contain many of the same features of food diaries, but link HE much more explicitly to PA. Rather than just highlighting how many calories are in a particular food, it will also highlight how much exercise is needed to burn it off. Most are aimed at adults, and many are now based in smartphones.

Examples

Energy Balancer App: This was developed by Medibank to allow users to balance the foods they eat with their daily activities, and help them to make healthier decisions. Using individuals' weights, the app calculates how much of a particular activity you would have to do to work off a particular food. For example, if an individual weighed 75kg and ate a meat pie, they need to do 1hr 41mins of gardening to balance out their calories. The tool includes a wide range of activities, from the sedentary (e.g. watching TV), to the active (e.g. swimming).

Find Your Balance Challenge: This follows the same principles as the energy balancer app, but is delivered as an intervention in US elementary schools. A teacher/mentor works with a class of students to identify their needs on the nutrition side and PA side of the Energy Balance scale. The class then writes a goal statement to address those needs, and devises a simple action plan. Judges then assess these plans, with the winning class receiving a \$30,000 grant towards implementing a positive Energy Balance change in their school.

Considerations

- The explicit linking of (un)healthy eating and physical activity may increase the motivation to eat better and exercise more. It is possible that this explicit linking, rather than the more abstract self-monitoring used in food diaries and pedometers, may be more cognitively appropriate for younger children.
- Framing PA in terms of play for children can make balancing out the calories more appealing. However, care should be taken not to justify the eating of unhealthy foods (particularly when they are unhealthy for reasons other than just their calorific content).
- There is also a danger that this approach reinforces the notion that PA and HE are only about calories, rather than the wider health benefits. Furthermore, there is a danger of under-reporting of intake, and over-reporting of expenditure, leading to an energy imbalance in the wrong direction. Further research is required.

Figure 5.12 MediBank Energy Balancer App, iPhone screenshots (iTunes 2013)

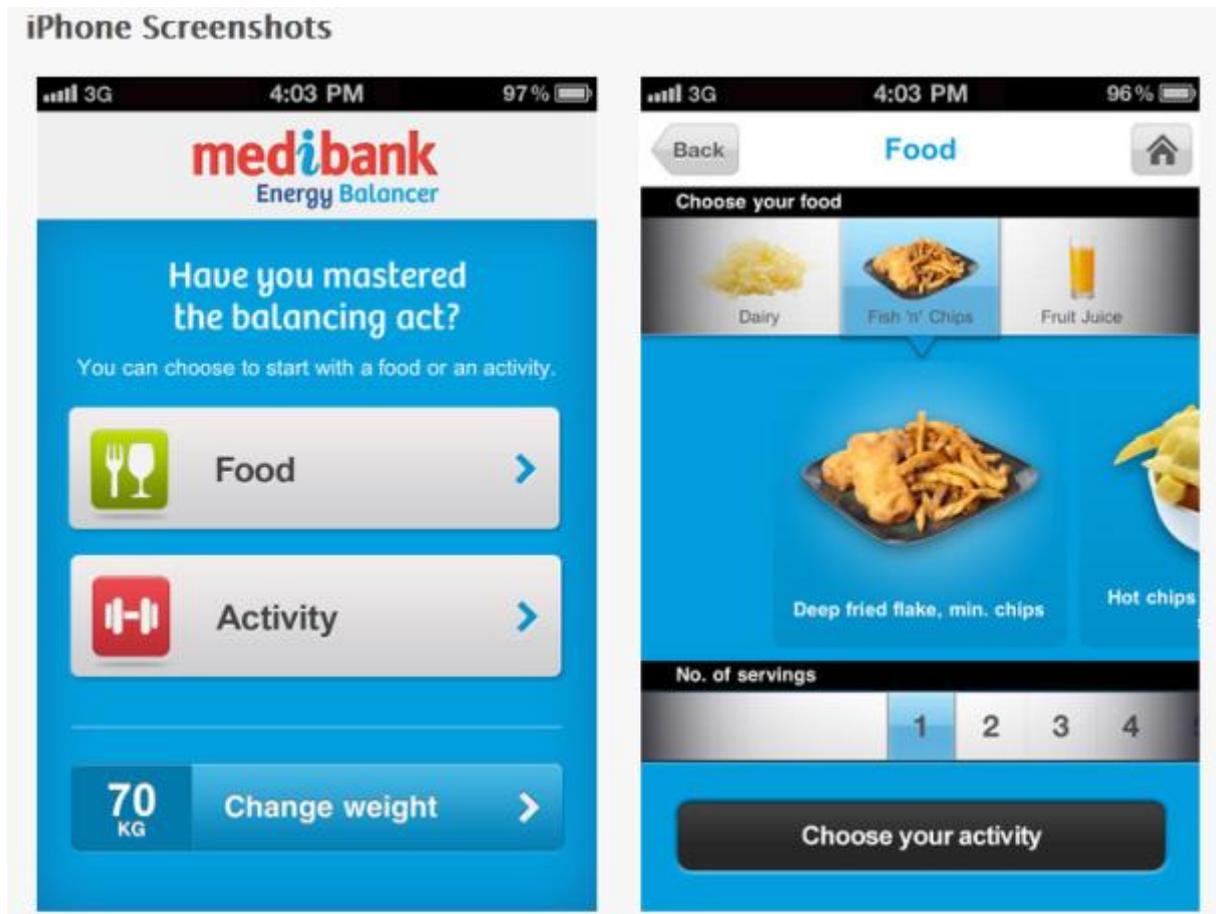


Figure 5.13 Find Your Balance Challenge



5.6 'Lifestyle' Info

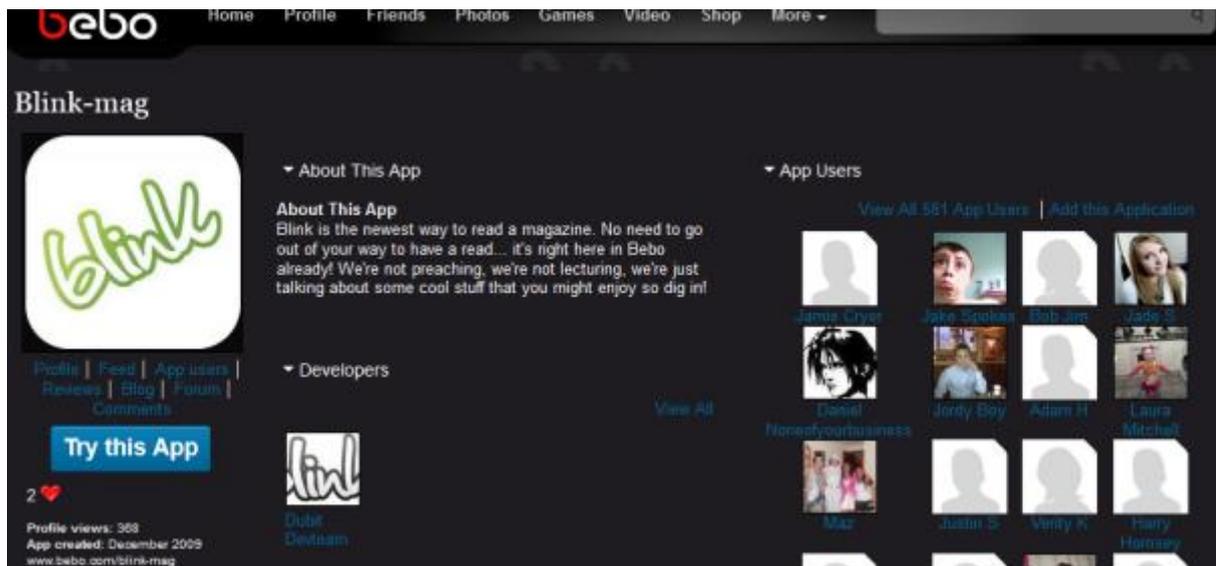
Description

HE and PA are promoted through a variety of different 'lifestyle' mediums, including print magazines, social networks, and online communities. User-generated content is often a feature of these sites; allowing individuals to feel ownership of the content. Social support functions may also be available. Sites are generally aimed at a specific demographic, and could be entirely devoted to HE and PA (e.g. Blink), or cover lifestyle issues more generally (e.g. NetMums).

Examples

Blink: This is an online magazine aimed at 13-17 year olds, particularly boys. It exists only as a social networking application across Facebook and Bebo. The idea behind it is to communicate HE messages, but on a site with a broad range of content. The site includes recipes, competitions, quizzes, personal HE plans and user-generated content. The site also includes interviews with inspirational youth who have excelled in a variety of fields such as sport, acting, fashion and art, to which young users should be able to relate.

Figure 5.14 Blink-mag Bebo page [accessed 24 January 2013]



Take Two Campaign: This is a campaign run by the Children’s Food Trust, in partnership with Fiona Faulkner, a children’s food writer and broadcaster. The aim is to help children ‘take two’ of their five a day every day at school lunchtime. The campaign is based around a Facebook page, where parents are encouraged to ‘tell us about the fruit and veg your kids are eating at lunchtime at school, share your tips and recipes and let us know how you get on’. The page also contains recipes and ideas.

Figure 5.15 Take Two At School on Facebook [accessed 1 February 2013]



Considerations

- Youth media is extremely fragmented, with social networks one of the few ways to engage teenagers en masse every day, regardless of their background or interests.
- It is important to embed HE messages within more general content e.g. surrounding, gaming, music and sport. This prevents the magazine seeming too much like a health promotion tool, which could put teenagers off.
- User-generated content, particularly for older children, gives a sense of ownership and 'cred' to a scheme, possibly increasing the value attached to messages.
- With user-generated content, care needs to be taken with the accuracy of messages. It can be an open forum for information exchange, therefore increasing the possibility of wide dissemination of non-credible, and potentially erroneous, health information (Chou et al. 2009).

5.7 Menu/ Recipe Planners

Description

These are very practical tools, directly linked to mealtimes. Like food diaries, they may contain nutritional information, and encourage tracking of food habits, but the focus is more on planning and making positive changes, rather than just monitoring habits.

Children are mostly targeted via their parents, but some planners, for example *my Change4Life cookbook*, and *Food, a Fact of Life*, do try and engage younger children directly. *Food, a Fact of Life* further subdivides its tools into the age ranges 2-5; 5-8; 8-11. All meals are targeted, though there is a particular set of interventions around packed lunches.

Increasingly, planners are delivered via multiple avenues, with TV adverts and online recipe cards, perhaps linking to specific offers in shops. Commercial partners are quite widely used.

Examples

Change4Life's Be Food Smart was designed to empower people to make smarter choices about what they eat and drink and capitalise on the positive intentions many people have to eat well in the New Year. The campaign encouraged the public to look out for the 'hidden nasties' - salt, fat and sugar - in many everyday foods and remind them that eating too much of these can be bad for their health.

Be Food Smart was an integrated campaign incorporating TV, radio and online advertising; digital tools and social media; ongoing Change4Life email communications; media partnerships, press inserts and a national PR campaign. There was also unprecedented levels of commercial partner activity as well as support from NGOs, local supporters and Local Authorities.

TV activity included a partnership with ITV creating a 3 minute ad-break showcasing Change4Life and promoting healthier products and choices. Partners were Quorn, Milk (Arla/Cravendale), Uncle Bens Rice (Mars), Fruit and Veg (Co-op), fresh fish (ASDA).

Roadshows were also held across the country between January and March demonstrating how to make healthy food choices and cooking simple recipes. These were in partnership with Local Authorities, shopping centres and commercial sampling companies.

Over 413,000 Meal Mixers (healthier recipe booklets) were distributed which contributed to 380,000 new registrations with Change4Life against a target of 150,000. Usage of new digital tools was also strong as the Be Food Smart mobile App greatly exceeded expectations with over 680,000 downloads and as well as over 139,000 hits on the online Meal Mixer.

Considerations

- Children have only limited influence over their parents. This is particularly the case if parents lack the skills or the confidence to be experimental in the kitchen.

- These were precisely the issues that were raised in the evaluation of a previous Change4Life campaign – Supermeals. Barriers to use of the recipe planners included fear of failure; ingredients people were unused to (and worried their kids wouldn't like); worries over wastage; habit (and the lure of a ready meal); and the length of time taken to cook (TNS BMRB, 2012).
- Both parents need to be considered. Even if the above issues can be overcome in one parent, they still might face pressure to cook 'normal' food from the other.
- School lunchboxes are likely subject to trends and comparisons between kids within schools. An intervention might therefore be more effective if many parents could be persuaded to partake, at the same time. This might favour a school-led intervention (for an evaluation of a lunch box intervention, see Evans et al 2010).

Figure5.16 Change4Life Be Food Smart Adverts



Figure5.17 Food, A Fact of Life, Healthy Lunchbox screenshots [Accessed 1 February 2013]



5.8 Physical Activity Equipment

Description

This covers low-tech, generally low-cost, PA equipment used to encourage PA and play. Examples might include skipping ropes, hoops, or branded items such as VERB's Yellow Ball. They do not need to be linked to a specific sport, or competitive activity; this can enable engagement with those who are reluctant to take part in traditional sports.

Examples

VERB YELLOWBALL: The VERB YELLOWBALL was the most visible aspect of the VERB programme. Over 500,000 rubber YELLOWBALLS were sent out to schools and community groups across the US. Students, aged 9-13, were encouraged to invent and play their own original games using YELLOWBALLS. They then pass play on, recording their games and ball numbers at a tween-targeted website – VERBnow.com. The campaign thus used a peer-to-peer programme to allow tweens to advocate for play directly.

Play was enhanced through student activity challenge cards, and the designation of a VERB YELLOWBALL captain. Students were randomly selected by placing a locker sticker on their locker; these students called the game for the day, and passed play on to the next student captain.

As part of Active Play: Simple PA equipment can play an important role in enabling PA, even with little other encouragement. For example, in Make Time to Play children aged 7-8 were given toys and/or cardboard boxes in their leisure time. The children spent a higher proportion of time doing MVPA when playing even with a simple cardboard box, than they did in PE, a school break or lunchtime (Morris et al. 2012).

Considerations

- PA equipment can play an important role in facilitating active play. Active play is generally considered to be unstructured, possibly outdoor, activity in children's free time. It can be a major contributor to children's PA, particularly among primary-school aged children (Brockman, Jago and Fox, 2010).
- Importantly, it may also aid social development, physical skills and resilience to mental health problems. It is suggested that these are not developed through organised sports clubs (Department for Children Schools and Families and Department for Culture, Media and Sport, 2008).
- Even simple 'toys' like cardboard boxes can facilitate active play (Morris et al 2012). Though how much of an increase in MVPA is down to the particular toy; having a toy at all; or simply a novel activity, needs more investigation.
- Interventions where ideas and games are spread peer-to-peer can be particularly successful. This is the technique exploited by VERB YELLOWBALL, and can result in a more relevant and authentic experience than structured games imposed by adults (Heitzler, Asbury and Kusner, 2008).
- Equipment needs to be adapted to children's age – younger children have undeveloped hand-eye coordination, and are slower and less refined in movement than older children. For example, larger, lighter balls can be used, allowing children more time to hit bigger targets. Intimidation can be a key reason children are resistant to PA, so appealing, easy-to-use equipment is key.
- Competition can be off-putting for some children, so utilising equipment in non-competitive ways is important. This is particularly true for those who are less naturally adept at sports, and possibly also for girls.

Figure5.18 VERB Locker Sticker Poster



Figure 5.19 VERB Challenge Card



5.9 What Works: Choosing tools

Previous sections have set out the defining features of effective interventions and the mechanisms within them; this section turns to address the question of specific tools. Again, it should be noted that the conceptual scheme used for the study does not suggest that a given tool ‘works’. Instead, the suggestion is that tools can be used to deliver / trigger the mechanisms described in the previous section. As such, evidence of effectiveness was gathered at the level of the intervention and its constituent mechanisms, rather than the tool. This enabled the inclusion of examples of tools where there was no evidence in relation to that specific example; it also prevented suggestion that a specific tool would produce a specific effect size. Table 5 below presents an overview of the information gathered on each tool.

The target group for the study presents a particular challenge in discussing tools. As noted throughout, the development of children across this age range means that the 2-11 age group cannot be considered as a whole and needs further subdivision. Specific consideration is therefore given to the likely mechanisms triggered by each tool, and their suitability for different age groups within the 2-11 range.

In addition to this, and considering the study’s emphasis on the ‘social’ context of behaviour (the ‘S’ in ISM), the vital role of parents and teachers should also be noted at the outset. They have an important influence as gatekeepers. As such, they might forbid, restrict, encourage, or even insist upon, the use of a given tool. Their roles will thereby act as a significant moderating factor in how any tool is received and utilised. This is a central consideration and, as will be seen, makes some of the potential tools seem more suitable than others in terms of directly targeting children.

Lastly, and building upon the moderating influence of parents and teachers, this section does not cover the (crucial) questions of delivery. It does not consider how a tool might be provided as part of an intervention, who it might be delivered by, how, for how long, to what intensity, in conjunction with what instructions, and so forth. Pointers for such design work are offered elsewhere in the report.

Table 5: The attributes of selected tools appropriate for interventions with 2 to 11 year olds.

Tool	Description / examples of use	Primary mechanisms and most suitable age groups	Pros, cons and considerations
Pedometers / Accelerometers	Small, portable instruments that measure amount (steps taken, at the most basic level) and (at a more advanced level) intensity of PA. Pedometers are more basic and are typically cheaper, although some (free) smartphone apps act as accelerometers. More sophisticated examples link to websites, where users can upload data (for comparison / monitoring / reward). Examples include: Zamzee and Striiv Play's Myland game.	Surprise (at level of (in)activity); social support (depending on administration); goal setting and self-monitoring. Therefore most suited to upper end of age-range: 9+	<u>Pros:</u> can be cheap (especially if run off smartphones); accepting some qualification, operates on powerful mechanisms; can be made fun; good evidence for durable effect in Zamzee. <u>Cons:</u> rapidly moving technology means apps get out of date fast – risk of Govt tools “ <i>looking dreary</i> ”; best for the pre-motivated (“ <i>you need high investment in PA to do FitBit in the first place</i> ”); low smartphone use in age group. <u>Considerations:</u> needs to be made fun – gaming element seems vital; perhaps combine with reward; analogous tool (smartcards for active travel) offers example of successful administration.
PA Kit	Low-tech, generally low-cost, PA equipment used to encourage PA and play. Often increased in size to ‘slow’ games and offer a chance to learn new skills. Examples might include skipping ropes, hoops, bats, balls, bibs, hoops, nets, and / or branded items such as VERB's YELLOWBALL, where pupils (9-13), were encouraged to invent, play and share their own original games.	Fun and skills; therefore suitable for all ages	<u>Pros:</u> can be used to enhance ‘brand awareness’ of a scheme; flexible; build vital skills; low barriers to use. <u>Cons:</u> potential for significant cost depending upon kit selected. <u>Considerations:</u> could be administered through schools; possibility for creativity / ‘user-generated’ content; non-competitive / fun use important.
Walk Tracking Smartcards	Cards (individually low-cost) that can be provided to children to record their walk to school by touching the card on fixed sensors (e.g. on lampposts). These sensors record data to monitor journeys. The only example uncovered in the study was ‘Beat the Street’, which uses smart cards and ‘Beat Boxes’ placed on routes into schools.	Fun, rewards and social comparison; therefore best suited towards the upper end of the age group (7+)	<u>Pros:</u> incorporates PA into everyday life; social; children given cheap equipment; could be used to enhance ‘brand awareness’. <u>Cons:</u> requirement for set-up on specific routes and administration of a competition (if used). <u>Considerations:</u> can be combined with websites / reward; opportunity to link into other school-based activities / more ‘system level’ intervention.
Diaries	Food diaries a well-established method for dietary assessment. More recent versions are increasingly electronic, allowing people to track their own habits. Photos and social comparisons often used in conjunction with the diary, as are forward planning	Surprise (at diet); social support (depending on administration); goal setting and self-monitoring. Therefore most suited to upper	<u>Pros:</u> apps can be cheap and (assuming accuracy of underpinning database) useful source of nutritional information; potentially accurate and powerful way of monitoring intake

Tool	Description / examples of use	Primary mechanisms and most suitable age groups	Pros, cons and considerations
	functions and 'food databases'. Examples include <i>MyNetDiary</i> - a smartphone app (£2.49), which allows its users to track their daily calorie intake and exercise.	end of age-range: 9+. However, information can be complex (and lack of examples targeting this age group).	<u>Cons:</u> potentially complex information – likely to require significant gatekeeper (parental) involvement; children have limited control over their diet; low smartphone use in age group <u>Considerations:</u> is direct targeting of children suitable? How to ensure accurate information?
Portion sizing	Considers both the quantity of food that children should be consuming, and relative amounts of different types of food. Generally low-tech, involving posters and guides - often delivered as part of a broader HE intervention. Can be reflective (asking individuals to consider what they have just eaten) and formative (getting people to consider changing how much, and what, they eat). Examples include the FSA's Eatwell Plate, which gives a visual representation of the types and proportions of foods needed for a healthy and well balanced diet.	Surprise; goal setting and information. Therefore most suited to upper end of age-range: 9+.	<u>Pros:</u> cheap, broad guidance on recommended quality / quantity of intake <u>Cons:</u> unlikely to change behaviour in isolation (based mainly on information); children have limited control over their diet <u>Considerations:</u> needs tailoring to specific age group; should be used as part of broader intervention (e.g. in school) given need for understanding / translation (e.g. what protein is); role of gatekeeper important (parent / teacher).
Menus	Practical tools, directly linked to mealtimes. Like food diaries, may contain nutritional information, and encourage tracking of food habits, but the focus is on planning and making positive changes, rather than just monitoring habits. Children are mostly targeted via their parents, but some planners, for example <i>my Change4Life cookbook</i> , and <i>Food, a Fact of Life</i> , do try and engage younger children directly.	Goal setting and information. Age group depends upon mode of administration, but likely to be at upper end of target group: 7+	<u>Pros:</u> can reduce practical / informational barriers to HE (especially HE on a budget); can help develop skills and tastes; can be fun. <u>Cons:</u> children have limited control over their diet / cooking. <u>Considerations:</u> needs careful targeting (<i>Food, a Fact of Life</i> further subdivides its tools into the age ranges 2-5; 5-8; 8-11); gatekeeper role again vital and so perhaps best used as part of broader intervention.
Balance apps	Energy balancers contain many of the same features of food diaries, but link HE and PA - highlighting calories in a particular food and how much exercise is needed to burn it off. Most are smartphone based and aimed at adults, but the <i>Find Your Balance Challenge</i> : follows the same principles as an energy balancer app, but is delivered as an intervention in US elementary schools. (A teacher/mentor works with a class of students to identify their needs on the nutrition side and PA side of the Energy Balance scale).	Surprise (at imbalance / level of PA needed to 'work off' foods); social comparison (depending on administration); and self-monitoring. Therefore most suited to upper end of age-range: 9+, and then only when administered by a gatekeeping teacher or parent (if at all – see	<u>Pros:</u> could combine PA and HE information to provide more accurate sense of intake / balance; could be made cheaply available through an app. <u>Cons:</u> highly complex information – real question of suitability for direct targeting; real risk of instant weight feedback supporting eating disorders among older ages; low smartphone uptake; children have little control over diet; need for highly accurate / updated information. <u>Considerations:</u> role of gatekeeper is vital – most likely

Tool	Description / examples of use	Primary mechanisms and most suitable age groups	Pros, cons and considerations
Stickers, Badges, Prizes	<p>Low-tech rewards – such as stickers, vouchers, badges, etc. Present in many of the more sophisticated examples of other tools (e.g. Striiv Play, Zamzee), but can also be used on their own. Schemes involving stickers and prizes as awards are often quite cheap. Distinction between rewards (instant and universal) and prizes (for selected ‘winners’ only, bigger ticket items). Examples include the reward element of <i>Beat the Street</i> - a walk to school campaign. Participants given an electronic card to tap on ‘beat boxes’ on the way into school. For each ‘beat box’ touched, they earn a point. Points go towards raising money for a charity of their school’s choice.</p>	<p>right) Rewards and goal setting, so suitable for all ages.</p>	<p>balance apps should only be used as part of a broader educational intervention.</p> <p><u>Pros:</u> suitability across age range (although need for tailoring); costs can be varied; can be linked to other pro-social behaviour (as in <i>Beat the Street</i>). <u>Cons:</u> potential to displace (more lasting / powerful) ‘intrinsic’ motivations; potential message that HE/PA requires ‘compensation’, rather than enjoyable in own right; need for administration (e.g. of prize draws). <u>Considerations:</u> different age groups will value different things; ‘collectability’ a useful additional factor (e.g. of badges in <i>Walk Once a Week</i>)</p>
Lifestyle ‘magazines’	<p>HE and PA are promoted through a variety of different ‘lifestyle’ mediums, including print magazines, social networks, and online communities. User-generated content is often a feature of these sites; allowing individuals to feel ownership of the content. Social support functions may also be available. Examples include Blink - an online magazine aimed at 13-17 year olds, particularly boys. The idea is to communicate HE messages on a site with a broad range of content - including user-generated. Also includes interviews with inspirational youth who have excelled in a variety of fields such as sport, acting, fashion and art.</p>	<p>Information and social comparison, so around ages 7+</p>	<p><u>Pros:</u> possibility of providing accurate information direct to beneficiaries; opportunity using social media for users to tailor / develop content. <u>Cons:</u> likely to be low reach (fragmented market); user-generated content raises question of accuracy. <u>Considerations:</u> need for careful tailoring depending upon exact age group targeted; need to embed HE/PA messages in broader content; user-generated content likely to be important to credibility.</p>

6. Implications for Intervention Designers

6.1 Lessons from Case Study Interventions

In compiling the case studies on each of the selected interventions, it became possible to draw out a number of lessons, based on the written evidence and that collected through the interviews. These lessons are arranged by dimension – such as by audience and by setting or delivery context – and they cut across the nine interventions summarised in Section 4 above. The lessons from the effective interventions are outlined in Table 6 below; they are written with intervention designers in mind.

Table 6: Lessons by dimensions of effective interventions for 2 to 11s

Dimension	Lessons
Target group	<i>Make it fun.</i> Children will respond more positively to interventions based on fun and games with friends and family. Learning skills is important.
	<i>Make it social.</i> Interventions should take account of 'environmental' and 'individual' factors (in the ISM model) - but 'social' factors are fundamental.
	<i>Make it part of everyday life.</i> Interventions targeting children below the age of 9 should focus on everyday active play (as opposed to more formalised PA activity) or repeated food tasting (but short-term behaviour change may be limited).
	<i>Make it age-appropriate.</i> 2-11 is not a target group, interventions must be focussed. For example, recreational (e.g. playing games) and utility based PA (e.g. travel to / from school) interventions should focus on over children over 9.
	<i>Make it culturally-specific.</i> For BME groups, targeted interventions may be more effective. See for instance the approach taken by VERB, with differentiated activities for different BME groups. (Note however that this may be less relevant for second, third and subsequent generations of BME groups.)
Target behaviour	<i>Make it behaviourally-specific.</i> HE and PA should be separated for the purposes of achieving behaviour change. The particular desired behaviour should be specified, e.g. reduced consumption of fizzy drinks; increased walking to school, etc.
	<i>Make it outcome-specific.</i> Obesity focused interventions should include HE and PA in combination - but not necessarily at the same time. (It should be noted that successful behaviour change interventions do not always lead to BMI or weight change in children).
	<i>Make it long-term.</i> To increase sustainability, interventions should include post-intervention maintenance. This might be based upon skill development, habit formation, and /or alterations to the environment.
Parental engagement	<i>Work through parents.</i> Parents are the agents of control for children – especially those at the younger end of the 2-11 age range. Their behaviours in terms of how they communicate and relate with children and organise the home may be a more pertinent target than directly addressing the child's behaviour. They must be engaged as agents of control, especially for HE. <i>"Families are key: if you are only working with the children, once the intervention's over, they'll relapse."</i>
	<i>Work with parents.</i> Parent must be engaged in terms of their own beliefs, attitudes and behaviours (especially for those at the younger end of the 2-11 age range). <i>"Be sure you engage parents every step of the way."</i>
	<i>Help parents identify a need for change.</i> Parents need to recognise that children may have, or be at risk of, overweight/obesity. An acknowledged need for change is a necessary precursor to successful intervention.
School engagement	<i>Work through schools.</i> Schools (especially primary) should be the root setting for HE, but food-based curriculum based interventions should be combined with other school environment components (e.g. food supply), and the intervention should

Dimension	Lessons
	extend to parents in the home setting.
	<i>Develop PA skills.</i> School-based PA interventions should include increased PA sessions and the development of fundamental movement skills.

6.2 Ten Top Tips for Intervention Designers

These simple points of guidance for designing PA and HE interventions for 2 to 11 years olds represent the overarching conclusions from the study. They draw on all the evidence under review, including the expert interviews, and the points made during the collaborative workshop. The tips aim to bridge from theory to practice.

Have a precise audience in mind from the outset

Work within tightly specified age bands: children grow fast, and effective interventions must be tightly targeted (e.g. to meet their stage of development, and to include ingredients which are credible and appeal to them). Also remember to include their parents and teachers in your delivery plans.

PA and HE are not behaviours but whole domains of behaviour

“If you want to change a behaviour, first specify that target behaviour” (GSR Behaviour Change Knowledge Review 2008). Each target behaviour needs specifying as tightly as possible, in order to develop effective interventions (e.g. not just ‘cut the fat’ but ‘reduce the amount of butter you use’).

Deliver PA & HE separately...but have a plan for both

Children aren’t much into ‘health’ and don’t see the links between having fun, being active, and eating well. But while presenting them as separate activities, programmes need to keep both in their sights if they want to impact on weight.

Most behaviour is social – so focus on the social context

Most of the behaviours we’re interested in involve children doing things with others, most of the influences on their behaviours are social, and most effective interventions work with children as part of their social groups.

Aim to make new behaviours habits

Habits ensure new behaviours will keep happening: either teach children and get them to repeat the behaviour until it’s habitual, and/or change the environment in which the behaviour’s being taught.

Ask: why would I?

Ask yourself ‘what’s in it for the child?’. And note that the answer should be some kind of instant gratification (especially fun or rewards – the top two effective mechanisms in this age range). NB Being ‘healthy’ is not an immediate benefit for most 2 to 11 year olds. Also think about what’s in it for parents or teachers as additional audiences: make it worthwhile for them...and easy!

Framing matters

Think about how you position the intervention (for children, and for their parents – often differently). For example, ‘weight’, ‘obesity’, ‘diet’, ‘healthy’ are not engaging for many people. Try ‘being active’, ‘having fun’ or ‘getting outdoors’.

Allow for varying contexts and personalities

People and places are different, so leave some flexibility for delivery (and learn what works).

Lead with the mechanisms

Once you have defined your target audience and desired behaviour, you then need to get practical: which mechanisms will help this group to achieve the specified change? This will then help guide your selection of tools.

Do one thing, then another (and get others to do things too)

There's no silver bullet for obesity prevention: so try one thing, and then try another. Get other practitioners to try things too, in order to have a system-wide impact on obesity. Finally, don't tell the public to 'just do one thing' in case they think that's all they need to do. Get them to do one thing (and maintain it) then move on to another, and another: in simple steps, amounting to lasting change.

6.3 Towards Recommended Interventions

Finally, to bring together the learnings and tips for designers presented here, we outline a set of potential interventions which are intended to exemplify the kinds of practical programmes which embody the effective approaches to engaging under 12s in physical activity and healthy eating.

The three potential programmes outlined here build on the evidence reviewed in this study, and the guidance extrapolated from that review. The ideas themselves were also shaped through the comments made by the expert advisors in the interviews, and by the small groups activities undertaken by DH policy people and their practitioner colleagues at the collaborative workshop. More detail on these proposals is available through a freestanding workshop report.

i) A PA programme, based on walking to school and back.

This would build on ideas developed in the collaborative workshop, and on the emerging evidence on the Beat the Street programme.

The programme would target pupils aged 9 to 11 (and could also extend into lower secondary school, especially for Year 7, where children are learning new routes). We would recommend drawing in elements of competition (between walking 'teams' or pods within a school or between schools), rewards (eg. for local charities, regular stickers, plus end of term prizes), and smartcards or pedometers (to validate attainment, and calculate impacts on PA). An attractive online interface could be built in, and there is potential to link this into HE activities in a school (breakfast or early evening).

In order to build the supporting evidence and business case for rolling out such an intervention, it could be set up as an application scheme, with schools then randomised into this year / next year samples (ie. stepped wedge design). Behavioural data would be captured through the technological components.

ii) An HE programme, based on children and parents trialling healthy foods.

This programme would build on the models of existing programmes which teach children and parents together about the nuts and bolts of HE, introduce them to healthy meals, and offer them the kit a support to start preparing them at home. 'Taster sessions' could provide an opportunity for local producers and retailers to get involved. The programme could also be combined with eg. walk to school and back activities.

iii) A PA programme, based on fun.

The framing of Zamzee can be combined with lessons emerging from encouraging adolescent girls to take PA ("A nightmare", according to an expert interviewee, "The social environment is critical... our interventions with individual [teen] girls have shown no impact; my preferred next step would be whole family approaches"). Providing informal physical activities, such as playground games (perhaps more for boys), and console dance sessions (perhaps more for girls), can be effective, especially if there is a social component. Again pedometers could be used to capture the behavioural data, and given this use of kit we would recommend trying the programme out initially with pupils in the upper end of primary

school. With a supporting system of instant rewards and longer-term prizes, this could become a kind of in-school Zamzee.

Annex 1 Search Methodology

The methodology followed four stages: an initial identification of systematic reviews; a search through relevant research institutions' publications; the identification of interventions; and a search for research and evaluation of interventions.

A1.1 Identification of systematic reviews

The initial focus was on systematic reviews of the literature – to enable us to quickly identify the key themes, articles and interventions. EBSCO was searched using the following terms:

- Systematic review physical activity intervention;
- Systematic review healthy eating intervention;
- Systematic review dietary intervention;
- Meta-analysis physical activity intervention;
- Meta-analysis dietary intervention;
- Systematic review obes* prevention intervention AND children OR family;
- Meta-analysis healthy eating intervention;
- Systematic review behaviour change obes*;
- Systematic review behaviour change physical activity;
- Systematic review behaviour change healthy eating;
- Healthy eating

Inclusion criteria were somewhat flexible. Whilst there was a focus on interventions/ reviews which focused on the target audience and setting, where a novel or innovative project was located this would also be included. This enabled us to source as many innovative and relevant ideas as possible, in line with the brief.

Where individual studies were surfaced by the search, these were included if relevant. Anything which did not occur in the developed world was ignored; likewise anything which focused on the causes or consequences of obesity unless, as above, it represented a particularly new source of information or ideas.

A1.2 Institutional search

Important research bodies, institutions and university departments were identified from previous reports, and Google searches. The focus was on the UK, though a few high-quality international sources were also included – Obesity Hub at the Health Well (from Ireland so quite applicable to the UK) and a few European sources. In total, 17 academic research institutions; 21 research and advocacy bodies (including MRC centres and think tanks); and 17 Government departments, agencies, or QUANGOs, were identified.

This search enabled the identification of grey literature, recently-published (or unpublished) literature, and gave us a greater depth of articles from key research bodies and institutes.

To identify publications, their websites were searched. This was either by reading through their publication list or, if this was too long, searching using the following terms:

- Systematic review
- Meta-analysis
- Behaviour change/healthy eating/physical activity/ review

The table below details the sources consulted:

Table A1.1 List of research bodies and institutions

Type of source	Sources to be consulted
Academic research institutions	British Heart Foundation Health Promotion Research Group, University of Oxford; Behaviour and Health Research Unit, University of Cambridge; Cancer Research UK Health Behaviour Research

	Centre, UCL; Transport and Health Group, LSHTM; DECIPHer, University of Bristol; Public Health, University of Sheffield; Department for Health, Behaviour Change, University of Bath; School of Medicine, Cardiff University; Public Health and Applied Health Intervention, University of Newcastle; Physical Activity and Public Health Research Group, Loughborough University; Centre for Research on Families and Relationships, University of Edinburgh; Institute of Health and Wellbeing, University of Glasgow; Behaviour Change Research Group, Sheffield Hallam University; Changing People's Behaviour Group (CCSR), University of Manchester; Centre for Health Improvement, QUB; Centre for Food Policy, City University; Centre for Public Nutrition Research, University of Dundee
Other research bodies and advocacy bodies	Cochrane library, UKCRC; FUSE The Centre for Translational Research in Public Health; Glasgow Centre for Population Health; UKCRC Centre of Excellence for Public Health NI; National Obesity Observatory; Healthy Places; International Obesity Taskforce; National Obesity Forum; Association for the Study of Obesity; Obesity Hub (Ireland); UKCRC Centre for Diet and Activity Research; European Congress on Obesity; UK Society for Behavioural Medicine; International Association for the Study of Obesity; Planet Health Cymru; MRC Epidemiology Unit; MRC Centre for Obesity and Related Metabolic Diseases; MRC Centre of Epidemiology for Child Health; MRC Human Nutrition Research; MRC Social and Public Health Sciences Unit, Scotland; JRF; King's Fund; BHF National Centre physical activity and health; GAPA; ISBNPA; HEPA EUROPE
Government departments and agencies	Change4Life; Games4Life; NICE ; Department for Transport; DCLG; Department for Culture, Media and Sport; Department for Education; Department of Health; NHS; Sport England; Sport Scotland; Sport Wales; Sport Northern Ireland; GLA; DHSSPS (NI); NHS Scotland; WHO

A1.3 Identification of interventions

The focus was on UK interventions, since 2002. Non-UK based interventions were only included if judged to be particularly important (as identified by expert interviews, or multiple references within the literature) – for example the first versions of MEND and EPODE, as well as VERB. Interventions were initially identified in four ways:

- Those identified incidentally by the systematic review search;
- By reading c.10 systematic reviews (those which were most relevant to the target group and setting; most recent; which we had access to) to identify the names of interventions reviewed;
- Those identified through searches of institutional websites;
- Those recommended from previous knowledge of the research team, the Department of Health, and interviewees.

A1.4 Intervention search

Evaluations and research on the interventions identified were then searched for. The intervention was discarded if there was no meaningful research into the effectiveness of the intervention. The search was:

- On EBSCO, using the names of the interventions identified;
- On EBSCO, using 'generic' words. This was done to try to mediate the bias towards interventions which had a 'name' or 'brand':
 - Accelerometer;
 - Pedometer;
 - Calorie counter;

- Food diary;
- Food labelling;
- Honest label;
- Menu/meal Planning;
- Food plates;
- Menu labelling.
- Where there were too many results to review, extra search terms was added to refine the selection:
 - Behaviour change;
 - Children/families;
 - Obesity/ physical activity/ healthy eating.
- On Google, using names of interventions. This was to identify grey literature, evaluations, presentations, and recent results. If there was a lack of relevant results/ too many results, the search terms – evaluation, research or report were added;
- On institutional web pages, using both intervention titles, and generic names.

A1.5 Summary of literature identified

Overall, 327 articles and papers were identified. 02 below sets out an analysis of publication characteristics. Of the 327, 259 of these came from the research team, 30 from the Department of Health, and 38 from interviews with experts. Just under half of articles (142) considered HE and PA together, with 124 considering PA alone, and 50 considering HE alone. The relatively lower number of HE papers reflects the available evidence base.

Around two thirds of the articles identified were peer reviewed academic papers, and there were also significant numbers of evaluations (43) and policy positions (27). A little under half were based on primary empirical evidence, and nearly 100 were literature reviews.

Of those with a specific geographical focus, most were UK based, though the USA also provided a significant number of articles (56). Of those targeted at a particular audience/ setting, the majority looked at children aged 2-11, and were in a school/after school setting. This is in line with the inclusion criteria outlined for the study.

Table A1.2 Literature review – Analysis of sources

Source of information	Number of articles
Call for evidence/ interviews	38
Department of Health	30
Systematic search	259
Total	327
Intervention focus	
Healthy eating (HE)	50
Physical activity (PA)	124
HE and PE	142
Not stated	10
Publication purpose	
Advocacy/ think piece	7
Evaluation	43
Intervention development	11
Peer-reviewed academic paper	209
Non-peer reviewed academic paper	25

Policy position	27
Not stated	5
Evidence type	
Empirical (primary)	144
Empirical (secondary)	18
Literature review	97
Recommendations	34
Theoretical development	27
Not stated	7
Geographic focus	
UK-wide	78
England	29
Scotland	7
Wales	55
Northern Ireland	4
USA	56
Australia	9
EU	10
Other international	8
Multi/not stated	123
Target audience	
Adults	17
BME	3
Children 2-11	116
Children other	46
Families	20
Obese	7
Other/multiple/not stated	118
Target setting	
Community	29
Healthcare/ local services	11
Home	7
School/after school	54
Media	14
Transport	6
Workplace	3
Other/multiple/not stated	203

A1.6 Short listing of sources for final inclusion

From the initial list, 89 sources were first selected for detailed review. This was achieved through a first sift of the long list based on reading of abstracts and/or summaries of papers. The primary criteria were whether the research paper could answer the review questions in terms of the scope and relevance of findings. Given that the scope of the project was to include around 100 publications, only the most relevant papers were selected. All others were considered as on a reserve list to be consulted if and when necessary.

Full text reading revealed a number of further source references to include in the review. Further inclusions also emerged as a result of suggestions from expert interviews and workshops. Ultimately, a total of 161 sources were short listed for inclusion.

Annex 2 Interviewees

PA (n = 10)
Tony Armstrong, Living Streets
William Bird, Intelligent Health
Steve Cole, Hope Lab (Zamzee)
Samantha Fawkner, Edinburgh
Ken Fox, Bristol
Melvyn Hillsdon, Exeter
Phil Insall, Sustrans
Ben Savage, Behavioural Insights, DfT
Paul Stonebrook, DH
Esther van Sluijs, CEDAR Cambridge
HE (n = 4)
Annie Anderson, Dundee
Helen Crawley, City Uni/ First Steps Nutrition Trust
Sara Kirk, MRC Cambridge
Louis Levy, DH
Combined (n = 10)
Heidi Blanck, Obesity Branch Chief, CDC
Drew Bradlyn, ICF
Janet Fulton, PA Team Lead, CDC
Michael Greenwell, ICF (ex-CDC , dir. VERB)
Zoe Hellman, Weightwatchers
Jacque Lavin, Slimming World
Sonia McGeorge, BHF
Harry Rutter, NOO
Rory Sutherland, Ogilvy
Phil Veasey, MEND

Annex 3 Workshop attendees

DH <i>Planning</i>
Emma Lyon
Dan Metcalfe
Karen Saunders
DH <i>Campaigns</i>
Emma Logan
Ian Williams
DH <i>Various</i>
Beelin Baxter -PA
Paul Stonebrook – PA
Danielle De Feo - Health Improvement Analysis Team
Louis Levy - Health Improvement Analysis Team
Alison Tedstone - Health & Wellbeing
Freud
Alison Hardy
Ogilvy
Jez Groom
Brian Sassoon
MEC
Rich Bradford
James Caig
DFT
Ben Savage
Bristol University (Department of Exercise, Nutrition and Health)
Ken Fox
Sustrans
Phil Insall (dir of Health)
WeightWatchers
Zoe Hellman

Annex 4 Bibliography

- Abraham, C., & Michie, S. (2008), 'A taxonomy of behaviour change techniques used in interventions', *Health Psychology*, 27(3): pp379-387.
- Adams, E., Goad, M., & Cavill, N. (2012), 'Evaluation of Living Streets' Fitter for Walking project', BHF National Centre for Physical Activity and Health.
- Ashbury, LD., Wong, FL., Prince, SM., & Nolin, MJ. (2008), 'The VERB™ Campaign: Applying a Branding Strategy in Public Health', *American Journal of Preventative Medicine*, 34(6S): pp S183–S187.
- Atkin, A., Gorely, T., Biddle, S., Cavill, N., & Foster, C. (2011), 'Interventions to Promote Physical Activity in Young People Conducted in the Hours Immediately After School: A Systematic Review', *International Journal of Behavioural Medicine*, 18: pp 176-187.
- Avery, A., Pallister, C., Allan, J., Stubbs, J., & Lavin, J. (2012), 'An initial evaluation of a family-based approach to weight management in adolescents attending a community weight management group', *Journal of Human Nutrition and Dietetics*, 25: pp 469-476.
- Bauman, A., Bowles, H., Huhman, M., Heitzler, C., Owen, N., Smith, B, J., & Reger-Nash, B. (2008), 'Testing a Hierarchy-of-Effects Model: Pathways from Awareness to Outcomes in the VERB Campaign 2002-2003', *American Journal of Medicine*, 34(6S): pp S249–S256.
- Bentley, G; Goodred, J; Jago, R; Sebire, S; Lucas, P; Fox, K; Stewart-Brown, S; Turner, K (2012), 'Parents' views on child physical activity and their implications for physical activity parenting interventions: a qualitative study', *BMC Pediatrics*, 12 (180).
- Berkowitz, JM., Huhman, M., & Nolin, MJ. (2008), 'Did Augmenting the VERB Campaign Advertising in Select Communities Have an Effect on Awareness, Attitudes, and Physical Activity?', *American Journal of Preventive Medicine*, 34(6S): pp S257–S266.
- BHF National Centre for Physical Activity and Health, 'New ways to promote physical activity and reduce sedentary behaviour'.
- Biddle, S. (2012), 'Sit less: why sedentary behaviour should be a priority for public health professionals', Loughborough University.
- Birch, LL. & Anzman, SL. (2010), Learning to Eat in an Obesogenic Environment: A Developmental Systems Perspective on Childhood Obesity. *Child Development Perspectives* 4 (2): pp.138-143.
- Birch, LL & Ventura, AK. (2009), 'Preventing childhood obesity: what works?', *International Journal of Obesity*, 33: pp 74-81.
- Blink-mag (2013) [online] <http://www.bebo.com/Profile.jsp?MemberId=10191274134> [Accessed 24 January 2013]
- Blomstrand, A., Ariai, N., Baar, A., Finborn-Forsfren, BM., Thore, J., & Bjorkelund, C. (2012), 'Implementation of a low-budget, lifestyle-improvement method in an ordinary primary healthcare setting: a stepwise intervention study', *BMJ*, 2(4).
- Borys, J, M., Le Bodo, Y., Jebb, SA., Seidell, J, C., Summerbell, C., Richard, D., De Henauw, S., Moreno, L, A., Romon, M., Visscher, T, L., Raffin, S., & Swinburn, B. (2012), 'EPODE approach for childhood obesity prevention: methods, progress and international development', *Obesity Reviews*.
- Borys, JM., Le Bodo, Y., De Henauw, S., Moreno, L., Momon, M., Seidell, J., & Visscher, T. (2011), 'Preventing childhood obesity: EPODE European network recommendations', *Epode European Network*.
- Boushey, CJ., Kerr, DA., Wright, J., Lutes, KD., Ebert, DS., Delp, EJ. (2009), 'Use of technology in children's dietary assessment', *European Journal of Clinical Nutrition*, 63(1): pp 50-57.

- Bravata, D., Smith-Spangler, C., Sundaram, V., Gienger, A., Lin, N., Lewis, R., Stave, C., Olkin, I. & Sirard, J. (2007), 'Using pedometers to increase physical activity and improve health: A systematic review', *Journal of the American Medical Association*, 19: pp 2296-2304.
- Breton, ER., Fuemmeler, BF. & Abrams, LC. (2011), 'Weight loss - there is an app for that! But does it adhere to evidence-informed practices?', *Translational Behavioural Medicine*, 1(4): pp 523-529.
- Brockman, Jago, Fox (2010), 'The contribution of active play to the physical activity of primary school children', *Preventative Medicine*, 51(2): pp 114-147.
- Brown, K., Ogden, J., Gibson, L. & Voegle, C. (2008), 'The role of parental control practices in explaining children's diet and BMI', *Appetite*, 50: pp 252-259.
- Buttriss, J et al. (2004), 'A Critical Review of the Psychosocial Basis of Food Choice and Identification of Tools to Effect Positive Choice - Final Report', British Nutrition Foundation for the Food Standards Agency.
- Cabinet Office (2008). *Food Matters - Towards a Strategy for the 21st Century*. Cabinet Office Strategy Unit.
- The Center for Training and Research Translation (n.d) *Color Me Healthy Full Description and Flyer* [online] <http://centertrt.org/?p=intervention&id=1095§ion=9> (Accessed January 2013)
- CDC, 'Life's First Great Crossroad: Tweens make choices that affect their lives forever', CDC internal working paper.
- Change4Life Be Food Smart (2013) [online] <http://www.nhs.uk/Change4Life/Pages/be-food-smart.aspx> [Accessed 22 January 2013]
- Children's Food Trust (2011), 'A recipe for healthier communities: the impact of let's get cooking', TNS BRMB.
- Chou, Hunt, Beckford, Moser & Hesse (2009), 'Social media use in the US: Implications for health communication', *Journal of Medical Internet Research*, 11(4).
- Clarke, B., Richards, M., & Wrigley, K. (2011), 'C4L Evaluation: Summer Campaign 2011, Qualitative Research, the findings', COI.
- CLES (2010), 'Evaluation of Get Walking Keep Walking: Third Year Report', The Centre for Local Economic Strategies (CLES).
- COI (2008), 'Understanding Teenagers - Insight Masterclass', Stephen Hooker et al at COI for DH, October 2008.
- COI (2011), 'Change4Life Autumn 2011 Adults Campaign Evaluation', COI.
- COI (2011), 'Change4Life/LazyTown Evaluation', COI.
- Coleman, R., & Moore, R. (2010), 'The impact of the pilot Activ8 Eatwell initiative in Northern Ireland'.
- Color Me Healthy (n.d.) *About* [online] <http://colormehealthy.com/about> (Accessed January 2013)
- Corder, K., van Sluijs, E., Goodyer, I., Ridgway, C., Steele, R., Bamber, D., Dunn, V., Griffin, S. & Ekelund, U. (2011), 'Physical activity awareness of British adolescents', *Archives of Paediatric and Adolescent Medicine*, 165(7): pp 603-609.
- Corder, K., van Sluijs, E., McMinn, A., Ekelund, U., Cassidy, A. & Griffin, S. (2010), 'Perception versus reality: Awareness of physical activity levels of British children', *American Journal of Preventative Medicine*, 38(1): pp 1-8.
- Craggs, C., Corder, K., van Sluijs, E. & Griffin S, J. (2011), 'Determinants of change in physical activity in children and adolescents: a systematic review', *American Journal of Preventative Medicine*, 40(6): pp 645-658.

Crocker, H., Viner, R. M., Nicholls, D., Haroun, D., Chadwick, P., Edwards, C., Wells, J. C. & Wardle, J. (2012), 'Family-based behavioural treatment of childhood obesity in a UK National Health Service setting: randomized controlled trial', *International Journal of Obesity*, 36(1): pp 16-26.

Daly-Smith, A., McKenna, J., Radley, D. & Long, J. (2011), 'The impact of additional weekdays of active commuting to school on children achieving a criterion of 300+ minutes of moderate-to-vigorous physical activity', *Health Education Journal*, 70(4): pp 428-434.

Darnton, A (2009), *Engaging young people and adults in obesity prevention – A Desk Research Review*. Andrew Darnton for DH / COI.

Darnton, A and Horne, J (2013). *Influencing Behaviours – Moving Beyond the Individual: A User Guide to the ISM Tool*. The Scottish Government.

Davis, A., Valsecchi, C. & Fergusson, M. (2007), 'Unfit for Purpose: How Car Use Fuels Climate Change and Obesity', Adrian Davis et al for the IEEP, August 2007.

Davies, P., MacPherson, K., Faruque, D. & Froud, E. (2010), 'Understanding the Effectiveness of Dietary and Food Choice Interventions: A Review of Reviews', Oxford Evidentia.

DCSF (2008), 'The Play Strategy', DCSF.

De Bourdeaudhuij, I., Van Cauwenberghe, E., Spittaels, H., Oppert, J., Rostami, C., Brug, J., Van Lenthe, F., Lobstein, T. & Maes, L. (2011), 'School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project', *Obesity Reviews*, 12: pp 205-216.

de Groot FP, Robertson NM, Swinburn BA & de Silva-Sanigorski AM (2010), Increasing community capacity to prevent childhood obesity: challenges, lessons learned and results from the Romp & Chomp intervention. *BMC Public Health* 10, 522.

de silva-Sanigorski, A., Elea, B., Bell, C., Kremer, P., Carpenter, L., Nichols, M., Smith, M., Sharp, S., Boak, R. & Swinburn, B. (2011), 'Obesity prevention in the family day care setting: impact of the Romp & Chomp intervention on opportunities for children's physical activity and healthy eating', *Child: Care, Health and Development*, 37(3): pp 385-393.

diSantis KI, Birch LL, Davey A, Serrano EL, Zhang J, Bruton Y & Fisher JO (2013): Plate size and children's appetite: effects of larger dishware on self-served portions and intake. *Pediatrics* 131, e1451-1458.

Dolan, P. & Kvestos, G. (2012), 'Educational interventions are unlikely to work because obese people aren't unhappy enough to lose weight', *BMJ*, 345.

Dowler, E, Caraher, M and Lincoln, P (2007), 'Inequalities in food and nutrition: challenging 'lifestyles'', in *Challenging health inequalities: From Acheson to Choosing Health*, E Dowler and N Spencer (eds) Bristol: The Policy Press.

Duncan, M., Birch, S. & Woodfield, L. (2012), 'Efficacy of an integrated school curriculum pedometer intervention to enhance physical activity and to reduce weight status in children', *European Physical Education Review*, 18(3): pp 396-407.

Duncombe, R., Sandford, R. & Barrett, L. (2012), 'Free Your Feet: End of Year 1 report', Institute of Youth Sport, Loughborough University.

Dunn, C., Thomas, C., Pegram, L., Ward, D. & Schmal, S. (2004), 'Color me healthy, preschoolers moving and eating healthily', *Journal of Nutrition, Education and Behaviour*, 36: pp 327-328.

Esliger, D (2012), 'Electronic gadgets for physical activity promotion: what's on offer?' Presentation to BHF Active, 21/11/2012.

European Commission (2012) Report from the commission to the European Parliament and the Council: in accordance with Article 184(5) of Council Regulation (EC) No 1234/2007 on the implementation of the European School Fruit Scheme [online] http://www.fooddudes.co.uk/en/reports/EU_report.pdf (Accessed January 2013)

Evans CE, Greenwood DC, Thomas JD, Cleghorn CL, Kitchen MS & Cade JE (2010), SMART lunch box intervention to improve the food and nutrient content of children's packed lunches: UK wide cluster randomised controlled trial. *J Epidemiol Community Health* 64: pp.970-976.

Find Your Balance Challenge (2013) [online] <http://www.togethercounts.com/at-school/win-for-your-school/balance-challenge> [Accessed 23 January 2013]

Fitzgibbon, M., Stolley, M., Schiffer, L., Braunschweig, C., Gomez, S., Van Horn, L. & Dyer, A. (2011), 'Hip-Hop to Health Jr. Obesity Prevention Effectiveness Trial: Postintervention Results', *Obesity*, 19: pp 994-1003.

Fitzgibbon, M., Stolley, M., Schiffer, L., Van Horn, L., KauferChristoffel, K. & Dyer, A. (2005), 'Two-year follow-up results for hip-hop to health jr.: A randomized controlled trial for overweight prevention in preschool minority children', *Journal of Pediatrics*, 146 (6): pp 18-25.

Flintoff, A., Foster, R. & Wystawoha, S. (2011), 'Promoting and sustaining high quality physical education and school sport through school sport partnerships', *European Physical Education Review*, 17(3): pp 341-351.

Foley, L., Maddison, R., Olds, T. & Ridley, K. (2012), 'Self-report use of time tools for the assessment of physical activity and sedentary behaviour in young people: systematic review', *Obesity Reviews*, 13: pp 711-722.

Food A Fact of Life (2013) [online] <http://www.foodafactoflife.org.uk/Activity.aspx?siteId=14§ionId=61&contentId=56> [Accessed January 2013]

Food Dudes (2009) Website [online] <http://www.fooddudes.co.uk/en/> (Accessed January 2013)

FSA Northern Ireland (2012) Activ8 Eatwell information pages [online] <http://www.food.gov.uk/northern-ireland/nutritionni/niyoungpeople/activ8ni#.UOsGi6zoGuM> (Accessed January 2013)

FSA Northern Ireland (n.d) The Eatwell Plate [online] <http://www.food.gov.uk/northern-ireland/nutritionni/eatwellplate/#.UOsHLqzoGuM> (Accessed January 2013)

Foresight (2007), 'Tackling Obesities: Future Choices - Project Report (2nd edition)', Government Office for Science, October 2007.

Foster, C., Hillsdon, M., Cavill, N., Allender, S. & Cowburn, G. (2005), 'Understanding Participation in Sport – a Systematic Review', BHF HPRG for Sport England, March 2005.

Foster, E., Matthews, JN., Lloyd, J., Marshall, L., Mathers, JC., Nelson, M., Barton, KL., Wrieden, WL., Cornelissen, P., Harris, J. & Adamson, AJ. (2008), 'Children's estimates of food portion size: the development and evaluation of three portion size assessment tools for use with children', *British Journal of Nutrition*, 99(1): pp 175-184.

Fox, K. & Hillsdon, M. (2007), 'Physical Activity and Obesity: Foresight Short Science Review', *Obesity Reviews* 8(s1): pp 115–121.

Gatenby, LA. (2011), 'Children's nutritional intake as part of the Eat Well Do Well scheme in Kingston-upon-Hull - a pilot study', *Nutrition Bulletin*, 36: pp 87-94.

Gneezy, U & Rustichini, A (2000), 'Pay enough or don't pay at all', *The Quarterly Journal of Economics*, 115(3): pp 791-810.

Gorley, T., Morris, J., Musson, H., Brown, S., Nevill, A. & Nevill, M. (2011), 'Physical activity and body composition outcomes of the GreatFun2Run intervention at 20 month follow up', *International Journal of Behavioural Nutrition and Physical Activity*, 8: pp 74-85.

Greenhalgh, J., Dowey, A., Horne, P., Lowe, F., Griffiths, J. & Whitaker, C. (2009), 'Positive- and negative peer modelling effects on young children's consumption of novel blue foods', *Appetite*, 768.

Guthrie, N., Dillon, F., Haritatos, J., & Cole, S., 'Motivating Physical activity in tweens: the Zamzee Randomized controlled trial and biomarker study', Hopelab Foundation.

- Hardman, C., Horne, P. & Lowe, F. (2011), 'Effects of rewards, peer-modelling and pedometer targets on children's physical activity: A school-based intervention study', *Psychology and Health*, 26(1): pp 3-21.
- Hardy, S., Lowe, A., Unadkat, A. & Thurtle, V. (2010), 'Mini-MEND: an obesity prevention initiative in a children's centre', *Community Practitioner*, 83(6): pp 26-29.
- Health Development Agency (2005), 'The effectiveness of public health interventions for increasing physical activity among adults: a review of reviews', NHS.
- Hebden, L., Chey, T., & Allman-Farinelli, M. (2012), 'Lifestyle intervention for preventing weight gain in young adults: a systematic review and meta-analysis of RCTs', *Obesity Reviews*, 13: pp 692-710.
- Heitzler, CD., Ashbury, LD., & Kusner, SL. (2008), 'Bringing "Play" to Life: The Use of Experiential Marketing in the VERB™ Campaign', *American Journal of Preventative Medicine*, 34(6S): pp S188–S193.
- Hellman, Z. (2012), Weight Watchers submission to 'Overweight and obese children and young people - lifestyle weight management services', Weight Watchers.
- Hesketh, KD. & Campbell, KJ. (2010), 'Interventions to prevent obesity in 0-5 year olds: an updated systematic review of the literature', *Obesity*, 18 (Supplement 1): pp S27-S35.
- Hillsdon, M., Jones, A., Coombes, E., Griew, P., Wilkinson, P., Hajat, S., Phelps, A. & Thompson, J (2012), '40 Area feasibility study (FAST)', Wellcome Trust.
- Hillsdon, M., Panter, J., Foster, C. & Jones, A. (2007), 'Equitable Access to Exercise Facilities', *American Journal of Preventive Medicine* 32(6) 506–508.
- Hip Hop to Health Jnr. (n.d.) Hip Hop to Health Jnr. Website [online] http://www.hiphoptohealth.com/blog/?page_id=11 (Accessed January 2013)
- HopeLab (2012) Zamzee Research Results [online] <http://www.slideshare.net/hopelab/zamzee-research-results#btnNext> (Accessed January 2013)
- Horne, P, J., Tapper, K., Lowe, C, F., Hardman, C, A., Jackson, M, C. & Woolner, J. (2004), 'Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention.', *European Journal of Clinical Nutrition*, 58: pp 1649-1660.
- Horne, PJ., Hardman, CA., Lowe, CF., & Rowlands, AV. (2009), 'Increasing children's physical activity: a peer modelling, rewards and pedometer-based intervention', *European Journal of Clinical Nutrition*, 63: pp 191-198.
- Horne, P., Greenhalgh, J., Erjavec, M., Lowe, F., Viktor, S. & Whitaker, C. (2011), 'Increasing pre-school children's consumption of fruit and vegetables. A modelling and rewards intervention', *Appetite*, 56: pp 375-385.
- Horne, PJ., Hardman, CA., Lowe, CF., Tapper, K., Le Noury, J., Madden, P., Patel, P. & Doody, M. (2009), 'Increasing parental provision and children's consumption of lunchbox fruit and vegetables in Ireland: the Food Dudes intervention', *European Journal of Clinical Nutrition*, 63: pp 613-618.
- Howard, S., Adams, J., & White, M. (2012), 'Nutritional content of supermarket ready meals and recipes by television chefs in the United Kingdom: cross sectional study'. *BMJ Christmas 2012*; 345: e7607. doi: [10.1136/bmj.e7607](https://doi.org/10.1136/bmj.e7607).
- Hughes, A., Stewart, L., Chapple, J., McColl, J., Donaldson, M., Kelnar, C., Zabihollah, M., Ahmed, F. & Reilly, J. (2008), 'Randomised controlled trial of a best practice individualised behavioural programme for treatment of childhood overweight', *Paediatrics*, 121(3): pp e539-e546.
- Huhman, ME., Potter, LD., Nolin, M., Piesse, A., Judkins, DR., Banspach, SW. & Wong, FL. (2010), 'The Influence of the VERB Campaign on Children's Physical Activity in 2002 to 2006', *American Journal of Public Health*, 100 (4): pp 638-645.

Huhman, M., Bauman, A. & Bowles, H. (2008), 'Initial Outcomes of the VERB Campaign: Tweens' Awareness and Understanding of Campaign Messages', *American Journal of Preventive Medicine*, 34(6S): pp S241–S248.

Huhman, M., Berkowitz, JM., Wong, FL., Prosper, E., Gray, M., Prince, D. & Yuen, J. (2008), 'The VERB Campaign's Strategy for Reaching African-American, Hispanic, Asian, and American Indian Children and Parents', *American Journal of Preventative Medicine*, 34(6S): pp S194–S209.

iTunes Store (2013) [online] <https://itunes.apple.com/gb/app/the-eatery/id468299990?mt=8> [Accessed 24 January 2013]

Illich, I (1974) *Energy and Equity*. New York, NY: Harper & Row.

Intelligent Health (2013) *Beat the Street 2012: Key Outcomes*. In press.

Jago, R., Davison, KK., Page, AS., Brockman, R., Thompson, JL. & Fox, KR. (2011a), 'Parenting styles, parenting practices and physical activity in 10-11 year olds', *Preventive Medicine*, 52: pp 44-47.

Jago, R., Davison, KK., Thompson, JL., Page, AS., Brockman, RJ. & Fox, KR. (2011b), 'Parental sedentary restriction, maternal parenting style and television viewing among 10- to-11-year-olds', *Pediatrics*, pp 2010-3664.

Jago, R., Macdonald-Wallis, K., Thompson, JL., Page, AS., Brockman, R. & Fox, KR. (2011c), 'Better with a buddy: The influence of best friends' on children's physical activity', *Medicine and Science in Sport and Exercise*, 43: pp 259-265.

Jago, R., Steeds, J., Bentley, G., Sebire, S., Lucas, P., Fox, K., Stewart-Brown, S. & Turner, K. (2012), 'Designing a physical activity parenting course: parental views on recruitment, content and delivery', *BMC Public Health*, 12: 356.

Jebb, S. (2005), 'Dietary strategies for the prevention of obesity', *Proceedings of the Nutrition Society* 64 (02): pp 217-227.

Jebb, S., Steer, T., & Holmes, C. (2007), 'The healthy living social marketing initiative: a review of the evidence'. MRC Human Nutrition Research for DH, March 2007.

Jones, A., Bentham, G. & Foster, C. et al. (2007), 'Obesogenic Environments: Evidence Review', *Foresight Tackling Obesity*.

Jones, A., Coombes, E., Griffin, S. & van Sluijs, E. (2009), 'Environmental supportiveness for physical activity in English school children: a study using Global Positioning Systems', *International Journal of Behavioural Nutrition and Physical Activity*, 6(42).

Katzmarzyk, PT (2010), 'Physical activity, sedentary behaviour, and health: paradigm paralysis or paradigm shift? ', *Diabetes* 59: pp 2717 -2725.

Kriemler, S., Meyer, U., Martin, E., Van Sluijs, E., Andersen, LB. & Martin BW. (2011), 'Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update', *British Journal of Sports Medicine*, 45: pp 923-930.

Krolner, R., Rasmussen, M., Brug, J., Klepp, K., Wind, M. & Due, P (2011), 'Determinants of fruit and vegetable consumption and adolescents: a review of the literature, Part II qualitative studies', *International Journal of Behavioural Nutrition and Physical Activity*, 8: 112.

Lakshman, R., Sharp, S., Ong, K. & Forouhi, N. (2010), 'A novel school-based intervention to improve nutrition knowledge in children: cluster randomised controlled trial', *BMC Public Health*, 10: pp 123-132.

Lambert, N., Plumb J., Looise, B., Johnson, IT., Harvey, I., Wheeler, C., Robinson, M. & Rolfe, P. (2005), 'Using smart card technology to monitor the eating habits of children in a school cafeteria: 2. The nutrient contents of all meals chosen by a group of 8- to 11-year-old boys over 78 days', *Journal of Human Nutrition and Dietetics*, 18(4): pp 255-265.

Lang, T. & Rayner, G. (2007), 'Overcoming Policy Cacophony on Obesity: An Ecological Public Health Framework for Policy Makers; *Foresight Short Science Review*, *Obesity Reviews* 8(s1): pp 165–181.

Leahey, TM., Gokee, LJ., Fava, JL. & Wing RR. (2011), 'Social influences are associated with BMI and weight loss intentions in young adults', *Obesity*, 19(6): pp 1157-62.

Livingstone, MB., Prentice, AM., Strain, JJ., Coward, WA., Black, AE., Barker, ME., McKenna, PG. & Whitehead, RG. (1990), 'Accuracy of weighed dietary records in studies of diet and health', *BMJ*, 300 (6726): pp 708-712.

Livingstone, S. (2006), 'New Research on Advertising Foods To Children: Update to Ofcom Appendix 2'. Ofcom, January 2006.

Lubans, DR., Morgan, PJ. & Tudor-Locke, C. (2010), 'A systematic review of studies using pedometers to promote physical activity among youth', *Preventative Medicine*, 48(4): pp 307-315.

Mandalia, D. (2011), 'Children's BMI, Overweight and Obesity', *HSE*, 1(11).

Marcus, C., Nyberg, G., Nordenfelt, A., Karpmyr, M., Kowalski, J. & Ekelund, U. (2009), 'A 4-year, cluster-randomized, controlled childhood obesity prevention study: STOPP', *International Journal of Obesity*, 33(4): pp 408-417.

Marshall, S. (2012), 'Take your tablet: using new technology to promote physical activity and reduce sedentary behaviour'.

Mayer (2009), 'Childhood Obesity Prevention: Focusing on the Community Food Environment', *Family and Community Health*, 32(3): pp 257-270.

McMinn, A., Griffin, S., Jones, A. & van Sluijs, E. (2012), 'Family and homes influences of children's after-school and weekend physical activity', *European Journal of Public Health*.

Mcminn, A., van Sluijs, E., Nightingale, C., Griffin, S., Cook, D., Owen, C., Rudnicka, A. & Whincup, P (2011), 'Family and home correlates of children's physical activity in a multi-ethnic population: the cross-sectional child heart and health study in England (CHASE)', *International Journal of Behavioural Nutrition and Physical Activity*, 8(11).

McMurdo, M., Sugden, J., Argo, I., Boyle, P., Johnston, D., Sniehotta, F. & Donnan, P. (2010), 'Do Pedometers Increase Physical Activity in Sedentary Older women? A randomised controlled trial', *Journal of the American Geriatrics Society*, 58: pp 2099-2106.

Medical Research Council (2013), 'Dietary Assessment methods - pros and cons', MRC.

Medical Research Council (2013) [online] Available at: <http://dapa-toolkit.mrc.ac.uk/dietary-assessment/methods/weighed-food-diary/pros-and-cons.html> [Accessed 1 February 2013]

MEND Central (n.d) Citizenship and PSHE resources [online] (Accessed January 2013)
<http://www.mendcentral.org/whatweoffer/teaching/pshe>

[MEND Move it \(2011\) Move It! Webpages \[online\] \(Accessed January 2013\)](http://www.mendmoveit.org/)
<http://www.mendmoveit.org/>

Michie, S., Abraham, C., Whittington, C., McAteer, J. & Gupta, S. (2009), 'Effective techniques in healthy eating and physical activity interventions: a meta-regression', *Health Psychology*, 28(6): pp 690-701.

Michie, S., Ashford, S., Sniehotta, F., Dornbrowski, S., Bishop, A. & French, D. (2011), 'A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: The CALO-RE taxonomy', *Psychology and Health*, 26(11): pp 1479-1498.

Mintel (2013). Consumer Report: Prepared Meals - UK - May 2013.

Monasta, L., Batty, G., Mcaluso, A., Rofani, L., Lutje, V., Bavcar, A., Van Lenthe, F., Brug, J. & Vattaneo, A. (2011), 'Interventions for the prevention of overweight and obesity in preschool children: a systematic review of randomized controlled trials', *Obesity Reviews*, 12: pp 107-118.

Morris, J., Mason, C., Sandford, R., Duncombe, R., Gorely, T., Hobson, S., Dorling, J., Brown, S., Musson, H. & Nevill, M. (2012), 'The impact of toys and play on Children's physical activity', Institute of Youth Sport, Loughborough University.

NHS (2008), 'Healthy Weight, Healthy Lives: A toolkit for developing local strategies', Dr Kerry Swanton at the National Heart Forum for the NHS, October 2008.

NHS Information Centre, Lifestyles Statistics (2012), 'Statistics on obesity, physical activity and diet: England, 2012', NHS.

NICE (2006), 'Four commonly used methods to increase physical activity: brief interventions in primary care, exercise referral schemes, pedometers and community-based exercise programmes for walking and cycling', NICE, : .

NICE (2009), 'Promoting physical activity for children and young people', NICE.

Oakley, AD., Collins, CE ., Morgan, PJ., Jones, RA., Warren, JM., Cliff, DP., Burrows, TL., Colyvas, K., Steele, JR. & Baur, LA. (2010), 'Multi-site randomized controlled trial of a child-centered physical activity program, a parent-centered dietary-modification program, or both in overweight children: the HIKCUPS study', *Journal of Pediatrics*, 157(3): pp 388-394.

O'Connor, T. (2009), 'Engaging parents to increase youth physical activity: A systematic review.', *American Journal of Preventative Medicine*, 37(2): pp 141-149.

Ofcom (2012), 'Children and Parents: Media use and attitudes report', Ofcom.

Ogilvie, D. & Hamlet, N. (2005), 'Obesity: the elephant in the corner', *BMJ*, 331: pp 1545–1548.

Page, A., Cooper, A., Griew, P, Davis, L. & Hillsdon, M. (2009), 'Independent mobility in relation to weekday and weekend physical activity in children aged 10-11 years: the PEACH project', *International Journal of Behavioural Nutrition and Physical Activity*, 6(2).

Pallister, C., Avery, A., Stubbs, J. & Lavin, J. (2009), 'Influence of Slimming World's lifestyle programme on diet, activity behaviour and health of participants and their families', *Journal of Human Nutrition and Dietetics*, 22: pp 351-358.

Panter, J., Jones, A. & van Sluijs, E. (2008), 'Environmental determinants of active travel in youth: A review and framework for future research', *International Journal of Behavioral Nutrition and Physical Activity* 5 (34)

Patrick, H., Nicklas, T. (2005), 'A review of family and social determinants of Children's eating patterns and diet quality', *Journal of the American College of Nutrition*, 24(2): pp 83-92.

Pedersen, Kang & Kline (2007), 'Portion control plate for weight loss in obese patients with Type II Diabetes Mellitus', *Journal of the American Medical Association: Internal Medicine*, 167(12): pp 1277-1283.

Prince, SM., Huhman, M. & Potter, LD. (2008), 'Influencing the Parents of Children Aged 9 –13 Years: Findings from the VERB™ Campaign', *American Journal of Preventive Medicine*, 34(6S): pp S267–S274.

Quick, S., Simon, A. & Thornton, A. (2010), 'PE and Sport Survey 2009/10', TNS-BMRB.

Rasmussen, M., Krolner, R., Klepp, KI., Lytle, L., Brug, J., Bere, E. & Due, P. (2006), 'Determinants of fruit and vegetable consumption and adolescents: a review of the literature, Part I quantitative studies', *International Journal of Behavioural Nutrition and Physical Activity*, 3(22).

Redballoon (2005), 'Project Hero: An explanation of young people's relationship with icons', MATTEL.

Reed, VA., Schifferdecker, KE., Rezaee, ME., O'Connor, S. & Larson, RJ. (2012), 'The effect of computers for weight loss: a systematic review and meta-analysis of randomized trials.', *J. Gen. Intern. Med*, 27(1): pp 99-108.

Sacher, PM., Kolotourou, M., Chadwick PM., Cole TJ., Lawson, MS., Lucas, A. & Singhal, A. (2010), 'Randomized controlled trial of the MEND program: a family-based community intervention for childhood obesity', *Obesity Journal*, 16(Supplement 1): pp S62-S68.

Sacher, PM., Wolman, J., Chadwick, P. & Swain, C. (2008), 'Mini-MEND: MEND's early years healthy lifestyle programme for 2–4 year olds and their families', *Nutrition Bulletin*, 33: pp 364-367.

- Schlosser, E. (2001), *Fast Food Nation*, New York, NY: Houghton Mifflin Harcourt.
- Singh, AS., Mulder, C., Twisk, JWR., Van Mechelen, W., & Chinapaw, MJM. (2008), 'Tracking of childhood overweight into adulthood: Systematic review of the literature', *Obesity Reviews*, 9: pp 474-488.
- Skouteris, H., McCabe, M., Swinburn, B. & Hill, B. (2010), 'Healthy eating and obesity prevention for preschoolers: a randomised controlled trial', *BMC Public Health*, 10: pp 220-229.
- Skouteris, H., McCabe, M., Swinburn, B., Newgreen, V., Sacher, P. & Chadwick, P. (2010), 'Parental influence and obesity prevention in pre-schoolers: a systematic review of interventions', *Obesity Reviews*, 12: pp 315-328.
- Southerton, D. (2006), 'Analysing the temporal organization of daily life: Social constraints, practices and their allocation'. *Sociology* 40 (3), 435-454.
- Sport England (2012), 'Sportivate Programme Evaluation: First year report', Sport Structures Ltd.
- Sport, Physical Education and Activity Research (SPEAR) (2011), 'Evaluation of the Change4Life School Sports Clubs Programme: Final report', SPEAR, Canterbury Christ Church University.
- Stathi, A. & Sebire, SJ. (2011), 'A process evaluation of an outreach physical activity programme in an inner-city primary school', *Journal of Physical Activity and Health*, 8 (Supplement 2): pp S239-S248.
- Stead, M., MacKintosh, A., McDermott, L., & Anker, T. (2008), 'How Do Young People Engage with Food Branding?', Project Final Report by IFM for the Public Health Research Consortium, December 2008.
- Steele, R., van Sluijs, E., Cassify, A., Griffin, S. & Ekelund, U. (2009), 'Targeting sedentary time or moderate-and vigorous-intensity activity: independent relations with adiposity in a population-based sample of 10-year old British Children', *American Journal of Nutrition*, 10: 3945.
- Story, M., Kaphingst, KM., Robinson-O'Brien, R. & Glanz, K. (2008), 'Creating Healthy Food and Eating Environments: Policy and Environmental Approaches', *The Annual Review of Public Health*, 29: pp 253-72.
- Stubbs J., Pallister, C., Avery A., Allan J. & Lavin J. (2012), 'Weight, body mass index and behaviour change in a commercially run lifestyle programme for young people', *Journal of Human Nutrition and Dietetics*, 25: 161-166.
- Sturm, R. (2008), 'Stemming the global obesity epidemic: What can we learn from data about social and economic trends?' *Public Health*, 122: pp 739-746.
- Sustrans (2009a), 'Bike It: Project Review 2009'.
- Sustrans (2009b), 'Travel Smart: Project Review'.
- Sustrans (2010a), 'Bike It Project Review 2010'.
- Sustrans (2010b), 'Travel Actively: Monitoring Report Year 2', Travel Actively.
- Sustrans (2011), 'Travel Actively Monitoring Report Year 3', Travel Actively.
- Swain, S. (2009), 'MEND Programmes: community solutions to a national problem', *Primary Health Care*, 19(6): pp 20-23.
- Take Two at School (2013) [online] <https://www.facebook.com/TakeTwoAtSchool> [Accessed 1 February 2013]
- Thornton, A., Evans, L., Bunt, K., Simon, A., King, S. & Webster, T. (2011), 'Climate change and transport choices: Segmentation model - a framework for reducing CO2 emissions from personal travel', TNS-BMRB with People Science & Policy for the Department for Transport.
- TNS-BMRB. (2012), 'Change4Life Supermeals Campaign Evaluation', tnsbmr.b.
- TSA, (2006), 'Understanding the Determinants of Participation in Sport for 15-19 Year Old Women', TSA for Sport England, January 2006.

Tudor-Locke, C & Lutes, L (2009), 'Why Do Pedometers Work? A Reflection upon the Factors Related to Successfully Increasing Physical Activity', *Sports Medicine*, 39(12): pp 981-993.

Uijtdewilligen, L., Nauta, J., Singh, A., van Mechelen, W., Twisk, J., van der Horst, K. and Chinapaw, M. (2011), 'Determinants of physical activity and sedentary behaviour in young people: A review and quality synthesis of prospective studies', *British Journal of Sports Medicine* 45 (11): pp.896-905.

UNC Center for Health Promotion and Disease Prevention (2009), 'Color me healthy', UNC Center for Health Promotion and Disease Prevention.

Upton, P. (2012), 'Exploring primary school teachers' experiences of implementing a healthy eating intervention', *Education and Health*, 30(2): pp 35-39.

Van Sluijs E., Kriemler, S. & McMinn, AM. (2011), 'The effect of community and family interventions on young people's physical activity levels: a review of reviews and updated systematic review', *British Journal of Sports Medicine*, 45: pp 914-922.

Verplanken, B, Walker, I, Davis, A and Jurasek, M (2008), 'Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses'. *Journal of Environmental Psychology* 28 (2) 121-127.

Wansink, B., Just, D. & Payne, C. (2009), 'Mindless eating and health heuristics for the irrational', *American Economic Review*, 99(2): pp165-169.

Wansink B, Painter JE & North J (2005), 'Bottomless bowls: why visual cues of portion size may influence intake'. *Obes Res* 13, 93-100.

Wardle, J. (2007), 'Eating Behaviour and Obesity; Foresight Short Science Review', *Obesity Reviews* 8(s1): pp 73–75.

Waters, E., de Silva-Sanigorski, A., Hall, B., Brown, T., Campbell, K., Gao, Y., Armstrong, R., Prosser, L. & Summerbell, C. (2011), 'Interventions for preventing obesity in children', *Cochrane Library*, 12.

Watt, RG, Hayter, AKM, Ohly, HR, Pikhart, H, Draper, AK, Crawley, H, McGlone, P, Cooke, L, Moore, L, Pettinger, C and Rees, GA (2012) 'Exploratory and developmental trial of a family centred nutrition intervention delivered in Children's Centres: the CHERRY Project – Final Report'. UCL and the University of Plymouth for the Department of Health.

Wavehill Consulting. (2009), 'Evaluation of the WoW scheme for Living Streets', Living Streets.

Whitehead, M (ed.) (2010). 'Physical Literacy: Throughout the Lifecourse'. London: Routledge.

Williams, B., Bhaumik, C. & Silk, A. (2012), 'LIFECOURSE TRACKER Wave 1 Spring 2012: Interim summary report', GfK Nop.

Witt, K. & Dunn, C. (2012), 'Increasing fruit and vegetable consumption among Preschoolers: evaluation of Color Me Healthy', *Journal of Nutrition, Education and Behaviour*, 44(2): pp107-113.

Wolman, J., Skelly, E., Kolotourou, M., Lawson, M. & Sacher, P. (2008), 'Tackling toddler obesity through a pilot community-based family intervention', *Community Practitioner*, 81(1): pp 28-31.

Wong, F., Greenwell, M., Gates, S. & Berkowitz, J. (2008), 'It's What You Do!: Reflections on the VERB Campaign.', *American Journal of Preventative Medicine*, 34(6S): pp S175-S182.

World Health Organisation (2009), 'Interventions in Diet and Physical Activity: What Works Summary Report', WHO.

Zamzee (2010) About Us. [online] (<https://www.zamzee.com/about> (Accessed January 2013))