



Reviews of Scientific Evidence and Policies on Nutrition and Physical Activity

Objective Area A2: Effectiveness and Efficiency of
Policies and Interventions on Diet and Physical
Activity



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E-mail: SANTE-CONSULT-C4@ec.europa.eu

European Commission

B-1049 Brussels

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Preface

About this project

Overweight, obesity and their related diseases represent a leading cause of morbidity and mortality, and pose a major challenge for the sustainability of healthcare systems of EU Member States. The growing prevalence of overweight and obesity among all age groups across Europe constitutes a serious concern for policy makers. Tackling this issue requires a comprehensive response that reflects the multifactorial and complex nature of obesity and overweight. One particularly important area of focus has been on the development of preventative strategies which include nutritional and physical activity interventions.

The European Commission Directorate General for Health and Food Safety (DG SANTE) recognises the significant challenges policy makers face in developing effective and efficient policy interventions relating to diet and physical activity. One such challenge includes the complexity and breadth of the evidence base. By providing independent, accurate summaries of recent and relevant information and statistics on determinants of diet and physical activity and their impact on health, this project aims to support policy makers to continue to develop policy instruments which enable people to make healthier lifestyle choices. In particular, this project aims to support the development of healthier behaviours in vulnerable and/or at-risk subpopulations (including children, pregnant and lactating women, and older adults) and low socio-economic status groups (including low income and education).

About this series

This evidence review is one of eight reviews relating to different determinants of diet and physical activity.

Seven of the reviews are of the scientific evidence and policies in the following areas:

- Knowledge, attitudes and behaviours contributing to positive energy balance (objective area A1);
- Dietary and physical activity patterns in Europe (objective area B1);
- Consumption of fruit juices, artificially and sugar-sweetened beverages and its impact on weight status and health (objective area B2);
- Consumption of high-fructose syrup and its impact on weight status and health (objective area B3);
- Relationship between weight status and physical activity with school and work performance outcomes (objective area C);
- Early warning indicators of obesity and physical inactivity trends (objective area D);
- Nutrition and physical activity guidelines for specific population groups (objective area E).

Building on these seven reviews, the final review (objective area A2) examines specifically the evidence for effective and efficient policies and interventions in terms of promoting, supporting and improving nutritional and physical activity behaviours at both individual and population level.

All reviews, and their summaries, are available on the DG SANTE webpage [here](#).

Approach and purpose

The reviews have been designed to provide policymakers with summaries of recent and relevant evidence in these key areas of interest. Given the broad scope of each of the reviews, it should be stressed that they are not intended to be rigorous systematic reviews of all literature published in this field. Rather, they are intended as pragmatic

reviews combining a comprehensive search methodology with expert academic input, facilitated through workshops, to provide a practical and accurate summary of key issues and tackling broad lines of enquiry, with the greater aim of supporting the development and improvement of policies in this area. Each of the project's eight methodologies and analyses was reviewed by DG SANTE and academic experts in these topics.

While the methods to conduct this comprehensive literature review are systematic, it is *not* a systematic review. This review does not systematically analyse literature to identify *all* relevant published data and/or appraise its quality. Methods to conduct the literature review consisted of five steps: (1) refining the research questions, (2) developing a search approach and databases, (3) conducting literature searches, (4) screening articles for inclusion; and (5) abstracting and synthesising relevant data.

To minimise bias, the literature search approach included identification of a priori search parameters (also considered first level inclusion and exclusion criteria), agreed with DG SANTE, to guide searches and inform screening and selection processes for data inclusion. Due to the immense number of literature search results at step 3, the application of quite limiting exclusion criteria at step 4 was deemed necessary. This may however have resulted in not screening all potentially relevant literature. All relevant articles that were found appropriate for inclusion were reviewed for relevance to each objective area, and the scope of the specific research questions. Furthermore, the inclusion of different types of scientific evidence (from systematic reviews and peer-reviewed original articles down to BSc theses) and the presentation of this scientific evidence next to grey literature information presented a challenge in terms of maintaining an understanding of the quality and weight of the evidence. The authors addressed this to some extent by structuring the document in such a way that peer-reviewed and grey literature are clearly identified. The full methodology and steps taken for each review is included in Annex of this document.

DG SANTE and the Joint Research Centre (JRC) provided input on all stages of the project and comments on the literature reviews. Expert workshops were organised to discuss findings, highlight additional relevant sources to fill gaps and improve the series of reviews. Experts were carefully selected from academic and policy-making fields, based on expertise of the specific topics addressed.

The methodology used across all eight reviews remained consistent, and within each review a detailed summary of the approach is provided, along with a full bibliography for further reading.

Glossary

The following definitions are common definitions that are used across all eight objective areas. Where a study uses a different definition, this will be highlighted on an individual basis in the review.

Table 1. Definitions of terms used across the reviews

Term	Definition	Source
Adult obesity	An abnormal or excessive fat accumulation that presents a risk to health, with a BMI of 30 or more.	World Health Organisation (WHO) (http://www.who.int/topics/obesity/en/)
Adult overweight	An abnormal or excessive fat accumulation that presents a risk to health, with a BMI equal to or more than 25.	WHO (http://www.who.int/topics/obesity/en/)
Alcopops	Pre-mixed beverages containing a spirit, wine or malt combined with a non-alcoholic drink.	1. Anderson, P., Suhrcke, M. and Brookes, C. (2012) An overview of the market for alcohol beverages of potentially particular appeal to minors. London: HAPI.
Artificially sweetened beverages (ASBs)	Beverages sweetened with low-calorie or zero-calories sweeteners such as sucralose, aspartame, saccharin, stevia or sugar alcohols.	ICF definition based on all literature identified in objective area B2 literature review
Body Mass Index	A person's weight (in kilograms) divided by the square of his or her height (in metres).	WHO (http://apps.who.int/bmi/index.jsp?introPage=intro_3.html)
Child/adolescent obesity	<ul style="list-style-type: none"> There are different systems available to measure child or adolescent obesity for different ages. Children under 5 obesity is weight-for-height greater than 3 standard deviations above WHO Child Growth Standards median; 	WHO http://www.who.int/mediacentre/factsheets/fs311/en/ (Other definitions are available for different national and international systems).

Term	Definition	Source
	<ul style="list-style-type: none"> Children aged 5-19 overweight is BMI-for-age greater than 2 standard deviation above the WHO Growth Reference median. 	
Child/adolescent overweight	<p>There are different systems available to measure child or adolescent overweight for different ages.</p> <ul style="list-style-type: none"> Children under 5 overweight is weight-for-height greater than 2 standard deviations above WHO Child Growth Standards median; Children aged 5-19 overweight is BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median. 	<p>WHO</p> <p>http://www.who.int/mediacentre/factsheets/fs311/en/</p> <p>(Other definitions are available for different national and international systems).</p>
Exercise	<p>Exercise, is a subcategory of physical activity that is planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective.</p>	<p>WHO</p> <p>(http://www.who.int/dietphysicalactivity/pa/en/)</p>
Insufficient physical activity	<p>Physical activity that does not meet WHO recommended levels of at least 60 minutes a day of moderate-vigorous activity for children and adolescents and at least 150 minutes of moderate-intensity aerobic physical activity throughout the week for</p>	<p>WHO</p> <p>http://www.who.int/mediacentre/factsheets/fs385/en/</p>

Term	Definition	Source
	adults.	
Physical activity	Any bodily movement produced by skeletal muscles that requires energy expenditure.	WHO (http://www.who.int/topics/physical_activity/en/)
Physical inactivity	A lack of physical activity	WHO (http://www.who.int/diet_physicalactivity/pa/en/)
Sedentary behaviour	Any waking behaviour characterized by an energy expenditure ≤ 1.5 metabolic equivalents (METs) while in a sitting or reclining posture.	Tremblay, M. S., et al. (2017). Sedentary Behavior Research Network (SBRN) – Terminology Consensus Project process and outcome. <i>The International Journal of Behavioral Nutrition and Physical Activity</i> , 14, 75. http://doi.org/10.1186/s12966-017-0525-8
Sugar sweetened beverages (SSBs)	Any beverage with added sugars. This includes soft drinks, soda, fruit drinks, punch, sports drinks, sweetened tea and coffee drinks, energy drinks and sweetened milk. These beverages may be sweetened with added sugars such as sucrose (table sugar) or high fructose corn syrup, which is what distinguishes them from 100% fruit juice and beverages with non-caloric sweeteners (e.g., aspartame, saccharin or sucralose).	US Department of Agriculture. 2010. <i>US Department of Health and Human Services. Dietary guidelines for Americans, 2010</i> . 7th edition, Washington (DC): US Government Printing Office

Objective A2: Effectiveness and Efficiency of Interventions and Policies on Diet and Physical Activity

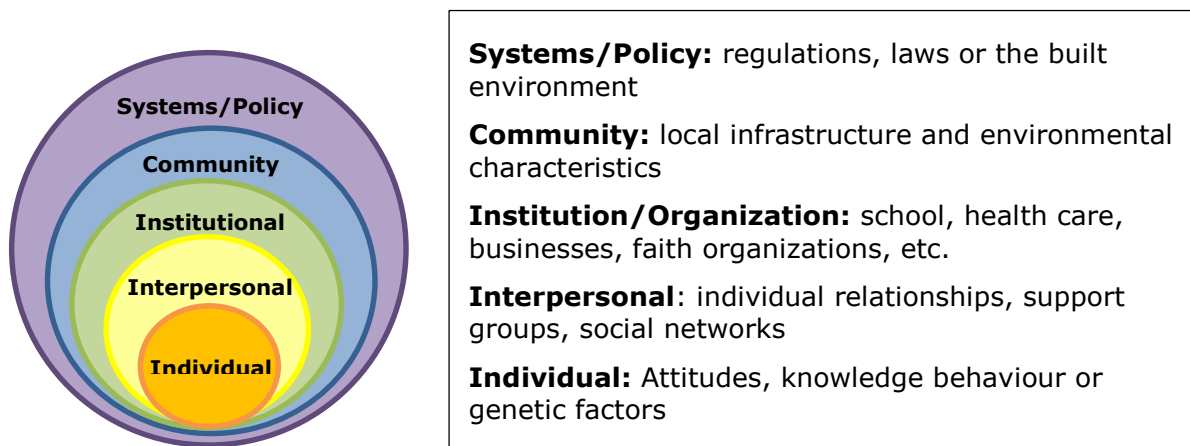
This review presents the scientific evidence on effective and efficient policies and interventions on diet and physical activity.

The report synthesises the findings of a review of both the peer-reviewed and grey literature on this topic. It has four sections: a) introduction to the topic; b) methodology, describing how the two reviews were undertaken and how relevant findings were extracted; c) findings from the peer-reviewed and grey literature, presented according to each research question; and d) conclusions drawn from the reviews, including an assessment of the strength of current scientific evidence, including any gaps in the knowledge base.

1 Introduction

It is well accepted that obesity and childhood obesity are complex, systemic issues (Aznar et al. 2016). Theoretical frameworks such as the social ecological model of health promotion note multiple levels of influence for health behaviour (Bronfenbrenner, 1977) and provide a useful framework with which to consider the complex interplay of factors influencing obesity. In the model, a person's health behaviours (e.g., dietary and physical activity) are influenced by factors at individual, interpersonal, institutional/organisational, community and systems/policy levels (Figure 1).

Figure 1. Social Ecological Model – Levels Influencing Obesity (adapted from CDC 2013)



Source: Adapted from CDC 2013

Given the complex interplay of causal factors, as discussed throughout this review, interventions and policies for tackling obesity must be **population-wide, integrated, multi-layered, multi-disciplinary and comprehensive**, and “involve a complementary range of actions that address the individual, community, environment and society” (Branca, Nikogosian and Lobstein 2007).

Since the early 2000s, a growing number of public health agencies and organizations have developed initiatives and strategic plans that incorporate obesity prevention interventions focused on policy, systems and/or environmental (PSE) change (Lyn et al. 2013). PSE change interventions build on the strategies and approaches used for tobacco prevention and go beyond individual-level programmes to change the environments in which people live, work, learn and play. The ultimate goal of PSE interventions has been to increase opportunities to make healthy living (e.g., increased physical or economic access to healthy foods or increased access to physical activity opportunities) easier in a

way that is far-reaching and sustainable, and cannot be done through individual level programmes and interventions alone.

In order to achieve wide-reaching change, many reviews call for a 'whole government approach' to tackling obesity. More specifically, a Health in All Policies (HiAP) approach, as referenced in Article 168 of the Treaty of the Functioning of the European Union¹, is being actively promoted. This approach involves raising awareness among all decision makers of their role in influencing health determinants, and actively including them in efforts to reach health objectives. Policy actions and interventions to tackle obesity should also involve the food and retail industry, civil society, statutory and voluntary organisations, schools, workplaces and community organisations (Oortwijn et al. 2011).

For any government or organisation looking to develop strategic plans for obesity prevention, current literature on PSE interventions can offer an important resource for determining what interventions have been implemented and which are more efficient and effective. In addition, the obesity prevention work conducted over the last 15+ years has noted lessons learned and important considerations about context and design when implementing PSE strategies that can offer guidance for future planning.

1.1 Research questions for this review

In this review, we focus on the most relevant and current peer-reviewed and grey literature addressing the scientific evidence of the effectiveness and efficiency of obesity prevention interventions and policies (covering diet and physical activity). To explore these topics, the literature review was conducted around the following questions.

1. What policies/interventions are more effective and efficient in this area (information, advertising, taxation, reformulation, regulations, partnerships, etc.)?
 - a) Systems/policy
 - b) Retail settings
 - c) Community settings
 - d) Childcare and pre-school settings
 - e) School and university settings
 - f) Worksite settings
 - g) Healthcare settings
2. How do differences in the context and design of interventions lead to differences in outcome?
3. What are the key elements of effective and efficient interventions?
4. How would the ideal intervention be designed?

The methodology for the peer-reviewed literature and grey literature searches are described in section 2, with greater detail on search terms provided in the Annexes to this review.

1.2 Scope and limitations of the review

As reflected in the methodology section below, this report aims to provide a comprehensive overview of effective and efficient policies and interventions focused on promoting healthy eating and physical activity. However, given the broad nature of the topic, it does not aim to provide a systematic review and assessment of all literature available on this topic. While the review recognises the importance of individual-level approaches to tackling obesity, it focusses mainly on assessing the effectiveness of large-scale interventions and policies including large-scale education campaigns or initiatives to

¹ Consolidated Version of the Treaty on the Functioning of the European Union, Article 168 (2007). C115/123. Official Journal of the European Union. Article 168 legally requires that health be taken into account in all EU policies.

drive small behavioral changes in whole school or workplace settings. In particular, the report focusses on changes that could be implemented or lobbied for at Member State or European-level. This focus is reflected in the search terms chosen below.

Gaps in the evidence base and limitations of the review

The review fully acknowledges the complexity of the causes of obesity and therefore the complexity of solutions for obesity prevention. As was clearly reflected in the literature identified, multiple complementary policies and interventions are required at a variety of levels (national, regional, community, school/workplace, and individual) and no single intervention or policy can solve the problem alone. However, only a handful of studies identified in this review provided any assessment of the effectiveness or efficiency of *combinations* of interventions. This is likely because of the difficulty of linking certain outcomes to specific activities or policies but is nevertheless a key limitation of this area of research: many interventions may be ineffective alone but become highly effective when combined with certain other interventions. This should be kept in mind when reading the review. In line with the evidence base, findings from the review have been reported by setting but links between multiple settings and interventions have been made as far as possible.

As noted above, the evidence related to obesity prevention initiatives, particularly those focused on PSE interventions, is growing. However, in general, there are not many studies looking at the long-term outcomes and impacts of policies and interventions due to the difficulties in collecting this type of outcome data. While there are some studies that have used statistical modelling to predict expected long-term outcomes and impacts, many focus on the shorter-term behavioural outcomes of interventions.

Furthermore, real-world, large-scale interventions and policies are difficult to evaluate given the complex interplay of variables. This restriction on the types of intervention that can be reliably evaluated has led to criticism that evidence-based policy is too narrow in its focus, and that it is biased towards the interventions that are easiest to evaluate (Branca et al. 2007). One of the most common settings for controlled interventions are schools because specific inputs (e.g. educational sessions) can be measured and experimental designs can be used to ensure the results have scientific validity. However, experimental designs do not always adequately assess the context of an intervention and the extent to which contextual factors can impact outcomes.

Evaluation difficulties raise a number of questions regarding what constitutes “sufficient evidence” of effect. At what point is there enough evidence to implement a policy? What is meant by policy or intervention *effectiveness* and how is effectiveness defined by different stakeholders? The findings under research question 1 below support the effectiveness of a number of interventions insofar as they have a proven effect on changing behaviours, however should they be classified as ‘effective’ when their longer-term outcomes (e.g. their impact on weight status) and evidence of sustainability are unclear or unknown? While this discussion is beyond the scope of the current review, these are key issues for academics and policy-makers to consider when selecting effective policies and interventions. For the purpose of this review, effectiveness has been defined in broad terms and throughout the review, it has been made clear whether effectiveness statements refer to evidence of short-term outcomes or longer-term outcomes and sustainability.

Finally, while more and more studies are starting to assess the effectiveness of interventions, there is a paucity of studies evaluating the cost effectiveness of interventions. Most evaluations and systematic reviews of interventions rarely refer to the costs of programmes, despite the cost of interventions being a primary concern for policymakers and public health managers (Branca et al. 2007). As Castle (2016) asserts in relation to weight management programmes, it is often very difficult to assess the resource effectiveness or cost effectiveness of such programmes, particularly because

studies rarely follow patients for long enough to assess whether weight-loss is maintained in the longer-term. This may explain why it is often neglected in evaluations.

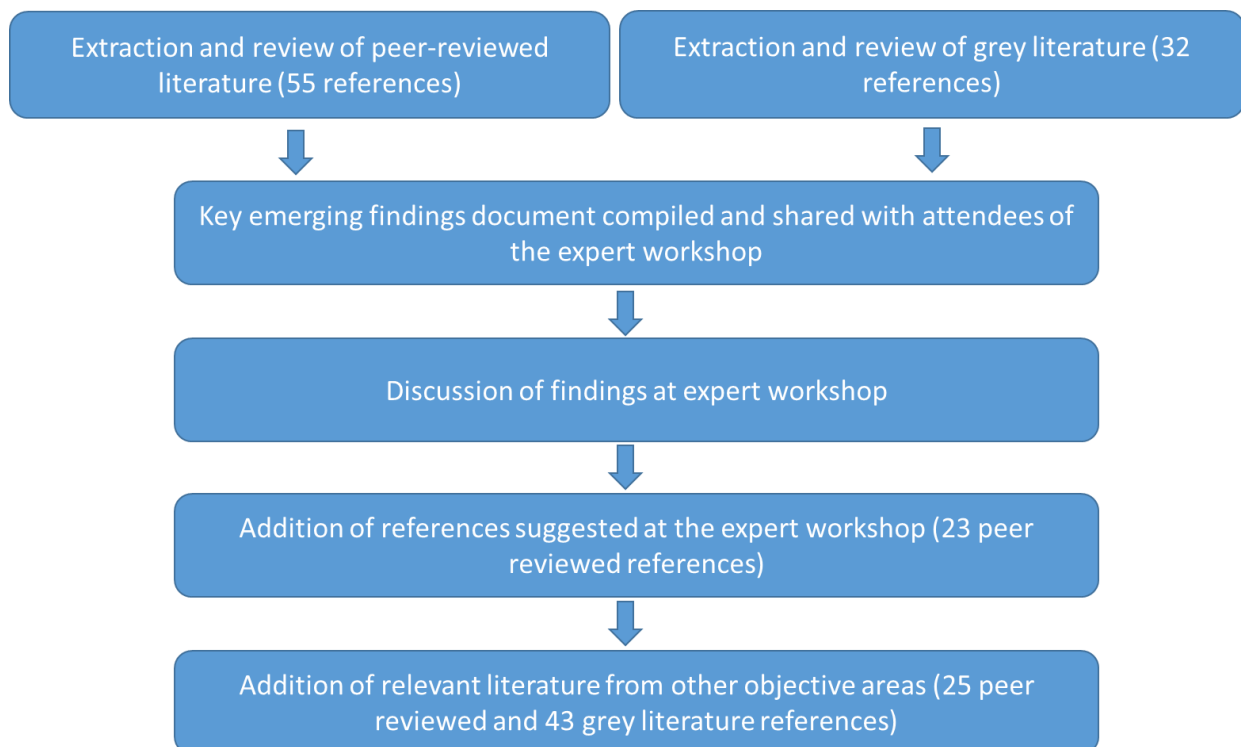
2 Methodology

Peer reviewed and grey literature were analysed to develop the findings of this review. For each set of literature, specific search terms, inclusion and exclusion criteria, and quality checks were carried out. The research questions and search terms were confirmed with DG SANTE at the start of the process.

After the initial searching and extraction of literature, expert workshops (with experts from relevant academic and policy-making fields) were conducted to discuss findings, highlight additional relevant sources to fill gaps and improve the series of reviews. 23 additional references were added on the basis of comments from the expert workshop to address gaps in the review.

The scope of this objective area covers the main policies discussed in all previous series of objective areas. Therefore, as an additional revision to this report, all relevant policy-specific information and analysis from other objective areas has been carried across into this review. Figure 2 below presents a high-level summary of the process.

Figure 2. Methodology for Objective A2



2.1 Peer-Reviewed Literature method

To search for and extract the most relevant peer reviewed literature the following steps were taken: refining the research questions; developing a search approach and databases; conducting literature searches; screening articles for inclusion; and abstracting and synthesizing relevant data.

A total of 3,559 search hits of peer reviewed literature were initially retrieved using selected search terms per research question. 379 duplicates were found and removed from the search hits resulting in 3,180 unique search hits for A2. From the 3,180 articles, the team screened 200 of the most relevant and recent titles and abstracts for the first three research questions (information for the fourth research question on the ideal intervention was drawn from references identified as part of the searches for questions

1-3). Where there was a lack of relevant literature for a research question, more than 200 articles were screened. For A2, 600 original research articles were screened, plus 408 systematic reviews. From the 1,008 most recent titles and abstracts screened, 75 were deemed of potential relevance and reviewed as full texts. From the 75 deemed relevant and reviewed as full texts, 55 publications were selected for inclusion in the final review. The full peer reviewed searching and extraction methodology is outlined in Annex 1.

Addition of recommended references from the expert workshop (23) and relevant literature drawn across from other policy areas (25) brings this total to 103 articles.

2.2 Grey Literature method

To search for and extract the most relevant grey literature, the following steps were taken: searching for publications using set keywords and databases; screening of search results and exclusion of less relevant literature; and, extraction and review of remaining documents. The grey literature search process was a more fluid and dynamic process compared to the peer reviewed method, where hand searching was also utilised to find the most relevant sources.

Search hits of grey literature were initially retrieved using selected search terms and filtered on the basis of key search terms in the title and relevance of the title to the review. 172 articles identified as relevant were saved to the library. A total of 109 results were excluded based on the inclusion/exclusion criteria, quality of evidence and relevance to the research questions. From the 64 deemed relevant and reviewed as full texts, 32 publications were selected for inclusion, in this final review. The full grey literature searching and extraction methodology is outlined in Annex 4.

Addition of recommended references from the expert workshop (0) and relevant literature drawn across from other policy areas (43) brings this total to 75 articles.

2.3 Definitions

This objective area focusses on the **effectiveness** and **efficiency of policies and interventions** to encourage healthy eating and physical activity. For the purpose of this review, the key words in bold have been defined as follows:

- **Effectiveness** refers to the extent to which the desired results of a policy or intervention were achieved²;
- **Efficiency** refers specifically to cost-effectiveness and to the use of resources (e.g. money, people, and partners) and/or the ability to reach a large number of people;
- **Policy** has been defined using the definition provided by the Centres for Disease Control and Prevention (CDC, 2015). A policy is “a law, regulation, procedure, administrative action, incentive or voluntary practice of governments and other institutions”. There are three main types of policy that fall under this definition, all of which can operate at national, state, local or organisational level:
 - Legislative policies are “laws or ordinances created by elected representatives”;
 - Regulatory policies “include rules, guidelines, principles or methods”; and
 - Organisational policies include rules or practices established within an agency or organization”; and
- **Interventions** refer to actions that are implemented to prevent, improve or stabilise a condition.

² Section 1.2 describes some of the difficulties in defining ‘effectiveness’ in relation to policies and interventions.

The following terms have also been used throughout the review:

- **Systems change** refers to interventions that impact all elements of an organization or systems (e.g., implementing a referral system in healthcare settings to refer overweight/obese patients to resources to improve diet and physical activity) (NACCHO 2011);
- **Environmental change** refers to interventions that involve change to the environment, typically the physical environment (e.g., new recreation facilities, new trails/paths, removing unhealthy items for purchase in school/ worksite/ healthcare settings) (NACCHO 2011);
- **Multi-component intervention** refers to interventions that incorporate more than one approach for improving physical activity and/or nutrition such as education and environmental change or policy and environmental change;
- **Multi-setting intervention** refers to interventions being implemented at multiple settings or levels; this could include school-based intervention with a home component or community interventions with a healthcare community (e.g., systems change in healthcare centres to refer overweight/obese patients to community prevention programs); and
- **Multi-behaviour intervention** refers to interventions targeting more than one behavior (e.g., dietary behavior and physical activity).

3 Findings and discussion

The findings from the reviews are presented by each research question, further separated by policy/intervention level. The findings from the peer-reviewed and grey literature have been combined: peer results have been reported first followed by grey literature to support and expand on key findings. A summary of key messages for each research question is presented at the beginning of each section.

3.1 Research Question 1: What policies and interventions are more effective and efficient in this area?

In line with Figure 1 above, the review focusses on high-level policies and interventions first, followed by community-level interventions, pre-school, school and workplace interventions and finally healthcare interventions. Table 2 below summarises the evidence reviewed in each section.

Table 2. Summary of effective policies and interventions

	Policy/Intervention	Evidence of effect
Systems/policy	CAP reforms	Moderate evidence of effect on dietary choices, but should be combined with other supply chain initiatives – recommended.
	Public Private Partnerships	More evidence is needed on the consumer impact of PPPs and the most effective approaches to PPPs.
	Taxation	Moderately strong evidence of effect on consumption, weaker evidence of impact on weight loss – recommended.
	Subsidies	Strong evidence of effect on consumption – recommended.
	Bans	Strong evidence of effect on consumption of trans fat foods – recommended.
	Reformulation	Moderate evidence of effect on consumption – more evidence needed to explore to what extent substitution with other unhealthy ingredients occurs.
	Marketing bans and restrictions	Moderate evidence for reduction in purchasing, but limited evidence for reduction in weight/BMI – recommended.
	Mass media campaigns	Strong evidence for increasing awareness of nutrition and physical activity, but limited evidence for changing behaviour – recommended.
Retail settings	Nutrition labelling	Strong evidence for increasing awareness, limited (but promising) evidence for changing behaviour/BMI in real world settings – recommended.
	Other retail interventions	Strong evidence for effect of point of sale interventions on purchasing – recommended.
Co	Community neighbourhood	Strong evidence for effect of neighbourhood design

	design policies	policies on physical activity – recommended.
	Cycling interventions	Evidence for increases in cycling behaviour – recommended.
	Walking interventions	Evidence for increasing physical activity with build environment and walking programmes – recommended.
	Environmental prompts	Strong evidence for increasing stair climbing – recommended.
	Community-based childhood obesity interventions	Best evidence for multi-level, multi-setting community interventions for increasing physical activity – recommended.
Childcare and pre-school settings	Nutritional interventions	Limited research undertaken.
	Physical activity interventions	Moderately strong evidence for increasing physical activity – recommended.
	Nutrition and physical activity interventions	Evidence for multi-component programmes on changing behaviour and BMI – recommended.
School and university settings	Improving the food environment	Strong evidence for effect on behaviour when focussing on one aspect of diet, but limited evidence for effect on BMI/weight – recommended. Evidence for reducing access to unhealthy foods – recommended.
	Creating an active environment	Moderately strong evidence for change in behaviour, but limited information regarding BMI/weight – recommended together with more research on health benefits.
	Dietary choices education	Limited, but promising evidence for change in behaviour – more research needed
	Physical activity education	Limited evidence – more research needed
	Multi-behaviour, multi-component, multi-setting interventions	Strong evidence for behaviour change, moderately strong evidence for BMI/weight – recommended.
	University setting	Moderately strong evidence for the effectiveness of shorter term interventions in changing behaviour – recommended
Worksite settings	Whole workplace interventions	Moderately strong evidence for increasing physical activity and health benefits – recommended. Evidence for reduction in absenteeism and increase in productivity following physical activity interventions – recommended.
	Whole environment changes	Evidence of effect of healthy environment changes on behaviour, but effect sizes are small – recommended.

		Strong evidence of effect of active environments on changing behaviour, but limited evidence for health benefits – recommended, but more research needed.
Healthcare settings	General	Limited research available for the effectiveness of clinician-led interventions – more research needed to assess impact on BMI as well as the most effective way to incorporate into clinical practice.
	Children	Limited evidence of effectiveness – more research needed.
	Adults	Primary care health counselling and remote health interventions seem promising to change behaviour, but more research needed to evaluate the effectiveness on BMI.

3.1.1.1 Systems/policy level

The following section looks at the effectiveness of government action to impact food production across the whole production system from ‘farm to plate’. This includes Common Agricultural Policy (CAP) reform policies, developing public-private partnerships (PPPs) with food producers and retailers, taxation and subsidies and bans and reformulation. It also looks at the effectiveness of government-led or large-scale mass media campaigns to influence nutrition and physical activity behaviours. As is evident below, in general, Governments have been more active in attempting to influence diet rather than physical activity (McDaid, Sassi and Merkur 2015; PHEIAC 2013).

CAP reform policies

Summary of Effectiveness:

- There is some evidence that reforming the Common Agricultural Policy (CAP) can influence dietary choice. However, such a policy alone is not enough: a Health in All Policies approach across the whole food system is required.

Taking a systems-wide approach to tackling obesity, farmers, food and beverage producers and retail industries are key actors in shaping the diets of consumers. There is suggestive evidence that governments can play an effective role in encouraging the food sector to support the improved diet quality of consumers (Traill 2013). However, most study outcomes focus on stakeholder engagement rather than changes in consumer dietary behaviour or longer-term weight outcomes.

While taxation and reformulation interventions are discussed below, at an EU-wide level, there has been a recent focus on making the Common Agricultural policy healthier (EPHA 2016) and encouraging a “Health in all Policies” approach to trade and agricultural policy. This approach encourages stakeholders to focus not only on the economic benefits of such policies but the social and economic costs of increasing the risk of non-communicable diseases. Given sparse research in the field it is difficult to quantify the extent to which the CAP is responsible for dietary outcomes. However, several reports, including a ground-breaking study by the Swedish National Institute of Public Health, have argued that there is a close link between the CAP and dietary choice. These reports align with research which concludes that increases in food availability are the dominant

drivers of population weight gain (EPHA 2016). Furthermore, because the large majority of the food Europe produces remains within the EU and is consumed or withdrawn in some way internally, European-wide food policies have the potential to have a large impact (EPHA 2016).

However, EPHA (2016) argue that reforms to the CAP alone, given the powerful position of the food processing and retail industries, are insufficient to steer consumption patterns. There needs to be a Health in All Policies approach covering the whole food system including production, processing, wholesaling, retailing, trade, marketing and consumption.

Public-private partnerships (PPPs)

Summary of Effectiveness:

- Public-Private Partnerships (PPPs) can effectively engage private-sector actors in achieving policy goals. However more evidence is needed on the impact of these partnerships on consumer outcomes. More information is also required on the most effective approaches to PPPs.

Linked to a comprehensive approach to tackling obesity, there is some evidence that, if properly monitored, voluntary agreements between governments and industry can be an effective approach to engaging private actors in achieving policy objectives (Bryden et al. 2013). Limited evidence suggests that voluntary agreements that include substantial disincentives for non-participation and sanctions for non-compliance are more successful than softer voluntary agreements and pledges (Knai et al. 2017) and many countries are now moving towards a more formal approach to PPPs (Bryden et al. 2013). There is some evidence that with softer agreements, private partners frequently chose food pledges reflecting work they were already doing (Durand et al. 2015); and voluntary pledges do not consistently reflect the most evidence-based strategies (Knai et al. 2015). Jensen and Ronit's (2015) assessment of the EU pledge for responsible marketing also concluded that more transparency and stringency is required.

However, food industry self-regulation for obesity prevention is an emerging area of research. Further research on the impact of public-private partnerships on consumers is required along with more research on the most successful forms of PPPs, including the most effective monitoring and sanctioning mechanisms and how PPPs interact with public regulation (Ronit and Jensen 2014).

Taxation and subsidies

The following sections discuss the impact of industry price-policies on consumer behaviour and weight status.

Summary of Effectiveness:

- Moderately strong evidence exists that taxation of nutritionally unbalanced foods can reduce consumption of these foods. However there is a lack of real-world studies in this area.
- Taxation may lead to a reduction in consumer weight, however the link is weaker than for consumption.
- Lower socioeconomic (SES) status households may be more affected by taxation on unhealthy food than higher SES households.
- Taxation is not a popular policy among stakeholders.
- Literature focussing on SSB taxes reports similar findings i.e. moderately strong evidence of a reduction in consumption of taxed beverages and some evidence of a reduction in consumer weight. Taxation of alcopops was also associated with a reduction in alcopop consumption, although not overall alcohol intake.
- There is strong evidence that subsidies for nutritionally balanced foods

Taxation

Taxes applied to nutritionally unbalanced foods can reduce consumption of these foods, however most evidence is restricted to experimental and modelling studies. Substantial peer-reviewed literature evidence including a systematic review (Batis et al. 2016; Niebylski et al. 2014, Escobar et al. 2013) and grey literature findings (WHO Regional Office for Europe 2015, Tedstone et al. 2015, Loughnane and Murphy 2015, Traill 2013, WHO Regional Office for Europe 2006a) reported moderately strong evidence that the taxation of nutritionally unbalanced foods can reduce consumption.

A systematic review by Niebylski et al. (2014), of 78 international studies³ on unhealthy food taxation and/or healthy food subsidies, concluded that there was moderately strong evidence for taxation on foods high in fat, sodium and sugar as an effective strategy for reducing consumption. They looked at 33 modelling studies which showed that taxes ranging from 10-15% produce reductions in consumption from 8-12%, and 24 experimental studies which identified price as a modifying factor in food choices (though substitution may occur).

Similarly, a study in Mexico by Batis et al. (2016) found that a 1 peso per litre tax on SSBs and an 8% tax on non-essential food with energy density (>/275 kcal/100 g), implemented in January 2014, led to an absolute decline in household food consumption of these taxed purchases. Their analysis of survey data on volume of Mexican household food purchases found a -5.1% relative change after one full year of implementation. The greatest change was observed in salty snacks (-6.3%) and cereal based sweets (-5.2%). No differences were seen in untaxed foods before and after implementation.

The grey literature further supports the effectiveness of fiscal measures in reducing consumption of unhealthy foods. A Health Evidence Network (HEN) synthesis report cited in WHO Regional Office for Europe (2006a) concluded that taxes could reduce the consumption of high fat foods and increase the purchasing of healthy foods. Loughnane and Murphy (2015)'s review also found economic modelling evidence that a sugar tax in

³ Western Europe, Canada, US, Australia and New Zealand.

particular can reduce sugar consumption, while Cornelsen and Carreido (2015) highlighted that taxation can prevent impulse buying.

However, an evaluation of 111 policy interventions⁴ by Traill (2013) found mixed results of the effectiveness of fiscal measures, arguing that while many experimental and simulation/modelling studies exist, there is a lack of real-world policy evaluations. Traill also argues that the distributional effect of taxation policies is unclear. Real-world policy evaluations are starting to emerge (WHO Regional Office for Europe 2015) and findings from these studies appear to be consistent with the main conclusions from experimental and modelling studies, but policy-makers should continue to prioritise evaluations of existing taxation policies. WHO's Regional Office for Europe (2015) also recommends that policy-makers ensure they establish clear policy objectives for taxation initiatives, target certain foods and/or nutrient groups and anticipate any broader effects of taxation (for example substitution) before implementation, to maximise effectiveness.

There is a weak link between taxation and a reduction in weight among consumers. Niebylski et al. (2014) found evidence from 24 empirical studies that taxation on unhealthy food may be linked to a reduction in weight among consumers, however the relationship is weaker than for consumption. Escobar et al. (2013) and Bes-Rastrollo et al. (2016) also found evidence from a meta-analysis and literature review respectively, of an inverse relationship between the price of SSB products and weight status of consumers. However, an earlier systematic review (Levy, Friend and Wang 2011), while finding evidence of decreased consumption resulting from taxation of unhealthy foods, reported no impact on weight status.

Looking more closely at the distributional effects of taxation, there is some evidence that lower socioeconomic (SES) status households may be more affected by taxation on unhealthy food than higher SES households. A systematic review (Backholer et al. 2017) found some evidence that there is a more significant reduction in consumption of SSBs among lower SES households than higher SES households after the introduction of taxation or price increases (see Box 1). Batis et al. (2016) also found that, in Mexico, low SES households showed the greatest responsiveness to the tax, however they did not buy as many foods in the taxed category both before and after implementation.

The impact of taxation on low SES groups has led to discussions regarding the reduction of societal health inequalities. Given that individuals of lower SES tend to have higher rates of obesity than individuals of higher SES, taxation policies have been identified as a successful way of helping to reduce health inequalities (WHO 2015).

Taxation and price policies may not be popular among stakeholders. Results from a European Commission-funded study, "PorGrow", which interviewed a wide range of stakeholders⁵ about their views on different policy options for tackling obesity (Lobstein and Millstone 2006) found that stakeholders supported a comprehensive and coherent portfolio of policy measures for tackling obesity, recognising the need for action and accepting the costs of interventions. However most required a justification of the wider health and social benefits of "upstream" policy interventions such as marketing controls, fiscal measures and changing planning and transport policies. Taxation was the least

⁴ Policy interventions were identified in scientific papers, policy documents, grey literature, government websites, other policy reviews, and interviews with policymakers. Existing policy evaluations were assessed and further analysis of secondary data sets using modern statistical techniques was undertaken to improve the evidence-base.

⁵ The project interviewed food producers, manufacturers and retailers, advertisers and caterers, life insurers, pharmaceutical companies, teachers, sport and physical activity organisations, public health experts, town planners, advocacy organisations and consumer groups across nine countries (Cyprus, Finland, France, Greece, Hungary, Italy, Poland, Spain and the UK.).

preferred policy option among all stakeholder groups⁶. This highlights the need to provide stakeholders with a clear rationale for implementing such policies.

Box 1. Focus on: Taxation on SSBs

The review identified a small body of literature (peer-reviewed and grey) focussing specifically on price policies for SSB products. The findings largely mirrored those of the wider studies reported above.

Taxation can reduce consumption of SSBs. Escobar et al.'s (2013) meta-analysis of nine studies reported that increased price of SSBs was associated with a decrease in SSB demand (Escobar et al. 2013) while demand for non-SSB products like milk and fruit juice increased.

In the grey literature, the introduction of taxes in Norway, Finland, Hungary, France and Mexico were found to be associated with a decrease in sales of SSBs and high sugar products (Tedstone et al. 2015). For example, in Norway, the introduction of a sugar tax in 1981, which was later increased in the 2011 budget, resulted in a large reduction in the average consumption of lemonade and regular soft drinks (from 4.8 to 2.5 and 2.3 to 1.6 times per week, respectively) between 2001 and 2008. This is despite increases in soft drink consumption in other European countries (Tedstone et al. 2015). Sénat (2014) also reported reduced SSB sales and consumption as a result of the "sugar tax" in France two years after implementation, as well as a fall of three calories per day for each French household (estimation based on previous research by Kantar Worldpanel).

The grey literature suggested a link between taxation and a reduction in the consumption of alcopops. However taxation was not found to reduce overall alcohol consumption and harm. Several countries including the UK, Germany, Luxembourg, Denmark, France and Switzerland have introduced alcopops taxes or increased prices through re-classification (Rabinovich et al. 2009; Anderson and Baumberg 2006). Anderson and Baumberg reported that the consumption of spirit-based alcopops halved between 2004 and 2005 after introduction of the alcopop tax in Germany, without a noticeable substitution of other drinks. Official records of the sales of spirit-based alcopops also showed a decline of 75% after the tax. The review largely attributes the fall in consumption to the effects of the tax, highlighting that of the 70% of teenagers who reported buying fewer alcopops, the main reason (63%) for buying less was due to them becoming more expensive.

Furthermore, the introduction of the Swiss alcopops tax led to low-sugar versions (containing less than 50g of sugar per litre) of products being produced to avoid the tax and official figures from the Swiss Alcohol Board in 2005 show that the tax introduction was followed by a large drop in alcopop imports in Switzerland (Anderson and Baumberg 2006). However, there is disagreement regarding the effectiveness of alcopop taxes in reducing overall alcohol consumption and harm as substitution may occur (Anderson and Baumberg 2006; Rabinovich et al. 2009; Anderson, Suhrcke and Brooks 2012).

There was mixed evidence of a link between taxation of SSBs and a reduction in weight among consumers. Studies identified either a weak

⁶ Public Interest NGOs, food chain operators, small food and fitness operators, large non-food operators, policy-makers, public service providers, and public health specialists.

inverse relationship between taxation and weight status (Escobar et al. 2013; Bes-Rastrollo et al. 2016) or no significant association (Levy, Friend and Wang 2011).

There is moderately strong evidence that SSB taxation has a larger impact on individuals of lower SES. Backholer et al.'s (2016) systematic review looked at 11 international⁷ articles from 2010-2015 that included studies on the association between a variety in SSB taxes and consumption and/or BMI. One study found a significant relationship between SSB tax increase and reduced consumption among adults with low income and low education levels and one study examining price elasticities found that low-income households were more responsive to increase in the price of SSBs compared to high-income households. Of the seven modelling studies included in the review, results varied, however, when studies simulated the effect of a tax on energy intake and health outcomes, results demonstrated either a similar benefit across differing income levels or a greater impact for low-income households.

Bes-Rastrollo et al. (2016) also noted that taxes on SSBs have a greater impact on individuals of lower SES as these individuals would pay a higher proportion of their income for this tax than wealthier individuals. However it seems the health benefits may be progressive because low-income individuals tend to be high consumers of SSBs and also tend to have higher BMI than wealthier people and stand to gain the most from a tax that would reduce their consumption.

Subsidies

Healthy food subsidies and financial incentives increase consumption of healthier foods. Two systematic reviews (Niebylski et al. 2014; An 2013) and grey literature (WHO Regional Office for Europe 2015; Loring and Roberston 2014; Traill 2013; Réseau de Recherche sur l'Amélioration de la Santé des Populations, Réseau ontarien de recherche sur les ressources humaines en santé, Réseau de recherche appliquée sur la santé des francophones de l'Ontario 2011) demonstrated the effectiveness of subsidies in encouraging the consumption of healthier foods.

In a 2013 systematic review, An examined 24 studies from the US, New Zealand, France, Germany, Netherlands, South Africa and the UK and included subsidies in restaurants, supermarkets, cafeterias, vending machines, and farmers markets, which ranged from 10-50% or \$7.50-\$50.00. Twenty-three of the 24 studies included found subsidies to significantly increase purchasing and consumption of healthy items, which generally included fruits and vegetables, low-fat snacks, fruit juice, vegetable soups, and low-fat milk. One study did not show improved food consumption after a 50 cent subsidy (a considerable lower incentive when compared to other subsidies examined). Fruit and low-fat snacks appeared to be the most frequently purchased foods linked to the presence of a subsidy. The systematic review by Niebylski et al. (2014) also reports that subsidies improved fruit, vegetable, and low-fat snack consumption in markets, restaurants, vending machines, and cafeterias. In general, the effect of subsidies tended to be proportional to the price difference.

The effectiveness of subsidies and financial incentives was also supported by grey literature findings. The evaluation of policy interventions by Traill (2013) identified limited but suggestive evidence supporting the effectiveness of subsidies on dietary patterns (no quantitative evaluations were identified but academic studies from the US

⁷ UK, US, Ireland, Australia and New Zealand

provided some evidence of effectiveness). However, a review of 33 evaluations of nutrition and healthy eating interventions in Ontario, Canada (Réseau de Recherche sur l'Amélioration de la Santé des Populations; Réseau ontarien de recherche sur les ressources humaines en santé; Réseau de recherche appliquée sur la santé des francophones de l'Ontario 2011) found that while financial incentives such as discounts on healthy foods in retail environments are usually effective in the short to medium term, longer-term effects were not identified.

More specifically, Loring and Robertson (2014) describe the positive health impact of Healthy Start, a government programme delivered across the UK which have included pregnant women and low-income families. Beneficiaries of the scheme were sent vouchers that could be used to buy groceries such as milk, and fresh or frozen fruit/vegetables. These vouchers were issued to families across the UK every four weeks. Pregnant women and children aged 1-4 who were eligible for the scheme received one voucher per week (worth £3.10) and infants got two vouchers a week. Women taking part in the programme consumed significantly more fruit and vegetables and were more likely to meet the recommended intake of iron, folate, calcium and vitamin C.

Cost effectiveness of taxation and subsidies

Niebylski et al. (2014) examined the cost effectiveness of unhealthy food taxation and healthy food subsidies across a number of Western European, Canadian, US, Australian and New Zealand studies. The authors concluded that **subsidising healthy food in conjunction with an unhealthy food tax may be the most effective and cost-effective intervention to improve health outcomes** as the risk of substitution is reduced. They reviewed modelling and cost-effectiveness studies which found that taxation at 20% and subsidies of 15% were most effective for reducing consumption of unhealthy food and increasing the consumption of healthier options, particularly fruit and vegetables.

In the grey literature, Traill (2013) found that fiscal interventions such as fat taxes can be very cost-effective, although interventions targeted at children are usually found to be less cost-effective. The latter finding is due to the discounting of future benefits as policies focussed on children will produce most of their positive health outcomes in adulthood. McDaid, Sassi and Merkur (2015) reinforce Traill's findings, concluding that taxation policies on junk foods (i.e. high fat, salt and/or sugar) are consistently cost-saving: they save more through reduced healthcare expenditure than they cost to implement and have overall favourable health outcomes. The cost-effectiveness of such policies is particularly high when the dietary outcomes also have a strong link with preventing cardiovascular disease and cancer.

Bans and reformulation policies

The following sections refer to policies and interventions encouraging industry reformulation.

Summary of Effectiveness:

- There is strong evidence that bans can reduce consumption of trans-fats and limited evidence of their longer-term health benefits.
- There is strong evidence that reformulation of products is linked with decreased consumption of calories, salt and sugar. However, there is a lack of research on the extent to which reformulation leads to replacement of one unhealthy ingredient with another.
- Very limited evidence of the cost-effectiveness of bans and reformulation policies was identified, however there is grey literature evidence supporting the cost-effectiveness of salt reformulation initiatives.

Bans

There is strong evidence that bans have an impact on trans-fats consumption and related health outcomes. Downs, Throws and Leeder et al. (2013) found that local and national bans were the most effective policies for reducing the consumption of industrially produced trans fatty acids (TFA) in foods. Their systematic review of policies included 26 studies spanning seven countries⁸ and five different types of TFA policy intervention: self-regulation (n=5), labelling alone (n=8), labelling and voluntary limits (n=4) local bans (n=5) and national bans (n=4). Regardless of the type of policy implemented, efforts were effective in decreasing TFA consumption but the evidence on national bans found that they 'virtually eliminated' TFA from the food chain (Downs, Throws and Leeder 2013), with local bans reducing TFA levels by 92-99% in fried and other restaurant food and 59% in fast food locations. Other policies had more variable effects on TFA levels across the reviewed studies.

Furthermore, the WHO's (2014) snapshot of successful nutrition policies cites Denmark's 2003 virtual ban on the sale of products containing trans-fats as a 'world first'. They note that trans-fat consumption in Denmark decreased among all age groups, and stood at around one tenth of previous levels. Denmark also experienced a significant decrease in mortality from cardiovascular disease, which may be partly attributable to the drop in trans-fat consumption. The report suggests that countries that have no policies on trans-fats have higher levels of consumption (Stender, Astrup and Dyerberg 2012).

Reformulation

There is strong evidence that reformulation of products is linked with decreased consumption of calories, salt and sugar. However, there is a lack of research on the extent to which reformulation leads to replacement of one unhealthy ingredient with another. In a simulation modelling study conducted by Gressier et al. (2017), the authors found adhering to nutrition standards industry-wide would lead to a significant reduction in average daily caloric intake, saturated fats, sodium and added sugars. The authors used the Nestle' Nutrition Profiling System standards for children, adolescents and adults⁹ to simulate industry-wide reformulation of foods and beverages. Other data used to inform the simulation model came from two national surveys, the 2011-2012 National Health Interview Survey (NHANES) in the U.S. (n=7456) and the 2011-2012 French Individual and National Survey on Food (n=3330). Mean intake decreased by 90kcal when foods were reformulated to meet nutrition standards.

Furthermore, a reformulation element contributed to the success of the Finnish North Karelia project that started in 1972 as a national pilot health strategy to prevent obesity and cardiovascular disease (Puska, 2000, cited in Robertson et al. 2004). It was a collaboration between government and industry - one industry initiative included the development of a cholesterol-lowering rapeseed oil from a plant common in the North of Finland, which was a healthier alternative to butter. Over a period of 25 years, butter was increasingly replaced by vegetable oils in the population. Robertson et al. note how collaboration between governments and industry can be effective in nudging behaviour to become healthier, though there is little discussion on the aspects of this collaboration, how this contributed to its effectiveness or the data that these conclusions were based on.

⁸ Brazil, Canada, Costa Rica, Denmark, the Netherlands, Korea and the United States

⁹ The Nestle Nutrition Profiling System is a nutrient profiling system that sets nutrient targets per serving and exist only for packaged and beverage products.

Furthermore, WHO (2014) provides an example from the UK of an effective salt reduction policy through reformulation. Food manufacturers were asked to gradually reduce the salt content in their products. The salt reduction programme started in 2003/2004 and led to a 10-15% reduction in salt intake, decreasing from 9.5g per day in 2000-2001 to 8.6g per day in 2008 and 8.1g in 2011 (Storcksdieck et al. 2014). This reformulation policy was accompanied by education campaigns and clearer nutritional labelling. More specifically, Bollars et al. (2013) found that The EU Framework for National Salt Initiatives helped the process of reformulation, by facilitating engagement with industry across Europe. They provide multiple examples of reformulation initiatives across Europe, including an extended advisory document on reformulation from the Superior Health Council for Belgium published in 2012. This included scientific advice and options for salt replacers and targeted policy-makers, the private sector, researchers and consumers. However, little evidence of the impact of these initiatives is cited.

However, in the grey literature, Brambila-Macias et al. (2011) argued that more research is needed on the extent to which industry may reformulate their products by removing one ingredient and replacing it with another unhealthy ingredient (e.g. replacing trans-fats with saturated fats).

Ma et al. (2016) examined the effect of a reduction in free sugars found in soft drinks in a 2016 modelling study on overweight, obesity and type 2 diabetes. The authors used UK soft drink sales data and historical trend data in bodyweight status for adults obtained from the Health Survey of England to model the effect of a hypothetical 9.7% per year reduction of free sugars (mono and disaccharides) added to soft drinks. The simulation demonstrated a reduction in energy consumption of 38.4 kcal per day by the end of the fifth year overall, 74 kcal per day among young adults and adolescents. This led to a potential 1.20 kg body weight reduction in the long-term and would reduce cases of overweight by half a million and obesity by 1 million.

Furthermore, a report by Tedstone et al. (2015) found that in England, drinks manufacturers have been reducing the amount of sugar in some sugar-sweetened drinks but retaining the sweetness through the addition of no/low calorie sweeteners and, in some cases, by portion size reduction. The evidence considered by the UK's Scientific Advisory Committee on Nutrition (SACN) found that replacing sugar-sweetened food and drinks with those sweetened with no/low calorie sweeteners can be useful in the management of energy intake and weight. The report by Tedstone et al. (2015) also reported evidence that lowering the sugar content of food and drinks sold in shops, restaurants, takeaways, and at work and institutions (for example, schools, hospitals and prisons) could be a successful way to reduce sugar intakes.

Box 2. Focus on: reformulation of SSBs

Cost effectiveness of bans and reformulation

Product reformulation, particularly policies aimed at reducing the salt content of processed foods (Traill 2013; McDaid, Sassi and Merkur 2015) have been found to be cost-effective in several economic evaluations. However, economic evaluations of other reformulation policies e.g. reducing trans-fat content, are limited.

Marketing bans and restrictions

Summary of Effectiveness:

- There is moderately strong evidence to support a link between marketing bans and restrictions and reduced purchasing of nutritionally unbalanced foods among children. Limited evidence suggests that marketing bans and restrictions could support the reduction of health inequalities.
- Simulation studies suggest that marketing bans and restrictions could have a positive impact on weight and BMI, however more real-world studies are required.
- Ensuring marketing bans and restrictions are wide-reaching and comprehensive, combining them with other changes to the food environment and implementing statutory regulations rather than allowing industry-self regulation improves their effectiveness.

Most studies identified in the review focus on the effectiveness of marketing restrictions and bans among children. The term marketing is used broadly in this section to refer to any actions that aim to promote or sell products or services, including advertising (Oxford English Dictionary definition). Bans refer to statutory, obligatory measures and restrictions refer to statutory or self-regulatory schemes to reduce exposure to marketing.

Overall there is moderately strong evidence to support a link between marketing bans and restrictions and reduced purchasing of nutritionally unbalanced foods. Dhar and Baylis (2011) examined the impact of Quebec's fast food advertising ban targeting children by examining fast food expenditure data among those affected by the ban (Quebec) and those not affected by the ban (Ontario). The authors found that the ban resulted in an \$88 million (in U.S. dollars) reduction in fast food purchase and related consumption. Grey literature evidence (Sjolin 2006) also supports the effectiveness of the fast food advertising ban in Quebec, noting that since the ban, there has been a decrease in the consumption of soft drinks and obesity rates in Quebec are among the lowest in Canada.

In the grey literature, Traill's (2013) evaluation of 111 policy interventions¹⁰ found suggestive evidence of the effectiveness of advertising regulation in reducing the awareness and positive attitudes of children towards unhealthy foods. However, the impact on behaviours, especially longer-term was unclear. More specifically, Loring and Robertson (2014) argue that population-based policies such as bans or restrictions on marketing products to children are likely to have a greater impact on reducing obesity inequalities than interventions targeted at individuals. This is because TV marketing increases inequalities as children in low income families spend more time watching TV.

Other sources of evidence further support these findings. For example, there is a large body of evidence to link advertising with increased consumption of nutritionally unbalanced foods among children (Dibb and Harris 1996; Wolfram 2000; Harris, Bargh and Brownell 2009). It is therefore logical that regulating such advertising would limit

¹⁰ Policy interventions were identified in scientific papers, policy documents, grey literature, government websites, other policy reviews, and interviews with policymakers. Existing policy evaluations were assessed and further analysis of secondary data sets using modern statistical techniques was undertaken to improve the evidence-base.

consumption. Furthermore, Engelhard and Garson (2009) argue that the success of advertising bans on tobacco in significantly reducing the use of tobacco suggests that a ban on advertising unhealthy food items could also be effective in changing consumption behaviours.

Simulation studies suggest that marketing bans and restrictions could have a positive impact on weight and BMI, however more real-world studies are required.

One simulation study¹¹ (Veerman et al. 2009) estimating possible impacts of restricting food advertising among children ages 6-12 years indicated that reducing exposure to food advertising on TV could reduce the prevalence of obesity (17.8% to 15.2% in boys and 15.9% to 13.5% in girls). The authors conclude that restricting food advertising on TV is a promising approach for addressing obesity and the impact could be even greater if restricting food advertising across multiple types of media. Furthermore, an OECD (2010) economic evaluation report on the economics of preventing obesity found that OFCOM's statutory advertising restrictions in the UK for children reduced their exposure to advertising of high fat, salt or sugar foods (39% and 28% less advertising of food high in fat, salt or sugar, among children aged 4-9 and 10-15 years, respectively). Adjusting for TV viewing habits and the amount of food advertising typically broadcast in different countries, they calculated that this would correspond to decreases in children's BMI by 0.13 to 0.34 points. However, given that both studies are based on simulation, results should be interpreted with caution.

The following best practice elements for advertising bans and restrictions were identified:

- **Bans and restrictions must be wide-reaching to be effective.** Dhar and Bayliss (2011) question the relevance of their results in a more inter-connected world where children are exposed to advertising not only through TV but also via the internet and social media. In fact, Adams et al.'s (2012) study looking at the impact of 2007 statutory scheduling restrictions on food/beverage advertising to youth in the UK found that exposure to food/beverage advertising actually increased during the period of the ban. They argued that, in order to be effective, the restriction needed to include a wider range of programming (not just children's channels or children's shows) because advertisers moved the times when advertisements were broadcast but not the quantity of advertisements.

The WHO (2010) also produced a set of recommendations on the marketing of foods and non-alcoholic beverages to children which included ensuring that *all* settings where children gather (for example, nurseries, schools, school grounds and pre-school centres, playgrounds, family and child clinics and paediatric services) are free from all forms of marketing of high fat, sugar and salt foods and encouraging Member States to cooperate to ensure the necessary checks are in place to reduce the impact of cross-border marketing of these products.

- **Combining marketing bans and restrictions with other changes in the food environment improves the effectiveness of interventions.** Reisch et al.'s (2014) study among European youth concluded that advertising restrictions or education/awareness interventions alone are not likely to increase dietary knowledge and behaviour and may require changes in the environment to "make the healthy choice the easy choice". A UK study by Aznar et al. (2016) also argued that any wide-ranging childhood obesity programme should incorporate fiscal measures and reformulation alongside food advertising and promotion.

¹¹ Veerman et al. used BMI calculated from the Nation Health and Nutrition Examination Survey (NHANES) as the outcome and estimates of the effects of advertising exposure from a panel of subject matter experts to inform their simulation.

In line with findings from tobacco consumption studies, combining advertising bans or restrictions with taxation, clear and simple labelling that convey the health risks of fattening foods, environmental measures to reduce exposure to unhealthy foods, and social marketing and information could be a successful way of reducing the consumption of nutritionally unbalanced foods (Engelhard and Garson 2009).

- **Statutory regulation is more effective than industry self-regulation** in helping to change children’s dietary behaviour and social norms (Aznar et al. 2016; OECD 2010).

Cost effectiveness of marketing bans and restrictions

Marketing bans and restrictions were found to be cost-effective in a small number of model-based studies focussing on children’s food advertisements (Traill 2013).

3.1.1.2 Mass media campaigns

Summary of Effectiveness:

- There is strong evidence that physical activity mass media campaigns can increase the awareness and attitudes of beneficiaries and can be cost effective. The impact on improving physical activity and healthy eating behaviours is more moderate but still positive.
- Limited case study evidence suggests that mass media campaigns combining both physical activity and healthy eating can be effective in changing behaviours.
- No studies were identified that assessed the effectiveness of nutrition campaigns on healthy eating.
- No studies were found that looked at the impact of mass media campaigns on longer-term behaviour and weight changes.
- There is some evidence that mass media campaigns may be less effective among disadvantaged groups.

There is strong evidence that physical activity mass media campaigns can increase the awareness and attitudes of beneficiaries. The impact on improving physical activity and healthy eating behaviours is more moderate but still positive. Traill et al.’s (2013) review of the literature concluded that the overall evidence for public information campaigns is suggestive, with strong evidence to show improvements in awareness/attitudes and a small impact on behaviours.

Focussing on physical activity, a number of reviews consistently concluded that mass media campaigns to increase physical activity have a positive, moderate effect on increasing physical activity in the target group (McDaid, Sassi and Merkur 2015; Traill 2013).

Limited case study evidence suggests that mass media campaigns combining both physical activity and healthy eating can be effective in changing behaviours (see Box 3 below).

Box 3. Effectiveness of the Change4Life marketing campaign in England

Change4Life

Aims and objectives

Launched in 2009, Change4Life is the social marketing component of a much broader response by the UK Government to address obesity in England (Department of Health 2010). The overall aim is to inspire a wide group of stakeholders including the NHS, businesses, local authorities, charities, schools, families and community leaders to encourage children and families to eat healthily and exercise more by promoting eight healthy behaviours.

Activities

As well as targeting individuals directly via TV adverts, newspapers, posters and online adverts, which use cartoons to suggest easy diet and exercise swaps, local supporters facilitated conversations with people about healthy eating and physical activity, and displayed or distributed leaflets and/or posters about Change4Life. Information resources about healthy eating were specifically targeted towards families identified as at greatest risk of overweight or obesity and all were designed with families from at-risk groups in advance to ensure they were adequately tailored. When families joined Change4Life, they received a questionnaire asking them about a typical day in the life of the child. Everyone who completed the questionnaire was then sent a tailored action plan with advice for each child. In addition, 200,000 of the most at-risk families received further support packs, which, using frequent reminders, tips and ideas, aimed to reinforce good behaviours.

Outcomes

Community support for the campaign was strong and the advertising reached nearly 100% of the target audience during the launch phase (99%), with 87% of mothers with children under 11 years old reporting that they remembered seeing some Change4Life advertisements. There was also evidence that the campaign helped parents make the link between the behaviours that cause excess weight gain and negative health outcomes. Furthermore, according to the tracking study for the intervention: over one million mothers say they have made changes to their children's activity levels and/or diet as a result of the Change4Life advertising; by the second year of the intervention, 180,000 more mothers claimed that their families adopted all eight of the Change4Life behaviours; and analysis of sales data from commercial partners suggested that Change4Life has had a positive impact on the types of food being purchased by families.

Very limited information was found assessing the effectiveness of nutrition campaigns on healthy eating. However, case studies of successful commercial food marketing identified a number of key success factors that could be transferred to public information campaigns including: emphasising the short-term benefits of healthy eating (e.g. good taste and wellness) and adding a stronger emotional appeal and stressing common values (Traill et al. 2013).

Furthermore, there is some evidence that mass media campaigns may be less effective among disadvantaged groups. Kuipers' (2010) review of 97 European and international 'innovative projects and promising approaches' to prevent or respond to obesity found that disadvantaged communities are less likely to respond to national programmes rather than local programmes and are more likely to drop out of mass media or education campaigns.

Cost effectiveness

Mass media campaigns for promoting physical activity were identified as providing excellent value for money (McDaid, Sassi and Merkur 2015).

3.1.1.3 Retail settings

The following section focusses on labelling interventions and other retail-setting interventions that aim to nudge consumer behaviour. Further information on the effectiveness of nudging interventions can be found in the Objective A1 review.

Nutrition/Menu Labelling

Summary of Effectiveness:

- There is strong evidence that nutrition labelling can improve consumers' awareness of healthy food options. Mixed evidence was found on its impact on dietary outcomes: knowledge of nutritional information does not always influence consumer choice.
- Limited but suggestive evidence was identified linking food labelling to changes in BMI.
- Front of pack labelling, particularly using colourful traffic light logos were identified as being the most effective form of labelling for conveying nutritional information, and in some cases, driving consumer behaviour.
- There is limited evidence of the effectiveness of menu labelling in real-world settings. However, there is some evidence that when labelling was combined with the provision of contextual information, it can drive consumer choice. Menu-labelling may also be more effective in certain settings and among specific groups of individuals.

There is strong evidence that nutrition labelling can lead to improved awareness of healthy options but mixed results on dietary outcomes. A meta-analysis¹² by Cecchini and Warin (2016) comparing the relative effectiveness of traffic light schemes, Guideline Daily Amount, and other food labelling schemes (e.g., front-of-pack logos) found that all nutrition labelling schemes studied had a positive, significant effect on the selection of healthier foods. Based on the effect sizes from the studies included in their review, they determined food labelling can be expected to increase the number of people selecting a healthier option by about 17.95% (CI: 11.24% to 24.66%). However the majority of the identified studies concluded that while nutrition information is required for consumers to make an informed choice, knowing the nutritional information of products does not influence consumers to choose healthy options (Brambila-Macias et al. 2011; Aschemann-Witzel et al., 2013; Borgmeier and Westenhofer 2009).

Similar results were identified in the grey literature, with most reviews arguing that labelling improves awareness but has little impact on consumer behaviour (Traill 2013) given that consumers do not always make rational choices (Bailey and Harper 2015). For example, an evaluation of the Joint Nordic "Keyhole" label¹³ (Nordic Council of Ministers, 2014), showed that 98% of the sample recognised the label and 85% knew that it meant

¹² This systematic review included 9 articles describing 9 studies from the US, Europe, and Australia. The analysis focused on two outcomes: 1) the number of people that switch to a healthier product following the implementation of food labelling and 2) change in calorie intake/choice following the introduction of a food labelling scheme. Seven

¹³ A label used in the Nordic region since 2009 providing information about fat, sugar and salt intake and the level of whole grain and fibre in food items.

a healthier food choice. However, only 40% of people felt that the label helped to identify healthier foods and only 30% used the Keyhole label when shopping¹⁴.

Limited but suggestive evidence was identified linking food labelling to changes in BMI. Cecchini and Warin's (2016) study found that labelling schemes reduced calorie choice/consumption but the results were not significant. Furthermore, a systematic review of observational and experimental studies conducted by Campos, Doxey and Hammond (2011) found evidence to suggest that the use of nutrition labels may be associated with lower fat consumption, increased consumption of healthier foods and lower overall energy intake. Studies included in the review represented seven countries¹⁵ and were conducted among children, adolescents and adults of different socio-economic backgrounds. The review highlighted that the use of nutrition labels tends to be lower among children and adolescents and obese older adults. Furthermore, an OECD (2010) analysis of cost-effective ways of preventing obesity calculated that food labelling would increase consumption of fruit and vegetables by 10g per day, reduce the energy consumption from fats by 0.42% and reduce the BMI of the population exposed to the labelling by 0.02 points. However, as this is a simulation study, results should be interpreted with caution.

Front of pack labelling, particularly using colourful traffic light logos were identified as being the most effective form of labelling for conveying nutritional information, and in some cases, driving consumer behaviour. The majority of products in the EU were found to contain nutrition information of some kind (Brambila-Macias et al. 2011). The highest proportions were identified in Ireland, the UK, and the Netherlands (95%) and the lowest in Cyprus and Slovenia (75%). However, nutritional labelling is not compulsory in the EU and, as a result, a variety of different labelling formats were identified. Not only did the type of nutritional breakdowns vary (e.g. fat and saturated fat breakdowns), the way the information was displayed also varied, for example Guideline Daily Amounts (GDA), Traffic Lights (TL) and amounts per portion, amounts per 100g.

As highlighted above, while most studies did not find strong evidence that labelling influences consumer behaviour, colourful labelling (Aschemann-Witzel et al. 2016), particularly the traffic light labelling system, was identified as being most effective at conveying nutritional information. Among adults (n=426 adults aged 21-54) in Hamburg, Germany), a randomised control study (Borgmeier and Westenhofer 2009) tested five different food label formats (a simple "healthy choice" tick, a multiple traffic light label, a monochrome GDA label, a coloured GDA label and a "no label" condition) and concluded that traffic light labels generated the highest percentage of correct choices (i.e. choosing the healthier option). Among adolescents (N=81 adolescents aged 16-18), traffic light symbols were identified as being easily understandable (Babio et al. 2014).

Furthermore, Cecchini and Warin (2016) reported that traffic light schemes were the most effective in encouraging consumers to select a healthier food option. This was supported by the grey literature which reported that consumers are more likely to use colourful labels at the front of packages to make food choices. A number of studies conducted in UK supermarkets found that consumers are increasingly using traffic light labelling to make healthier choices (Engelhard and Garson, 2009). However, a potential confounding factor is the extent to which food manufacturers are reformulating products or reducing portion sizes to increase the number of products that can be classified as "healthy" or green.

¹⁴ Annual (N=1,000) and biannual (N=5,000) surveys are conducted by the Norwegian Directorate for Health and Social Affairs.

¹⁵ United States (N=88); Europe (n=12); Canada (n=9); Australia (n=4); Norway (n=2); Thailand (n=1) and Trinidad (n=1).

Furthermore, there is limited evidence of the effectiveness of menu labelling in real-world settings: effectiveness was associated with the provision of contextual information alongside labels and certain consumer demographics. A systematic review by Sacco et al. (2016) reported that menu labelling may be effective in reducing calories purchased by or for children and adolescents in their examinations of hypothetical food purchases in artificial environments. However, the authors concluded that studies conducted in hypothetical settings likely overestimated the impact of menu labels on adolescent behaviour as they are less able to capture the influence of contextual factors on decision-making behaviour such as, price, hunger, social context, and convenience.

In real-world studies, menu labelling had a more limited impact on food purchasing behaviours, with the exception of studies conducted in school-based cafeterias. However, Sacco et al. reported that relevant real-world studies included in their review did not have appropriate control groups, included small sample sizes, and evaluated menu labelling impact over relatively short periods.

There is some evidence that, when combined with contextual information, menu labelling can drive consumer choice. Sinclair, Cooper and Mansfield's (2014) systematic review concluded that when calories were the only aspect of menu labelling used, this did not influence menu selection or food consumption. However, menu labelling did influence consumer selection (healthier choices) and total dietary intake (lower caloric intake) when calorie counts were presented with contextual information (e.g., recommended total daily intake) and/or interpretive labelling (e.g., red for high calorie/sugar/fat and green for lower calorie/sugar/fat). Findings from the review were based on 17 publications based in the U.S. (seven quasi-experimental based in fast food/take away restaurants or cafeterias and 10 experimental studies).

Similarly, Kiszko et al.'s (2014) review of 31 studies did not find consistent evidence of menu labelling being used by consumers or positively influencing purchase or consumption. However, the authors noted that their review featured less restrictive inclusion criteria when compared with other previous reviews and some of the studies lacked the provision of additional context to help consumers know if an item would be considered healthy or less healthy in relation to dietary guidelines or recommendations.

Menu-labelling may be more effective in certain settings and among specific groups of individuals. Sacco et al. (2016) found that the setting, or context, in which menu labelling is applied may influence willingness to use this information, and therefore, its impact. For example, the authors noted that menu-labelling had a greater impact in full-service restaurants, cafes and sandwich shops compared to studies in fast food settings. They also found that menu-labelling was more often effective when used by children and adolescents than when used by adults (Sacco et al. 2016). Similarly, Kiszko et al.'s (2014) review suggests that women, people living in wealthier neighbourhoods, people who previously selected very high calorie items, and people on diets were more likely to use nutritional information and menu labelling to make decisions. Sinclair, Cooper and Mansfield (2014) also found that women were more likely to use menu labelling to inform their selections than men.

Cost-effectiveness of food and menu labelling

Very limited evidence was found on the cost-effectiveness of food labelling. While Traill (2013) found food labelling schemes to be cost-effective, particularly when implementation was mandatory, few studies were found to support the finding.

3.1.1.4 Other retail environment interventions

Summary of Effectiveness:

- Promotions in supermarkets, restaurants and cafes can successfully influence short-term dietary behaviour.
- There is strong evidence that point of sale labelling can influence consumer purchasing behaviour.
- There is some evidence that reducing portion sizes may reduce consumption. However, no association was found between the size of serving plates and utensils and consumption.
- Product placement can be an effective strategy to influence consumer purchasing behaviour, particularly when combined with point-of-purchase labelling.

The following interventions focus on ways the retail environment can nudge individuals to select healthier choices. Interventions to nudge consumer behaviour are discussed in more detail in A1. However, the following interventions were identified as successful in nudging consumers to become healthier:

- **Supermarket and restaurant promotions.** There is evidence that supermarket promotions (Branca, Nikogosian and Lobstein 2007) are effective in improving short-term dietary behaviour, especially if accompanied by related nutritional information. Promotions in restaurants and cafes appear to have an even greater impact on nutritional behaviour than those in supermarkets.
- **Point-of-sale labelling.** There is persuasive evidence that point-of-sale labelling can improve purchasing behaviour (Allan, Johnston and Campbell 2015; Skov et al. 2013). Skov et al. (2013) reviewed five studies that looked at point of sale nutrition labelling, as part of a wider review of point of sale interventions. Point of sale labelling includes placing low calorie or “healthy” signs/logos near low-calorie products or signs with the calorie content of foods. Their review found a positive association between point of purchase interventions and healthier purchasing behaviour. However none of these studies looked at calorie consumption or longer-term impacts on weight status or BMI.
- **Changing the size of serving plates or portion sizes.** One study identified in Skov et al.’s (2013) review (Freedman et al. 2010) found that reducing the serving size of chips in a paper bag from 88g to 44g over time led to a decrease in the total grams of chips consumed. However no conclusive evidence was found to indicate that changing the size of serving plates or serving utensils led to altered levels of consumption (Skov et al 2013; Arno and Thomas 2016).
- **Product placement.** When the positional change of foods in a retail environment is small, no effect on purchasing was observed (Bucher et al. 2016). However, focussing on low-income, high-minority supermarkets, Foster et al.’s (2014) case-control study across eight supermarkets in the US found that when stores changed the placement of lower-calorie products that were the same price as their less healthy counterparts to be more eye-catching with improved signage to promote the healthy choice in a stealth manner, there was a positive impact of the selection of foods in some categories after six months, particularly milk and lower-calorie frozen meals.

3.1.1.5 Community settings

The “community” category is usually diverse and poorly defined meaning that some of the interventions reviewed in this section as community interventions may overlap slightly with those reviewed in other parts of this report. The focus of this section is on built-environment changes in the community and specific interventions delivered within a community setting.

Summary of Effectiveness:

- There is strong evidence that neighbourhood design policies and interventions can influence physical activity levels. In particular, changing urban environments to ensure a safe environment for exercise were associated with increased physical activity levels.
- There is evidence that investments in cycling infrastructure can increase the percentage of individuals cycling.
- Built environment interventions can increase pedestrian activity, however this review found no evidence of by how much. Organised participatory programmes, such as walking programmes, were also identified as an effective strategy for increasing physical activity levels.
- Stair prompts can be an effective way of increasing stair use
- Multi-level, multi-setting community interventions were identified as being most effective for tackling childhood obesity.
- Limited information on cost-effectiveness was identified however travel/transport-related interventions and pedometer interventions were found to be cost-effective.

A large body of literature reports the effectiveness of urban design and land use policies in encouraging physical activity. Given the inherent sustainability of such policies, there has been an increased focus on them in recent years, particularly in the US.

There is strong evidence that neighbourhood design can influence physical activity levels. A systematic review by McCormack et al. (2011) found that neighbourhood design was an important determinant of physical activity. Heath et al. (2006) reported the effectiveness of policies and practices aimed at community-scale urban design and land use in increasing levels of physical activity (n=13). Street-scale urban design and land use policies/interventions were also associated with increased levels of physical activity ranging from 16-26% increase (n=6). However, the authors found insufficient evidence for transportation and travel policies (n=3) such as car and van-pool initiatives and subsidising bus passes.

In particular, changing urban environments to ensure a safe environment for exercise was associated with increased physical activity levels. In their systematic review, Audrey and Batista-Ferrer (2015)¹⁶ reported outcomes in relation to children and adolescents' physical activity: studies were conducted in urban areas in high-income countries. A total of 33 articles highlighting 27 separate intervention studies were included. The authors found that interventions aimed at reducing traffic injuries and increasing young people's active travel to school were promising strategies for increasing physical activity. Accessible pavement and connecting streets were also identified as important components to facilitate and increase active travel. However, they found

¹⁶ Changes in the built environment included traffic calming measures, such as slower speed limit signs, painting crosswalks, installing pedestrian crossing signs, adding bike lanes and bike racks, as well as opening and renovating parks.

limited evidence that improvements to playgrounds or parks resulted in increased usage or physical activity.

INPES' (2015) review of effective interventions to increase physical activity levels in France also highlighted the importance of developing green spaces; creating places reserved for the practice of winter sports and walking trails or paths; promoting "mobile" activities e.g. walking and cycling; and providing appropriate workplace-based sports facilities.

Cycling interventions

There is evidence that investments in cycling infrastructure can increase the percentage of individuals cycling. Stewart, Anokye and Pokhrel (2015) examined the effect of capital investment in cycling infrastructure such as construction of a cycling bridge, tax free loans to purchase bicycles, traffic calming, bike lane construction, and creating 'traffic free' areas for cyclists on the proportion of individuals cycling. The study reported modest increases in the proportion of people cycling, ranging from a 0.69 percent increase to 7 percent increase. However, in one intervention, the construction of a cycling bridge in Glasgow was associated with a 47.5% increase in the number of cyclists entering the city centre from the south side of the city (almost no increase in cyclists was observed in the north side). Despite the relatively small percentage increase reported in these studies, the authors point out that because these interventions have the potential to reach the entire population, these effects translate in to thousands of people who are now integrating physical activity in to their daily lives through cycling.

Grey literature findings also report evidence that comprehensive infrastructure changes can increase cycling levels (McDaid, Sassi and Merkur 2015). A case study of 38 'Ciclovias' or 'cycleways' in different countries (C3 Collaborating for Health, 2012) found a limited but positive association between active travel opportunities and public health outcomes. Ciclovias originated in Latin America and are characterized by the banning of motorized transport on busy streets one day a week or month and the street being made available to walkers, runners and cyclists. The first ciclovia was in Bogota, Colombia, starting in 1976, where over 70 miles of roads are still closed every Sunday for seven hours, at the estimated low cost of US\$6 per person per year. Free exercise classes are held in local parks (known as Recreovia) and Bogota also has permanent cycle paths called ciclorutas. Since its beginnings the idea of the ciclovia has extended to other countries including Peru, Mexico, New Zealand and across the US. The review authors also referenced an economic analysis of four ciclovias which found that adults participating in the ciclovia at least one day a month scored higher on a health-related quality of life measure than those who did not participate (even allowing for sociodemographic and other potential adjusting factors).

Walking interventions

Built environment interventions can increase pedestrian activity. The C3 Collaborating for Health (2012) review identified the following factors as having a favourable impact on pedestrian activity, although no information was provided on the extent to which activity increased:

- Street lighting and pavements
- Availability of public transport
- Street connectivity
- High housing density and mixed land use
- Car-free zones
- Pedestrian crossings and traffic calming in residential areas
- Reductions in motor vehicle speed
- Limited or more expensive parking.

Grey literature also highlighted the importance of walking routes that have a mixture of shops, schools, workplaces and other habitable places in promoting walking activity (Edwards and Tsouros 2006).

Organised participatory programmes, such as walking programmes, can be an effective strategy to increase physical activity levels. In particular:

- **Pedometers and pedometer-based programmes** have become more popular in the last few years due to the low-cost of pedometers and the fact that they can objectively measure people's activity levels. Using pedometers as part of walking group programmes, worksite programmes or promoting them through public awareness campaigns can be effective but the evidence is limited to six months post intervention. Pedometer interventions were found to be most effective when using step-based goals rather than time-based goals; and when combined with behaviour change support and goal-setting (McDaid, Sassi and Merkur 2015);
- **Group-based walking interventions** have also been found to be effective (McDaid, Sassi and Merkur 2015). At MS-level, Phillips, Knox and Langley's (2012) evaluation of Natural England's "Walking for Health" scheme, which consists of local and regional partner organisations running walks in local areas with walk leaders, showed an observable shift from participants doing zero days of physical activity to doing one or two days per week. Although the scheme did not meet its targets of three days or more of physical activity per week per person, results suggest that similar schemes could help to improve physical activity levels for particularly sedentary individuals, for example, females and older people. There was also some evidence of sustained longer-term impact on participants' physical activity levels.

Environmental prompts

Stair prompts can be an effective way of increasing stair use. Soler et al. (2010) conducted a systematic review on the impact of point-of-decision prompts for stair use (N=16 studies) and concluded that point-of-decision prompts were effective in increasing stair use. The impact of choice prompts on physical activity was also assessed by Lewis and Eves (2012) who implemented a multi-component stair climbing intervention. The intervention was conducted in a tram station in the UK where signs were posted encouraging people to use the stairs. In the first week, a single sign was placed at the bottom of the stairs noting, "*Regular stair climbing helps to prevent weight gain*". Two weeks after this sign was posted, a second sign was added at the top of the stairs saying, "*Well done stair climbers! You have just burned a 16th of the calories needed to avoid weight gain.*" The authors observed the results of four different scenarios in order to assess the setting at baseline and the impact of the signs alone and in combination. The results obtained through observation of 38,187 pedestrians revealed that stair climbing increased when both messages were used.

The grey literature also found that using posters or banners to encourage individuals to take the stairs appear to have a weak, positive effect on increasing physical activity (Branca, Nikogosian and Lobstein 2007). Marteau et al. 2001 (cited in Bailey and Harper 2015) suggested that stairs should be made more prominent and appealing so people are more likely to be attracted to these as opposed to elevators or escalators.

Community-based childhood obesity interventions

Focussing specifically on childhood obesity interventions, multi-level, multi-setting community interventions were identified as being most effective. Bemelmans et al. (2011) undertook a comprehensive review of existing European-wide evidence on 83

community-based interventions (CBIs)¹⁷. The vast majority of CBIs in the study (93%) implemented a variety of instruments, targeting both the environment of children and their activities. Frequently reported instruments were related to professional training (70%), actions for parents (73%) and actions aimed at changing the social environment, while the most frequently reported educational activities targeted at children were education about a healthy lifestyle (89%); group education (88%) and counselling sessions (57%). Despite variation in the quality of study designs, 22 CBIs reported data on the effectiveness of the overall CBI. Seven CBIs reported small reductions in overweight prevalence rates from 0% to 6% over time; and three CBIs reported short-term reductions in mean BMI of between 0.3 and 1.2kg/m² for overweight children. In addition, positive effects were reported on general wellbeing, individuals feeling healthier and knowledge. Overall, the evidence suggests that when looking for an optimal CBI, “the more comprehensive, the better”.

Furthermore, a number of community interventions were identified that focussed on supporting the reduction of childhood obesity in children from low income families. The following examples also support the need for multi-setting, multi-component (physical activity and nutrition) interventions to tackle obesity, including among low SES groups:

- **Portugal’s Program Obesity Zero (POZ)** was a multi-component, community-, family- and school-based intervention to reduce childhood obesity in low-income families in Portugal. A total of 266 overweight children aged 6–10 years from low-income families across five municipalities in Portugal were included in the intervention. Parents and children attended four individual nutrition and physical activity counselling sessions, a one-day healthy cooking workshop and two extra-curricular sessions in school, providing nutrition education. Results included reductions in children’s waist circumference and body mass index (BMI) after six months, a higher fibre consumption, and decreased intake of sugary soft drinks. Improvements in physical activity levels and (reduced) screen time were also observed, suggesting that POZ is a promising municipality-level intervention programme to tackle childhood overweight and obesity in low-income families (Loring and Robertson 2014).
- A review of the **Government-led Special Supplemental Nutrition Programme for Women, Infants and Children (WIC)** in the US (Branca, Nikogosian and Lobstein 2007) which provided nutrition information, supplementary foods, and health referrals to approximately 8 million low-income pregnant women and children under five (through a variety of interventions) reported an increase in children’s playtime, a decrease in sedentary time and a reduction in television viewing among children.

Cost effectiveness of community interventions

Limited information is available regarding the cost-effectiveness of community interventions. However, generally, community-based interventions do appear to be cost-effective. A literature review reported by McDaid, Sassi and Merkur (2015) concluded that the cost-effectiveness ratio for community-based interventions would be between a few thousand dollars to about \$70,000 per DALY/QALY. More specifically, an economic assessment carried out for NICE suggested that travel/transport-related interventions could be cost-effective and, on the basis of a number of assumptions, could fall below a

¹⁷ The European-wide study identified 278 potentially eligible community-based initiatives (CBIs) aimed at reducing childhood obesity. Questionnaires about the CBIs were sent to all CBIs and returned by 88 respondents. After excluding five CBIs, 83 were analysed, implemented in 17 countries. Eligible projects were implemented between 2005 and 2011, activities were implemented over at least one year, were accompanied by a process evaluation and met the inclusion criteria based on the WHO definition for CBIs. Health objectives had to involve obesity, physical activity and/or nutrition.

threshold of 50,000 \$PPP per healthy life-year gained, while another study found that, in an Australian context, pedometers have been modelled to be cost-effective (McDaid, Sassi and Merkur 2015).

3.1.1.6 Childcare and pre-school settings

While pre-schools have the potential to be an effective setting for influencing children's food choices at an early age, Mikkelsen et al. (2014) argue that there is a paucity of properly designed healthy eating interventions in pre-school settings that use clear indicators and verifiable outcomes. Limited evidence was found in the current review, with none of the studies including an analysis of the cost-effectiveness of implementing interventions in these settings.

Summary of effectiveness:

- One grey literature study suggests that educating staff, parents and children in nurseries and kindergartens using professional dieticians could be an effective way to improve the diets of children.
- There is moderately strong evidence that physical activity interventions in childcare settings can improve physical activity levels in children.
- Play equipment and facilities in the built environment can increase levels of physical activity in young children.
- As in other educational settings, multicomponent interventions have been proven to be more effective than single component interventions in driving behaviour change in young children.

Nutritional interventions

Limited grey literature evidence suggests that educating staff, parents and children in nurseries and kindergartens using professional dieticians could be an effective way to improve the diets of children. An evaluation of the Polish programme 'Healthy we eat, healthy we develop', that ran between 2014 and 2017, provides evidence of the impact that education and awareness-raising programmes can have on improving the diets of children, including helping them to reduce their consumption of SSBs (Wasilowska-Gregorowicz and Dudek 2016). The programme aimed to train 180 nutritionists to work in 15,000 nurseries and kindergartens to inform children, staff and parents about the nutritional requirements for pregnant women and children under the age of six years. By 2015, 76% of nurseries and kindergartens that had worked with an educator had made changes to their menus; after participating in workshops on the adverse health effects of sugar and salt in the diet of the child, over a third of institutions (36%) had taken steps towards reducing both salt and sugar in the food they prepare for children; and 16% of institutions had increased the availability of fruits and vegetables and replaced sweetened drinks with water.

Physical activity

Physical activity interventions in childcare settings can improve physical activity levels in children. Finch et al. (2016) performed a meta-analysis examining the effectiveness of childcare physical activity interventions. Seventeen studies were included from the U.S., Europe, Israel, and Australia and studies used accelerometers and pedometers to measure outcomes of physical activity levels, MVPA, steps, and sedentary time. Finch et al. found that overall, physical activity interventions significantly improved child physical activity. Interventions that included structured activity, were delivered by

experts, and were based on theory were all shown to have significant effects on child physical activity.

More specifically, play equipment and facilities in the built environment can increase levels of physical activity in young children. In a study conducted by Gubbels et al. (2012), the authors assess physical activity levels of children (N=175) aged 2-3 who attended one of nine childcare centres in the Netherlands selected for the study. The authors examined the availability of play equipment and the facilities available (playground, track, portable equipment, balls, etc.) and conducted direct observation of child physical activity. The results showed that presence of portable play equipment or running tracks were positively associated with physical activity. Yet slides, swings and sandboxes were negatively associated with physical activity intensity.

Nutrition and physical activity

As in other educational settings, multicomponent interventions have been proven to be more effective than single component interventions in driving behaviour change in young children. Mikkelsen et al.'s (2014) systematic review examined nutrition interventions in preschools, kindergartens and day care facilities for 3-6 year olds. Twenty-six studies were evaluated in the review, including eight single intervention studies, eleven educational interventions, and, seven multi-component (environmental change and education) studies published in North America, Europe, China Thailand, Turkey, Malaysia, Israel, and, Colombia. Interventions included increasing the availability of fruit and vegetables, modification of school meals as well as serving fruit and vegetables to students before meals, limiting portion sizes, and, increasing access of water. The following outcomes were measured: BMI, diabetes, skinfold, weight and height, and food consumption/intake. Single component interventions did not demonstrate positive outcomes related to nutrition; however, six of the seven multicomponent interventions showed a significant increase in fruit and vegetable consumption and one study reported an effect on fruit consumption only. None of the studies found an effect on BMI.

Nevertheless, effects on BMI were identified in Zhou et al.'s (2014) systematic review of nutrition and physical activity interventions in childcare settings. 15 studies, from the U.S, Europe, Australia and Israel, were examined. Just under half (n=7) of the studies implemented multi-component interventions focusing on nutrition and physical activity, and all intervention groups within those studies were reported to have lower BMI post intervention, compared to the control groups. This suggests that physical activity may be an important component of childcare setting interventions.

The EU funded study 'ToyBox'¹⁸ is another example of how multi component interventions can be effective in preventing childhood obesity. The programme aimed to develop and test an innovative and evidence-based obesity prevention programme for children aged four to six years old. The intervention targeted key behaviours related to early childhood obesity including drinking, eating and physical activity, in pre-schools in six European countries (Belgium, Bulgaria, Germany, Greece, Poland and Spain). Results showed an increase in children's water consumption, and a decrease in children's consumption of sweets, pre-packed juices and sugar-sweetened beverages for those in the intervention group compared to the control group. A total of 309 kindergartens and 7,056 pre-school children and their families, stratified by economic level, participated in the intervention.

¹⁸ The intervention was implemented over 24 weeks between October 2012 and April 2013 and focussed on: setting environmental changes in the classroom; children implementing the new behaviour in the kindergarten (e.g. water consumption, healthy snacking); teachers implementing fun classroom activities with the active participation of whole class; and actively involving parents to apply environmental changes and implement these lifestyle behaviours together with their children at home.

3.1.1.7 School and university settings

Educational settings provide an early opportunity to improve the dietary behaviour and physical activity engagement of children and young adults. Interventions in these settings can contribute to health-related outcomes such as improved nutritional intake and weight loss (WHO 2006b). A wide range of studies have assessed the effectiveness of school-based interventions. As discussed in detail below, three effective approaches to achieving nutritional and physical activity outcomes in educational settings have been identified. These are environmental changes; educational interventions; and multi-behaviour and multi-setting interventions. Compared to school settings, few studies focusing on the university-setting were identified.

Summary of effectiveness:

- There is strong evidence that focussing on one aspect of the diet, for example improving the availability of fruit and vegetables, can lead to increased consumption of the chosen products. However, interventions to increase fruit and vegetable availability may be less successful in increasing vegetable consumption (relative to fruit consumption). Limited evidence exists regarding effective changes in BMI.
- Reducing access to foods high in fats, sugar or salt and/or promoting the consumption of alternative 'healthier' foods, for example through changing the contents of vending machines, was also identified as an effective strategy to improve the nutritional intake of school students.
- Offering physical activity breaks throughout the day, encouraging active travel to and from school and providing after-school physical activity programmes were identified as effective approaches to increasing physical activity levels.
- The research reviewed suggests that multi-setting, multi-component programmes that combine a focus on both nutrition and physical activity across home and school environments, and have an educational component combined with an aspect of environmental change, can be a particularly effective approach to drive behaviour change and reduce BMI. However, limited evidence is available on the longer term outcomes of all school-based interventions.
- There is evidence that universities provide an effective setting for implementing nutritional and physical activity interventions, particularly course-embedded interventions and those that target student self-efficacy. However more studies outside of the US are required to validate existing findings. The review found no studies focussing on the impact of nutrition or physical activity interventions on attrition, retention and academic performance.

Environmental changes in schools
Improving the food environment

As Gananan et al. (2014) demonstrate in their review of 23 international studies¹⁹, a number of policies

and programmes can lead to changes in the school food environment, including: improving the availability of certain foods; local wellness policies; state-wide nutrition

¹⁹ Studies were conducted in the U.S., England, France, South Africa and the United Kingdom.

policy, pricing strategies; and other changes to school food delivery. Schools may use several policies and interventions together, for example employing a dual approach to changing or improving the food environment (i.e. increasing the number of opportunities for children to consume health-enhancing foods, whilst also reducing the availability of certain foods such as those that are high in salt, fat and sugar).

There is strong evidence that focussing on one aspect of the diet, for example, improving the availability of fruit and vegetables can lead to increased consumption of these products. Limited evidence exists regarding effective changes in BMI. It has been suggested that focusing on a single aspect of the diet may be the most effective approach to improve dietary behaviour (Branca, Nikogosian and Lobstein 2007). Schools often focus on increasing the availability and consumption of fruits and vegetables, for example, by changing school meals to contain more fruit and vegetables; providing free or subsidised fruit and vegetables; running gardening, cooking or tasting programmes (De Sa and Lock 2007); changing vending machine, cafeteria, snack, and after school food offerings (Ganann et al. 2014); or, organising visits to farms (INPES 2005).

The effectiveness of this approach in encouraging the consumption of fruit and vegetables (and shaping healthy behaviours) has been highlighted by several reviews (de Sa and Lock 2007; Ganann et al. 2004; Nornberg et al. 2015; and Evans et al. 2012). De Sa & Lock (2007)²⁰ found that the majority (65%) of school interventions reported significant increases in the consumption of fruit and vegetables. No studies reported decreased intake. The authors also reported additional outcomes such as improved knowledge, and improved attitudes to, and preference for, fruit and vegetables. Furthermore, several studies in their review reported that free fruit and vegetables schemes can help to reduce inequalities in diet and another provided evidence of increased fruit and vegetable intake and decreased weight.

Increasing the availability of fruit and vegetables can also be employed as part of a national or transnational strategy. For example, the European School Fruit Scheme (SFS) effectively increased fruit and vegetable consumption among children in the short-term (PHEIAC 2013)²¹. An evaluation of the scheme in 2011, found that between 2009 and 2011 the scheme reached just under 13 million children across the 24 participating MSs, and looking at the available data for 2010/2011, 290 million portions of fruit and vegetables were distributed to 8.2 million children. Longer-term positive impacts were expected if the duration of the programme exceeded one year and if fruit and vegetables continued to be provided for free and were distributed at least three times a week (PHEIAC 2013).

However, interventions to increase fruit and vegetable availability may be less successful in increasing vegetable consumption (relative to fruit consumption).

For example, based on a meta-analysis of 21 studies covering interventions to increase fruit and vegetable availability in the US, Europe, Canada and New Zealand, Evans et al. (2012) did not find that school-based interventions led to a significant increase in daily

²⁰ 41 references, reporting on 35 studies were included in the review. References included peer reviewed and grey literature on the effectiveness of interventions to promote fruit and/or vegetable consumption in schools worldwide.

²¹ The European School Fruit Scheme (SFS) started in the 2009/2010 school year. The overall policy objective of the intervention was to increase the share of fruit and vegetables in children's diets through making fruit and vegetables easily accessible in schools; providing fruit and vegetables free of charge; and educating children, parents and teachers about the benefits of eating fruit and vegetables. The annual budget of the SFS was EUR 90 million which was used to support Member State (MS) schemes. MS were required to draw up a plan for national or regional level implementation of the scheme. So far 24 MS have participated in the scheme, and the SFS and contributed to developing new national or regional schemes in 31 countries/regions as well as extending existing ones.

vegetable consumption. However, they did find that school-based interventions of all types demonstrated an increase daily fruit consumption (0.25 portion increase when excluding 100% fruit juice; 0.32 portion increase when including 100% fruit juice) (Evans et al. 2012)²². Nornberg et al. (2015) concluded that interventions *solely* focussing on increasing the amount and/or variety of vegetables were effective at helping to improve vegetable intake (compared to other policies to increase the availability and consumption of vegetables, such as providing them for free or pre-portioning them).

In addition, there is inconclusive evidence as to whether broader national or transnational approaches to increasing the availability of fruits and vegetables have the same impact as local, school-based approaches. For example Ganann et al. (2014) indicate that broader state or federally mandated educational programmes or policies that were aimed at changing decisions of food service managers or school principals had mixed or small impact on availability (Ganann et al. 2014).

Changes in the food environment are not limited to increasing the availability of fruit and vegetables. **Reducing access to foods high in fats, sugar or salt and/or promoting the consumption of alternative 'healthier' foods is also an effective strategy.** A particular focus appears to be on reducing the consumption of, or restricting access to, food and drinks with high sugar contents. Interventions or policies may involve restricting or banning of vending machines or tuck shops, restricting students leaving school grounds during the school day, raising awareness of the sugar/calories in sugar-sweetened beverages and/or providing smaller portion sizes of sugar-sweetened beverages (Storcksdieck genannt Bonsmann et al. 2014). More broadly, interventions such as the EU School Milk scheme also promote the consumption of alternatives to SSBs.

Levy, Friend and Wang (2011) performed a systematic review of school nutrition policies²³ and price interventions aimed at reducing SSB consumption among youth. The authors examined 26 articles published in the US, Europe, Canada, and Brazil. The authors reviewed articles that examined the effect of SSB policies in middle and high schools (n = 23) and concluded that policies reduced consumption up to 25%. Fewer studies have been performed looking at high school SSB policies, but reductions in consumption were also seen at that level.

Grey literature findings by Sjolín (2006) and Jacobson (2005) also suggest that banning vending machines and the sale of soft drinks and candy in schools, and installing water fountains instead could be an effective strategy to reduce consumption of SSBs and sugary snacks. A 'softer' approach is suggested by Branca, Nikogosian and Lobstein (2007) – they report that even when vending machines for healthy drinks such as water or pure fruit juice are set alongside the school's usual vending machines, children will choose the healthier options. The key to the successful vending of healthy alternatives is to ensure student involvement, continuous provision (i.e. checking the machine is full and working), and locating vending machines close to dining areas. This intervention also aligns with goals set out in the European Commission's (2014) action plan on childhood obesity, for example, ensuring that half of all MSs implement restrictions on the presence of soft drinks vending machines in primary schools.

Finally, there is evidence of other policies and interventions being used to improve the food environment of schools. In their systematic review of 18 published studies and unpublished literature in the US and Europe (up to November 2007), Jaime and Lock (2009) found that nutritional guidelines were effective in decreasing consumption of fat

²² Interventions to increase the availability of fruit and vegetables included providing them for free to school children, incorporating fruit and vegetables in school lunches, or offering fruit and vegetables in school stores and snack bars.

²³ This included removing SSBs from vending machines and snack bars.

and saturated fat and increasing fruit and vegetable availability for school-provided meals. However, the authors noted that more studies are needed to evaluate the impact of guidelines on school aged children's overweight and obesity. Branca, Nikogosian and Lobstein (2007) also found that 'breakfast clubs' can have a positive effect on behaviour, dietary intake, health, social interaction, concentration, learning attendance, and punctuality and reducing inequalities.

Creating an active environment

The following types of active environment interventions were identified in schools:

- **Ergonomic interventions such as standing desks** have emerged as a strategy to decrease sedentary time and prolonged sitting in a number of settings. However, the effectiveness of this intervention in schools, and on academic performance, is unclear (Minges et al. 2016);
- **Offering physical activity breaks throughout the day** could be an effective intervention in reducing sedentary time at school. For example, a school-based physical activity programme providing an enhanced physical activity school programme and physical activity opportunities throughout and after the school day, examined in Liao et al.'s (2014) review of randomised controlled interventions, demonstrated that children in the intervention group had a significantly lower increase in BMI when compared to the control group. Similarly, Barr-Anderson et al. (2011) found that the inclusion of small bouts (e.g. around 10-15 minutes) of physical activity during the day in schools may be a promising approach for increasing physical activity: half of the 28 studies describing school-based interventions involving short bouts of exercise reported improved levels of physical activity.
- **Interventions encouraging active travel** (for example, walking and cycling) can help to increase physical activity levels, though it is less clear if there is a sustained impact on BMI or weight gain. Chillon et al. (2011) examined 14 studies in a systematic review focussing on primary schools in the US, UK and Australia, and interventions such as improving the safety of routes to school (SRTS), Walking School Bus (WSB) or Walk to School (WTS). Almost all studies (n=10)²⁴ reported an increased proportion of children walking or biking to school (ranging from a 3% to 64% increase). Similarly, in a systematic review of 12 studies performed by Smith et al. (2015) that examined the effectiveness of the Walking School Bus interventions in schools in the US, Australia and New Zealand, it was reported an increase in the time spent undertaking moderate-vigorous physical activity (from 2 to 14 minutes across the study) following the intervention (in all three studies measuring the impact against indicators). One study in this review also reported that those participating in the intervention experienced less weight gain over the two-year intervention period than the control group.

Active travel programmes also appear to have additional health and wellbeing benefits. For example, an evaluation of the UK's Walk Once a Week programme noted improvements in children's moods and attention spans, and the extension of benefits to family members (for example, 23% of children on the UK's WoW programme walked to school with a parent). There was also a resulting cost benefit ratio of 0.32 (£900,000 of costs compared with benefits of £2.8 million). (Wavehill Consulting, 2009, cited in C3 Collaborating for Health 2012).

- **Providing after-school physical activity programmes.** Such programmes could also be an effective way of increasing physical levels in children. In this

²⁴ Two studies did not report improvements in physical activity outcomes. No improvements in BMI or weight related outcomes were reported.

instance, Beets et al. (2009) analysed 13 articles published between 1980 and 2008, representing 11 after-school intervention studies (sample sizes ranged from 43 to 1,119). The authors noted significant increases in physical activity as well as increases in fitness and improved BMI. However, the components and key elements that relate to effective interventions are unclear.

Educational interventions in schools

Educational interventions in schools can be an effective way to establish healthier dietary choices and physical activity behaviours among children and young people.

Education to improve dietary choices

Often, topics on 'healthy eating' are embedded in national curriculums but approaches to teaching may vary. As a result, the intended outcomes of food and nutrition and education may also vary.

The literature review identified sensory or taste education as an effective strategy to nudge children towards healthy eating. In this regard, Lowe et al. (2006) tested a programme of education (through 14 separate pieces of research, involving more than 450 children in both home and school settings) to encourage 5-6 year olds to eat more fruits and vegetables. Part of the intervention included getting children to test new ('exotic') fruits and vegetables, whilst also asking the children to watch healthy eating and nutritional videos. The sensory and informative educational experience (which lasted between 2-3 weeks) led to children consuming 100% of the fruits and 83% of the vegetables they had consistently rejected prior to the intervention (prior to the intervention, consumption was 4% and 1%, respectively). Follow up observations two and six months after the intervention showed that children were still eating 100% of the fruit, though only 58% of vegetables.

On the other hand, Griffin (2011) used a more traditional approach to improve children's knowledge regarding their sugar consumption and energy balance, with no significant results. Griffin implemented two educational sessions, one focussing on non-milk extrinsic sugars and the other on physical activity and energy balance. She then conducted a cluster-randomised control trial with 268 children aged 10-12 in 15 primary schools. Data collected using self-completed questionnaires and focus groups at a number of time-points suggested that the educational intervention was not successful at improving knowledge regarding energy balance and no changes in behaviour were observed. Focus groups highlighted that children did not view health as a driver for dietary choice and Griffin argued that even with improved knowledge, children are unlikely to change dietary behaviour if it requires overriding existing taste preferences. This emphasises the importance of multi-component policies and interventions that combine education with environmental change, as discussed in the next section, to facilitate behaviour change.

Physical activity education

Limited information was found looking at the effectiveness of educational interventions to improve physical activity. However, in schools, the presence of a local champion, a school intervention coordinator to oversee implementation of the curriculum and environmental changes and trainings can help to improve the success of educational interventions (Greaney et al. 2014).

Multi-behaviour, multi-component and multi-setting interventions

The following sub-section focusses on multi-behaviour, multi-component and multi-setting interventions to improve dietary behaviour and physical activity in schools. Interventions that combine diet and physical activity actions were found to be more effective than interventions focused on one domain (McDaid, Sassi and Merkur 2015). This finding was also highlighted in Brown et al.'s (2016) systematic review; the authors

determined that multicomponent interventions targeting both dietary and physical activity components were moderately effective methods for improving BMI in elementary school children. Specifically, they found that multi-component interventions that included environmental change and educational components were associated with reduced BMI, increased PA, lowered SSB intake and increased fruit intake.

There is also evidence to suggest that school-based approaches are more effective when part of a wider multi-setting intervention, such as those also incorporating home-based components (e.g. reducing TV viewing or videogame use) (Branca, Nikogosian and Lobstein 2007) or mass media campaigns and primary care interventions (McDaid, Sassi and Merkur 2015). For example, the European Commission's Joint Research Centre (JRC) toolkit to promote water consumption in schools (Storcksdieck genannt Bonsmann et al. 2016) highlights the importance of implementing a multi-component intervention across the school and home environment that includes:

1. An educational component: teaching children about the importance of water intake, demonstrating the negative effects of consuming sugar-sweetened beverages, or using peers as role models;
2. An environmental components: installing water fountains or free water bottles for re-filling, or using banners or posters to promote water intake; and
3. A parental/family component: parents' evenings and information sessions, distributing leaflets and posters or using parental role modelling/ goal setting to reduce sugar-sweetened beverage consumption and increase children's water consumption.

The case study below discusses a particularly successful intervention, the Food Dudes programme, and its impacts on nutritional behaviour.

The 'Food Dudes' healthy eating programme

The 'Food Dudes' healthy eating programme in schools was originally developed in Bangor, Wales in 1992 (Boyce, Robertson and Dixon, 2008) and was implemented in Ireland and the UK. The programme aimed to influence dietary behaviour choices made by school children (aged 4-11) by:

- Increasing the availability of fruit and vegetables;
- Offering rewards (e.g. stickers and certificates) when fruit or vegetables are consumed;
- Launching a targeted campaign centred on four fictional superheroes (dubbed the 'food dudes') that gain powers when they eat fruit and vegetables, and who have to save the world from 'junk punks' (unhealthy foods); and,
- Providing nutrition packs for parents.

Robust evaluations have found that the programme has been successful in schools of all socio-economic levels, with particularly positive results observed among children with the lowest pre-intervention fruit and vegetable consumption levels (Loring and Robertson 2014).

Additionally, Boyce, Robertson and Dixon (2008) found that since the beginning of the programme, there has been an increased consumption of fruit and vegetables in schools that introduced the programme. For example, results obtained via questionnaires with parents in 31 schools from phase 3 of the programme in Ireland (two and a half years after the start of the programme) showed that children's fruit and vegetable consumption in their lunchboxes increased by 76%; and at home children's consumption of fruit and vegetables increased by 24%. This demonstrates the potential effectiveness of campaigns that are based on information-sharing without a financial incentivising element.

Overall, the 16-day programme has the potential to complement other schemes such as the EU School Fruit Scheme, particularly for socially disadvantaged children and its success is noted by both its scalability (e.g. the programme was introduced to every school in Ireland) and replicability (e.g. a sister project called the "Fit'n'Fun Dudes" project was launched to improve children's activity levels).

Similarly to interventions targeting dietary behaviour, multi-component physical activity programmes tend to be more effective than single component interventions at increasing activity levels of school children with potential consequences for reducing BMI (see, for example, Van Sluijs, McMinn and Griffin's (2007) systematic review of 57 articles focusing on the effectiveness of multicomponent physical activity interventions for adolescents). Multi-component physical activity interventions may have other positive health effects, for example reducing blood pressure (Harris et al. 2009) or reducing SES differences in obesity among children (aged 18 or younger) (Hillier-Brown et al. 2014).

The following components of interventions were identified as being particularly effective:

- **Implementing longer-term physical activity interventions lasting one year or more.** Mei et al. (2016) conducted a meta-analysis of 18 studies examining long-term school-based physical activity interventions among elementary school children (grades 1-6). The authors found that students receiving the physical activity interventions lasting one year or more had a significantly higher reduction in BMI (2.23 kg/m² in the intervention group).

- **Linking school-based interventions to out-of-school actions** could increase effectiveness of multi-component strategies (Van Slujs, McMinn and Griffin 2007), Branca, Nikogosian and Lobstein 2007). For example, the PA4E1 (Physical Activity 4 Everyone) intervention is a multi-component physical activity secondary school intervention grounded in social cognitive, socio-ecological theory and the World Health Organization's Health Promoting Schools framework. Hollis et al. (2016) reported that changes in the school curriculum and environment, and the involvement of parents and the broader community, helped the intervention produce moderate, population-level/school-level decreases in adiposity in the intervention group at 12 and 24 months. Similar results were found in a separate assessment conducted by Sutherland et al. (2016), who measured the effects of the intervention on the amount of daily moderate-to-vigorous physical activity using accelerometry data and reported a statistically significant mean difference of seven minutes between group means at 24 months.

3.1.1.8 University settings

University or higher education settings provide an appropriate setting for promoting healthy lifestyles among young adults. These settings have the potential to engage large numbers of students in behavioural change interventions and have access to a large number of students living away from home for the first time with autonomy over their eating habits. Furthermore, as academic institutions, they can support the development of high-quality research studies in this area and contain high quality facilities, resources and qualified staff, ideal for implementing interventions (Plotnikoff et al. 2015). Within a university setting, improved nutritional and physical activity behaviour may also have wider impacts on attrition, retention and academic performance but, to date no studies have focused on these outcomes.

A systematic review of 41 studies (RCTs, non-randomised controlled trials and pre-post designs with no control group) of university interventions (intervention durations ranged from a 30 minute one-off intervention to an intervention over four academic calendar years) supports the effectiveness of interventions in this setting (Plotnikoff et al. 2015). More specifically, of the 29 studies focussing on physical activity, 18 reported significant improvements in physical activity engagement; and of the 24 studies reporting nutritional outcomes (fruit and vegetable intake was the most commonly reported outcome), 12 studies reported positive outcome (in three studies, a significant improvement in diet quality was observed). Four of 12 studies also reported significant improvements in weight outcomes.

More specifically, the review found that shorter interventions (one university semester or less) generally resulted in a greater number of significant outcomes than interventions of longer durations; interventions targeting only nutrition resulted in more significant outcomes compared to targeting physical activity, weight or multiple behaviours. Studies targeting self-efficacy and course-embedded interventions with frequent face-to-face contact with professionals/facilitators were also identified as being particularly effective and interventions where students received feedback on their progress appeared to be more effective than attending lectures or receiving educational resources. However, the majority of studies in this review were conducted in the US²⁵ making the global generalisability of these results unclear. Furthermore, participant numbers were overall surprisingly small and most participants were female highlighting the importance of conducting further study in this setting.

Findings from three primary research studies also support the effectiveness of interventions in university settings, although all focus on improving the dietary

²⁵ 33 studies were conducted in the US, 2 in Turkey, 1 each in Jordan, Lebanon, Scotland, Ireland, Taiwan and Australia.

environment. Bucher, van der Horst and Siegrist (2011) found that **changing the food environment** by offering more healthy options, such as an assortment of vegetables is an effective approach for encouraging students to consume a higher proportion of vegetables. Results were based on the author's study of ninety-eight students from the University of Zurich, who were divided into three groups and provided with a replica buffet option. Burns and Rothman (2015) also reported that increased fruit availability may nudge people to choose different fruit options, and therefore encourage healthier dietary choices.

Changing the payment options for food can also influence the dietary behaviour of students. Findings from an experiment conducted by Just et al. (2008) (reported in a systematic review by Skov et al. 2013), showed that the use of a prepaid debit card restricted to healthy foods resulted in more healthy foods selections when compared to students who were assigned unrestricted cash payments or general debit cards as the method of payment.

3.1.1.9 Worksite settings

The following sections consider the effectiveness of comprehensive whole workplace interventions and whole environment changes in workplaces. Several national and international policy statements have emphasised the importance of workplace settings in promoting better health and wellbeing (McDaid, Sassi and Merkur 2015). This is because they have the potential to reach large numbers of individuals and, if required, target

Summary of Effectiveness:

- Whole workplace interventions that target the entire office or company are effective at improving physical activity. However there is mixed evidence of the impact of workplace physical activity interventions on productivity and absenteeism. The review did not find enough evidence to conclude the effectiveness of interventions focused on improving dietary behaviour and choices in workplace settings.
- Focussing on workplace built environment changes, worksite health promotion interventions with an environmental change component (e.g. changing the availability of fruit and vegetables) have demonstrated small but positive effects on dietary behaviour. Larger positive effects were identified for ergonomic workstation interventions that focussed on reducing sedentary behaviour and/or promoting physical activity.
- Multi-behaviour interventions, combining healthy eating information with activities to increase physical activity in the workplace may be more effective than single behaviour interventions. Longer-term interventions, high-frequency approaches and taking a more personalised approach were identified as particularly successful. Encouraging small bouts of physical activity and implementing group-based interventions with set targets were also identified as effective ways to improve physical activity outcomes.

programmes at specific sub-populations.

Whole workplace interventions

Whole workplace interventions which target the entire office or company were found to be effective at improving physical activity levels. However, the review did not find enough evidence to conclude the effectiveness of interventions focused on improving dietary behaviour and choices in workplace settings.

Workplace-based programmes usually utilise a range of strategies and are offered to all employees (McDaid, Sassi and Merkur, 2015). Examples include: workplace-based health and nutrition education programmes (including behavioural training and social prescriptions for exercises or specific diets), promoting active transport between work and home (Branca, Nikogosian and Lobstein 2007); and employee health checks and screening programmes (McDaid, Sassi and Merkur 2015).

Cairns et al. (2015) concluded in their systematic review that workplace nutrition and physical activity interventions targeting lower socio-economic status workers (such as counselling, health education and behavioural prompts) seemed to demonstrate positive results²⁶. However, as the authors note, the evidence base is weak, with most reviews largely from the USA, and of a low quality.

Focussing on physical activity interventions in the workplace, early evaluations of workplace physical activity programmes often reported their ineffectiveness (McDaid, Sassi and Merkur, 2015) or were generally inconclusive (Branca, Nikogosian and Lobstein 2007). However, recent evidence suggests that there are consistent and positive effects of workplace physical activity interventions on physical activity behaviour, fitness, anthropometric measures and lipids (McDaid, Sassi and Merkur 2015).

Importantly for workplaces, **physical activity interventions may also lead to reductions in absenteeism** (up to 33-50% according to some of the studies reviewed by the Transport for London (undated)) **and increases in productivity**, with consequent benefits for the economy (Branca, Nikogosian and Lobstein 2007). However, there is inconclusive evidence regarding which interventions or policies may be most effective in this respect. For example, eight studies reviewed by Pereira et al., (2015) emphasise that high intensity interventions, with higher levels of compliance from employees are most effective at improving productivity and reducing presenteeism (working while ill), but may not be effective at reducing absenteeism.

Likewise, in their review of 14 articles, Cancelliere et al. (2011) found exercise interventions promoting moderate to vigorous physical activity to be most effective in decreasing presenteeism, compared to wider physical activity interventions, ergonomic changes or lower back pain prevention programmes. However, this may be a result of the types of work or environments considered in the review – for example, effects may be greater for white collar workers than for blue collar workers (Oortwijn et al. 2011, Pereira et al., 2015).

Whole environment changes

This section focusses on interventions to change the workplace physical environment.

Healthy environments

The literature search identified two studies that focus on changing workplace environments to promote healthier eating or change dietary behaviour: observed effects were small or short-term. Mhurchu, Aston and Jebb (2010) performed a systematic review of 16 articles examining the impact of worksite nutrition interventions (such as changes to vending machine and canteen availability and menu reformulation) in North America and Europe. While the authors found that the environmental interventions resulted in positive dietary outcomes (such as increases in fruit and vegetable consumption, and decreases in fat consumption), effect sizes were small, and importantly smaller than individual-level interventions. In their review of 22

²⁶ Fourteen studies evaluated behavioural interventions (including exercise, counselling and education), three studies examined behavioural and environmental interventions (e.g. behaviour interventions plus access to healthy food, stairwell enhancements) and one study examined a workplace food voucher scheme.

articles on environmental interventions²⁷, Allan et al. (2016) found that 13 studies also reported small to moderate effects on eating behaviour such as increased fruit and vegetable consumption, increased purchase of healthier snacks or decreased purchase of less healthy snacks.

Active environments

Changes to the workplace built environment such as the introduction of ergonomic workstations (standing desks and active workstations including exercise machines), have been shown to have positive effects on physical activity (Ben-Ner et al. 2014; Carr et al. 2016; Torbeyns et al. 2014). For example, based on 32 longitudinal and cross-sectional studies of active workstations in the US, Torbeyns et al. (2014) conclude that standing desks, walking desks, and cycling workstations decreased sitting time, increased energy expenditure, had a positive effect on various health markers, and had no detrimental effect on work performance.

Active workstations have also been linked to a reduction in BMI, although limited evidence was identified. Koeppe et al. (2013) concluded that following a one-year intervention involving 36 sedentary office workers in the US, daily physical activity increased among participants using the treadmill desk. Weight loss was greater among obese employees compared to non-obese employees.

In addition to physical changes to the work environment, complementary interventions which target the behaviour or decisions of employees may also be effective. For example, as part of their systematic review of interventions in office buildings and other settings, Soler et al. (2010) found that point-of-decision prompts or motivational signs placed near stairwells or at elevators and escalators can encourage stair use. However certain forms of attire such as suits or smart work clothing may reduce the effectiveness of the prompts. Findings from other studies also suggest that interventions encouraging stair use in the work place are effective (Bellicha et al. 2015; Branca, Nikogosian and Lobstein 2007). In particular, Bellicha et al. (2015) noted that that using motivational and directional signs in tandem was particularly effective, increasing stair climbing in over four-fifths of the 16 studies focusing on stair-use interventions in the workplace. However the authors identified a number of limitations relating to the design of included studies (e.g. lack of randomisation or measurement of long-term effects) which affect the strength of review conclusions.

Effective elements of workplace interventions

Evidence shows that multi-behaviour interventions, combining healthy eating information with activities to increase physical activity in the workplace may be more effective than single behaviour interventions, especially when designed by employees and supported by senior managers (Thorndike 2011; Branca, Nikogosian and Lobstein 2007).

Findings from systematic reviews highlighted further ways in which interventions or policies may be more effective in workplace settings:

- **Longer workplace interventions** may be more effective for behaviour change than short term interventions. Mache et al. (2015) noted that there were greater reductions in weight and BMI and fruit and vegetable consumption among 1,573 employees of a German logistics company (who were overweight or obese) when the workplace health promotion intervention had been in place for one year.

²⁷ Most of these interventions were multi-component, combining modalities such as point-of-purchase prompts, messaging, and alterations to the availability of various foods; only studies of interventions with significant dietary environmental components were included.

- **High-intensity methods**, such as structured programmes targeting nutrition, physical activity or both (as opposed to unstructured ones or augmenting the provision of information with counselling), seem to yield the greatest benefits (Anderson 2009).
- **A personalised approach** may also be effective. As previously mentioned, individual counselling was found to be an effective component of a physical intervention for people at high risk of cardiovascular disease according to the Swedish National Food Administration's (NFA) Public Action Plan. Additionally, György et al. (2015) found that computer-based tailored nutrition and physical activity education, which provides respondents with individualized feedback about their dietary behaviour and physical activity levels, is more effective at motivating people to make changes than general nutritional and physical activity education.

Additional strategies were also suggested specifically for improving the success of physical activity interventions. For example, Barr-Anderson et al. (2011) found **introducing small bouts of physical activity to a routine work** (or school) day to be a promising approach for increasing physical activity. The authors reviewed 40 studies of interventions, including those commonly involving the integration of 10-minute bouts of physical activity during the day or 10-15 minute physical activity breaks. In half of all worksite-based studies, there was a significant association with improved levels of physical activity. Similarly, Oortwijn et al. (2011) report that regular participation supports the efficacy of physical activity workplace programmes, however other factors (e.g., personal feedback, social support input, and the influence of surrounding and contextual factors) are also important.

Furthermore, **there is some evidence that workplace interventions which have peer or senior involvement, or are 'group-orientated' are also effective.**

Initiatives that measure and set targets for employees (for example the number of daily steps) may have positive outcomes regarding increasing physical activity levels, reducing BMI and increasing productivity at work. In this instance, evaluations (reported in C3 Collaborating for Health, 2012) of The Global Corporate Challenge (GCC)²⁸ – a 12-week walking programme originating in Australia – show that the percentage of participants walking 10,000 steps a day increased to 58% (from 18%) after the GCC. In addition, there was an average 10% reduction in body fat reduction (and 5.2cm reduction in waist size) report as well as an average of 4.5kg/9.9lbs weight loss. Studies also reported increases in the daily work productivity of over half the participants, and improvements in teamwork, job satisfaction and attendance.

Finally, the WHO Regional Office for Europe (2007) report, *Steps to health, A European Framework to promote physical activity for health* cites a US systematic review from 2006 which looks across different approaches to promoting physical activity and assesses the strength of evidence of their ability to promote physical activity respectively. The evidence review underpinning this framework, which was produced through consultation with experts and policymakers across Europe, identified strong evidence to support the effectiveness of comprehensive worksite approaches, and strong but limited evidence for strategies facilitating physical active transport (e.g. bike stands or sheds in workplaces). However, they also note that many of the studies included in the systematic reviews they looked at did not last longer than a year and thus long-term effects require further study.

²⁸ In 2011, 130,000 people from 1000 organisations in 55 countries took part. Teams of 7 people from workplaces that entered were issued two pedometers and tasked with walking 10,000 steps each day. Participants record their daily steps on a website and their individual and overall team is tracked, illustrated as a journey travelled across a map. Evaluations were conducted by Lancaster University, Monash University, and the Foundation for Chronic Disease Prevention in the Workplace (FDPCP)

3.1.1.10 Healthcare settings

Primary care environments are an important setting for the *treatment* of overweight and obesity. The main strategies for treating obesity include the provision of lifestyle advice, referral for weight management, drug prescriptions and bariatric surgery referrals in severe cases (Booth, Prevost & Gulliford 2013). Physical activity interventions, including step count 'prescriptions' from clinicians, are also increasingly being used to effectively support the management of a range of long-term conditions including type 2 diabetes and hypertension (Dasgupta et al. 2017).

However, limited information is available on the use of primary care interventions as a way of *preventing* overweight and obesity in general population groups i.e. non-clinical populations. Furthermore, most studies identified focus on nutrition and physical activity interventions to support general health outcomes, including cardiovascular health, and as a result do not assess the impact on weight status. More evidence is required on the longer-term impacts of primary healthcare interventions, particularly their impact on patient weight.

Summary of Effectiveness:

- Primary care providers could play an important role in preventing childhood obesity, however more evidence of the impact of primary care-based interventions is required.
- Among adults, there is evidence for the effectiveness of primary care counselling in improving physical activity and nutritional behaviour, however no evidence of its impact on weight status was identified.
- Grey literature findings suggest that remote health interventions can be effective in increasing physical activity levels and improving dietary behaviour. The role of technology in obesity interventions will be an important area for future research.
- Despite its wide promotion in the UK, more evidence on the effectiveness of social prescribing interventions on behavioural and weight changes is required.
- A lack of information was found relating to interventions in secondary healthcare settings.
- The grey literature suggests that primary care interventions could be a cost-effective approach to reducing and preventing adult obesity.

Children

Primary care providers could play an important role in preventing childhood obesity, however more evidence of the impact of primary care-based interventions is required.

A systematic review by Vine et al. (2013) looking at 96 studies on childhood obesity interventions in healthcare settings in the US identified the main types of intervention implemented in these settings. However, the majority of studies provided no assessment of effectiveness. The main types of obesity prevention intervention are as follows:

1. **Annual weight status assessments and monitoring of BMI** and indicators of a healthy diet, active living and child and family health history. However, one study (Ewing et al. 2009, cited in Vine et al. 2013) of a primary care-based weight assessment programme found that despite short-term weight improvements, there was no significant reduction in BMI after 12 months. Furthermore, the

articles reviewed highlighted a number of potential barriers to this approach, including clinicians' lack of familiarity with the use of BMI; lack of agreement about the utility of BMI as a screening tool; lack of office time to gather background information from families; and lack of practice-level resources.

5. **The promotion of a healthy lifestyle by clinicians** including promoting adherence to dietary guidelines, limiting screen time and sedentary behaviour, and increased participation in physical activity. Multiple articles (Barnes 2010, McCambridge et al. 2006, Krebs and Jacobson 2003, The Community Guide 2007, Nicklas and Johnson 2004, DuPlessis et al. 2005, Lichtenstein et al. 2006, all cited in Vine et al. 2013) suggested that the provision of healthy lifestyle advice should become standard clinical practice for clinicians working with children and adolescents. However, no studies described or assessed specific health promotion interventions for pregnant or breastfeeding women in the primary care setting.
6. **Healthcare system capacity-building.** This includes the training of clinicians in standardised evidence based assessment and counselling and ensuring they are comfortable in communicating test weight assessment results to patients. It also includes improving organisational systems or care models, for example creating practice based obesity prevention clinics.
7. **Clinician referral to support services,** for example referral by a clinician to obesity prevention or treatment interventions.
8. **Community health education,** for example clinicians acting as important role models, educators, and promoters of healthy lifestyle practices to their patients and other community residents.
9. **Multi-sectoral community initiatives** that include physicians partnering with public health professionals to coordinate and focus new and existing services for residents. Over the past decade, primary care providers have been encouraged to build partnerships across disciplines to work collaboratively with public health departments and other colleagues, to identify and decrease barriers to the health and well-being of the children in their communities, and to coordinate and focus new and existing services for the benefit of all local children.
10. **Policy advocacy.** This includes healthcare professionals supporting and advocating publicly for a number of policy changes e.g. increased funding for childhood obesity prevention research.

Adults

Among adult populations primary care health counselling and remote health interventions were identified as promising approaches to tackling obesity. More information is required on the impact of social prescribing initiatives. There is a growing body of evidence (Lin et al. 2010; Franklin and Vanhecke 2008) to support the effectiveness of behavioural health counselling for preventing cardiovascular disease in adults by changing patient behaviour. While no studies focussed on weight outcomes, a number of studies reported positive behavioural outcomes that have the potential to impact weight status. For example, Orrow et al.'s (2012) review of RCTs of physical activity promotion in sedentary adults recruited in primary care (15 trials, n= 8745) showed that the promotion of physical activity among sedentary adults in primary care settings led to a significant increase in physical activity levels after 12 months (as measured by self-report)²⁹. However, there was insufficient evidence to recommend exercise referral schemes over advice or counselling interventions.

Grandes et al.'s (2009) case-control study of the effectiveness of the PEPAF (Experimental Program for Physical Activity Promotion) also concluded that the provision

²⁹ Minimum follow-up time for studies was 12 months and the majority of interventions took place in primary care and involved the provision of advice and counselling on multiple occasions. Three trials investigated exercise referral.

of physical activity advice and physical activity prescriptions to patients (n=2,248 physically inactive patients) by family physicians was an effective way to increase patient physical activity levels, although the overall clinical effect was small. The grey literature also found that care counselling interventions about the benefits of physical activity in reducing the risk of obesity can lead to increased physical activity levels in patients, and, in some cases, can have positive effects on a patient's lipid profile (McDaid, Sassi and Merkur 2015).

Grey literature findings suggest that remote healthcare interventions could be an effective way of individually supporting patients, and may support longer term behavioural change. A review of studies and recommendations carried out by INPES (2014) on the effectiveness of remote health interventions found that online and/or telephone counselling is particularly effective in increasing physical activity levels, where effects are likely to last at least six months. They were also identified as effective in influencing dietary behaviour. The evidence suggested that the longer the duration of support (e.g. 6-12 months) and the more post-intervention support (for example, more than 12 follow-up calls) provided, the more likely it is that participants will maintain improved physical activity levels. Internet-based interventions such as tailored information websites and/or online support programmes (delivered through regular, personalised emails or sent/monitored directly by a licensed therapist), were also found to be effective but positive impacts were more modest and shorter-term (three months). Finally, there was evidence that short message service (SMS) interventions were effective in promoting behavioural change, for example smoking cessation or increasing physical activity.

Finally, social prescribing, or linking patients in primary care with sources of support within the community to help improve their health and well-being, is being widely promoted across the UK to tackle long-term conditions, including obesity. However a systematic review by Bickerdike et al. (2017), of 15 studies, concluded that while it is being widely advocated and implemented, current evidence fails to provide enough detail to judge its effectiveness or value for money.

A lack of information was found relating to interventions in secondary healthcare settings. In the grey literature, Tedstone et al. (2015), in a report for Public Health England, suggested that lowering the sugar content of foods sold in institutions such as hospitals could be a successful way to reduce sugar intakes. More research in this area is required.

Cost effectiveness

The OECD (2010) reported that primary care interventions have a good cost-effectiveness ratio (less than three times GDP/capita per DALY prevented). This finding was supported by other reviews assessed by McDaid, Sassi and Merkur (2015).

3.2 Research question 2: How do differences in the context and design of intervention and policies lead to different outcomes and health impacts?

This section focusses on how contextual factors (setting and beneficiary demographics) and general design features of an intervention can affect their outcomes and health impacts. Information used in this section is based on specific searches undertaken for this question and information reported under question 1 above. In general, limited information was found regarding how the context and design of an intervention affects its outcomes. More studies, including innovative study designs, are required that look at the impact of contextual factors and design features on project outcomes.

Summary of Contextual and design factors suggested to impact policy or intervention effectiveness:

- The setting of an intervention:
 - Intervention/policy interactions can positively or negatively impact their effectiveness;
 - Organisational structures, buy-in from management and other stakeholders can influence the effectiveness of interventions/policies; and
 - Specifically in a school setting, time can influence effectiveness – time related to space in the curriculum, and time related to necessary training for teachers.
- Population/ intervention group demographics:
 - There is some evidence that gender, age and SES can influence effectiveness, but more research is needed.
- Several design aspects have been identified that may improve effectiveness, for example:
 - Ensuring complementarity of components in a multi-component intervention;
 - Developing stakeholder partnerships, including participants in planning and upskilling organisational staff to support implementation;
 - Using theory-based components of interventions; and
 - Tailoring an intervention for a specific target group or context.

3.2.1 Contextual factors relating to the setting of an intervention

Review of the peer-reviewed and grey literature revealed aspects of the intervention context and setting that can serve as a barrier or facilitator to implementation and therefore play a role in the observed impact (or lack thereof) of obesity policies and interventions. Contextual factors have been reported by setting below.

Systems/policy level:

- The interplay of complimentary policies can influence the effectiveness of price policies, reformulation and advertising restrictions/bans.
- Menu labelling may be more effective in certain settings and when contextual information is provided alongside nutritional information.

The interplay of complimentary policies can influence the effectiveness of price policies, reformulation and advertising bans/restrictions. The interplay of a number of policies and interventions can affect the effectiveness of policies and interventions at all levels, however clear evidence is available on the impact of interplays on price policies, bans and reformulation. As discussed in section 3.1.1.1 above, introducing taxation policies in an environment with healthy food subsidies is likely to improve their effectiveness. Similarly, ingredient bans must be aware of the wider food environment and existing policies to assess the likelihood of industry replacing banned ingredients with equally unhealthy products. Finally, the effectiveness of advertising bans depends on the reach of the ban: collaboration with neighbouring MS is essential to identify the presence of complimentary bans and advertising regulation.

Menu-labelling may be more effective in certain settings. The setting, or context, in which menu labelling is applied may influence willingness to use this information, and therefore, its impact. For example, Sacco et al. (2016) noted that menu-labelling had a greater impact in full-service restaurants, cafes and sandwich shops compared to studies in fast food settings. As discussed in section 3.1.1.1 above, consumers are also more likely to utilise menu labels when contextual information about the healthiness of the food is provided alongside it. **Strong existing social structures can facilitate**

Community settings:

- Limited information was found regarding contextual factors in community settings.
- Strong existing social structures can facilitate implementation.

implementation. The Oireachtas Library and Research Service (2011) briefing found that using the existing social structures of a community – for example schools, school networks or weekly meetings of older adults - helped to reduce barriers to implementation by encouraging buy-in and networking of stakeholder groups.

Childcare Settings:

- Different organisational structures and levels of buy-in can affect the success of an intervention.
- Findings from New York City's childcare regulations found that centres with shorter days, less staff turnover, staff with higher levels of education and outdoor space were more likely to be compliant with regulations.

Different organisational structures can affect the success of an intervention. Neelon et al. (2016), in a study examining lessons learned from two obesity prevention efforts implemented in childcare settings, noted that organisational structures varied from centre to centre which affected implementation. They argued that it is important to have a clear understanding of contextual factors and ensure that the intervention is implemented in a way that meets the needs of centre staff but also retains the fidelity of the intervention. In particular, the authors found that the presence of an advisory group supported successful implementation of an intervention. Agreeing realistic expectations that consider broader economic and organisational challenges was also identified as a factor that contributed to successful implementation.

Focussing on specific aspects of organisational structure, a case study from New York City indicates that **shorter days/ fewer hours of operation, lower student/teach ratio, staff stability, better educated staff and outdoor play space (for physical activity) were associated with greater compliance with nutrition and physical activity guidelines.** In their 2014 article Nonas, Silver and Khan review the lessons learned from implementation of New York City's regulations on nutrition, physical activity and screen time. Data for the study were collected from 110 childcare centres located in high-poverty neighbourhoods through interviews with centre staff and direct observation of centre characteristics (physical environment, availability of different foods/beverages). The authors noted that many of the centres lacked space for children to be physically active and were challenged to meet the guidelines for physical activity. However, the team found that training staff about structured physical activity lessons helped centres overcome this barrier. When conducting further analyses, the authors found that centres that had received training on structured physical activity were able to comply with physical activity guidelines.

School Settings:

- Differences in education structures across MS can affect the effectiveness of school-based interventions.
- Time, budget and staff buy-in are potentials barriers to implementation of school-based obesity prevention interventions
- Presence of a local champion as well as a school coordinator can be important elements for successful interventions as they help to ensure full school coordination and buy-in.
- The presence of existing collaborations and partnerships can facilitate implementation.

Differences in educational structures can impact effectiveness. De Sa and Lock (2007) highlight the impact of differing educational structures on the success of certain intervention designs. Interventions should consider these differences during design stage to ensure they are properly tailored to the setting (see section 3.2.3).

Time, budget and buy-in are potentials barriers to implementation of school-based obesity prevention interventions. In a qualitative study conducted by Greaney et al., 2014, the authors examine factors within schools that were barriers or facilitators to the implementation of an intervention to improve dietary behavior through environmental change (increasing availability of healthier foods) and education. Findings from interviews with key stakeholders revealed time was a major barrier, particularly for the education component. Difficulty in having time to train teachers and teachers unwillingness to use the healthy eating curriculum were also aspects of the intervention context notes as barriers. Greaney et al. also noted that food service personnel in schools were sometimes identified as barrier to changing the school food environment because some were reluctant to make changes. Lastly, budget limitations were noted as an aspect of the school context that at times made it difficult to change the environment and increase the offering of healthier foods.

The presence of a local champion and school intervention coordinator have been noted as facilitating implementation of school-based interventions. Greaney et al.'s qualitative study also examined facilitators associated with implementation and found that having a school coordinator available to oversee implementation of the curriculum and environmental changes helped facilitate successful implementation and gave school-staff opportunities to ask questions and problem-solve barriers/challenges.

The study also noted that schools where there was a champion and buy-in from administrative and school staff had greater success with implementation. In an article by Fagan et al. (2009) the authors also note the importance of local champions for successful implementation.

The presence of existing collaborations and partnerships can facilitate implementation. Fagan et al. (2009) also noted that sites with existing collaborations and partnerships are more successful in implementing interventions.

Worksite Settings:

- Limited information was found regarding the impact of setting on the effectiveness of worksite interventions.
- Setting and attire may impact the effectiveness of point-of-decision stair-climbing prompts.

Setting and attire may impact the effectiveness of point of decision stair-climbing prompts. In their systematic review, Soler et al. (2010) evaluated the effectiveness of point-of-decision prompts, or motivational signs, placed near stairwells or at the elevator and escalators, encouraging people to use the stairs. The studies took place in a variety of locations, such as a university, office building, malls, airports, train and bus stations, and a healthcare facility. Baseline measures of stair usage differed across settings, as did the effectiveness of the interventions, suggesting that the goal (leisure, activity work), or type of dress (suit or work clothes) of people in certain locations may impact the effectiveness of the point-of-decisions prompts. These factors should be taken in to account when designing stair climbing interventions (Soler et al., 2010).

3.2.2 Context – population demographics

The demographics of a population or intervention target group can influence the effectiveness of some interventions. The following sections look at the impact of different demographic components in more detail. It is important to note that no information was identified on the impact of ethnicity or older age on intervention outcomes and limited information was provided as to why these demographic differences exist.

Gender

In line with Kiszko et al.'s (2014) findings above, Sinclair, Cooper and Mansfield (2014) found that women were more likely to use menu labelling to inform their selections than men. Within a school setting, Kropski, Keckley & Jensen's 2008 systematic review of 14 studies conducted in the UK, US, Chile, Australia and Germany examining the impact of long-term school-based programs aimed at improving weight status in children found similar gender differences. The authors found that there were key differences between how boys and girls respond to a given intervention, suggesting that intervention components may need to employ different techniques for boys vs. girls in order to effectively have an impact on the study as a whole (Kropski et al, 2008).

In contrast, the 2007 study done by Van Sluijs, McMinn, and Griffin found that of the studies under review, interventions targeting one sex did not find a differential response between the two sexes, raising doubt about the need for separate interventions based on gender (Van Sluijs et al, 2007).

Finally, in a university setting, results from a questionnaire examining gender differences in the health habits of university students (Plotnikoff et al. 2015) showed that males were less interested in nutrition advice and health-enhancing behaviours, suggesting that

interventions targeting health behaviours in university/college students may need to be gender-specific to address the different needs and interests of both sexes.

Age

At a basic level, targeting younger age groups has the potential to have a greater impact on nutritional and physical activity behavior over the life course than interventions in adulthood. As discussed in section 15 above, advertising restrictions are particularly successful among young children, however use of nutrition labels tended to be lower among children and adolescents than among adults. In contrast, Sacco et al. (2016) reported that menu-labelling was more often effective when used by children and adolescents than when used by adults.

SES status

A number of references identified in the review highlighted that SES barriers can limit the effectiveness of certain policies and interventions. This is particularly concerning as low SES status individuals are more likely to be overweight or obese and should be considered as priorities for obesity interventions. For example, compared to other groups, the provision of educational information without any other activities is relatively ineffective among lower income groups and may increase inequalities (Robertson, Lobstein & Knai 2007). Most individuals of lower SES in Europe already know what constitutes a healthy diet. The priority is instead to address barriers to the consumption of healthy products i.e. affordability, accessibility, availability and practicalities relating to healthy food.

As a result, interventions that address obesity at a population level are more likely to be effective than interventions at an individual level, particularly for low SES groups (Loring and Robertson 2014), as they better address the underlying causes of inequality and obesity. As highlighted in section 3.1.1.1 above, price interventions such as subsidies and taxation are likely to have a greater impact on individuals of lower SES compared to the wider population. As lower SES individuals are also more likely to have higher rates of obesity, this differential impact was seen to be beneficial, however the equity of such policies is an important consideration. Marketing bans were also identified as being particularly effective for children of low SES as this group are more likely to be exposed to marketing of unhealthy foods (Loring and Robertson 2014).

Furthermore, Harris et al.'s (2006) analysis of the Australian Better Health Initiative (ABHI) Implementation Plan suggested that the implementation and impact of the physical activity and nutrition guidelines could vary depending on geographical location and the socioeconomic situation of the parents. Children living in rural and remote areas where there are few services and those children whose parents are unable to afford services or reach them could experience a more limited implementation of the guidelines. Further, child services may differ in the successful uptake of guidelines, for example services which are part of larger organisations, or have wealthier parent clients, could adopt guidelines more easily.

Finally, there is some evidence that individuals of low SES may require extra measures to benefit from universal policies, for example interventions to address self-esteem (Loring and Robertson 2014).

3.2.3 Design

The literature identified the following general aspects of policy/intervention design as being most effective. However, it should be noted that most studies did not provide information as to why such elements improved effectiveness:

1. **Ensuring elements of multi-component interventions are complimentary and synchronised.** Mikkelsen et al. (2016) present key factors associated with the implementation of three multi-level, multi-

- component obesity prevention interventions in the US. They stressed that: ensuring different components of the programme reinforce each other (e.g., education/media campaigns create awareness of menu labelling in restaurants and/or the importance of meeting dietary guidelines); creating consistency across levels of implementation and intervention components (e.g., similar branding, messaging and/or framing); and synchronizing intervention components across settings and levels (e.g., ensure environmental changes to increase physical activity opportunities are in place before release media/educational campaigns to increase awareness of physical activity guidelines and opportunities available in the community; or ensure stores are stocking healthy foods prior to release of media promotion to increase awareness of healthy corner store intervention) were essential.
2. **Developing strong stakeholder partnerships and considering evaluation from the outset.** Developing community partnerships with key stakeholders from the beginning to develop vision, mission and goals as well as planning for realistic and useful evaluation activities were identified as key components of successful multi-component interventions (Mikkelsen et al. 2016).
 3. **Involving participants in planning and implementation.** For example, engaging employees in the planning and implementation of workplace-based interventions (Branca et al. 2007).
 4. **Funding capacity-building and training** as part of an intervention to upskill existing staff and facilitate longer-term sustainability.
 5. **Using a theoretical framework was identified as a key component of effective interventions in childcare settings.** Finch, et al. (2016), conducted a meta-analysis of 17 studies conducted in the USA, Australia, Switzerland, Belgium, Germany, Israel, England and Scotland to determine the effectiveness of physical activity interventions in childcare organizations. The authors found a key component of effective interventions was the use of theory in the intervention design. Additionally, Lai et al.'s 2014 review also found that use of a theoretical framework in intervention design was positively associated with producing sustained impact in PA outcomes (Lai et al. 2014).
 6. **Tailoring interventions to target groups.** As highlighted in section 3.2.2 above, demographic factors can impact the effectiveness of interventions. Effective policy-making should therefore ensure that interventions are designed with the specific target group/s in mind from the outset so that interventions can be properly tailored to their needs and the outcomes maximised. For example, a study by Phillips et al. (2012) evaluating Natural England's Walking for Health scheme, which aimed to promote walking across a number of population groups but with a main focus on females and individuals aged 55-64 years (which they identified as some of the most sedentary individuals), found that despite the scheme not meeting its overall intended outcomes, it has the biggest effect on its main target audience i.e. female participants and individuals aged 55-64 years. This led them to conclude that "targeting these groups appears to have worked" and the scheme was successful at improving physical activity for the most sedentary.
 7. **Tailoring interventions to contexts.** Finally, de Sa & Lock (2007) reported that school programmes to increase fruit and vegetable consumption were more effective when the design of the intervention was tailored to the specific context of each Member State. For example, the Pro Children intervention study, conducted in three countries with differing education systems, combined free fruit and vegetable provision with educational initiatives and parental support. The study varied the timing of delivery of the free fruit and vegetables depending on the country it was being implemented in, to account for the fact that Norway and the Netherlands have no school meal provision at lunchtime.

Adaptation of the programme to different school systems, aided by strong partnership working, resulted in an average 20% increase in fruit and vegetable consumption in the schools after one year, leading the study to conclude that school fruit and vegetable programmes must have the potential to be flexible and adapt to the varying national contexts.

3.3 Research question 3: What are the key elements of effective and efficient interventions?

Key elements of effective interventions and policies are reported in the tables below, by setting and type of intervention. All information included in the tables comes from findings reported under other research questions in this review. It should be stressed that the elements reported below are by no means exhaustive, nor have they been critically assessed in order of the most effective. Rather, they are a summary of factors or components of interventions identified as important by the authors of studies referenced throughout this review.

Table 3. Tax interventions on nutrition

Overall key elements of tax interventions
<ul style="list-style-type: none"> • Implementing tax on unhealthy foods or SSBs of at least 20%. • Implementing taxation in conjunction with subsidies to reduce the risk of substitution. • Considering potential impact on non-taxed foods and substitution options/consider only taxing products where healthier alternatives are available. • Establishing cross-national agreements to avoid cross-border alternative purchasing (e.g. Danish consumers shopping in Germany). • Implementing tax in conjunction with education and health promotion interventions. • Considering the proportional effect on disadvantaged groups.

Table 4. Reformulation interventions

Overall key elements of reformulation interventions
<ul style="list-style-type: none"> • Combining reformulation with complimentary policies/interventions. Accompanying reformulation policies with education campaigns, clearer labelling, and the improved availability of healthier alternatives can improve effectiveness. • Assessing the likelihood and impact of replacement. Careful research needs to be conducted on the effects of replacing one ingredient with another. For example, the replacement of <i>trans</i>-fats with saturated fats.

Table 5. Marketing bans and restrictions

Overall key elements of marketing bans and restrictions
<ul style="list-style-type: none"> • Ensuring marketing bans are wide-reaching and comprehensive. Successful bans require reducing or preventing access to fast food marketing across all social media and TV outlets and ensuring cross-border collaboration. • Statutory regulations were identified as being more effective than industry

- self-regulation.
- Combining advertising bans with other changes to the food environment.

Table 6. Mass media campaigns

Overall key elements of mass media campaigns
<ul style="list-style-type: none"> Ensuring the consideration and targeting of high-risk groups Ensuring campaigns are wide-ranging and cover multiple forms of media e.g. TV, newspapers, online, leaflets. Keeping campaigns simple, with simple messaging and easy advice.

Table 7. Labelling interventions

Overall key elements of food labelling interventions
<ul style="list-style-type: none"> Mandatory labelling across the industry. Making food labels mandatory across the industry could be the most effective, as well as cost effective, way to change consumer behaviour. Using traffic light labelling. Front of pack labelling, particularly the traffic light label scheme (green, amber and red) is found to be a particularly effective design. Providing contextual information about the healthiness of foods alongside clear ingredient labelling can increase effectiveness.

Table 8. Community level interventions

Overall key elements of community level interventions	
<ul style="list-style-type: none"> Developing effective partnerships between all stakeholders, including beneficiaries. Actions that are taken on board by stakeholders at all levels in the community are likely to have the biggest impact. Implementing across multiple levels and settings. The involvement of all sectors in the community such as transport, education and health in the design and implementation of interventions can increase the likelihood of success. Messaging campaigns could also be promoted across all policy areas for maximum impact. 	
Nutrition	Physical Activity
	<ul style="list-style-type: none"> Adapting the built environment to promote physical activity was identified as a successful community intervention, particularly changing urban environments to ensure a safe environment for exercise. Such interventions are also inherently sustainable.

Table 9. Childcare settings interventions

Overall key elements of childcare interventions

- **Facilitating longer-term implementation.** Interventions delivered over a longer period of time have been associated with higher levels of impact.
- Delivering multi-component interventions.
- **Prioritising disadvantaged groups.** To improve equity in implementation, delivery of an intervention should focus on disadvantaged groups, for example, taking into account the location and SES status of parents or guardians.
- **Delivering appropriate training for staff.** The provision of training to support implementation by existing staff can improve buy-in and support sustainability.

Table 10. School setting interventions

Overall key elements of school interventions	
<ul style="list-style-type: none"> • Adapting/tailoring the intervention to the administrative and policy context of the school and the target group and ensuring alignment with national-level policies and interventions targeting schools. • Taking a multi-component and multi-behaviour approach. School based interventions combining educational, behavioural and environmental change activities and targeting both physical activity and nutrition were identified as an effective way to target obesity. • Using a multi-setting approach. Interventions that also include a family or home component were identified as being particularly effective. • Including a non-financial incentivising element, for example reward systems for participation such as badges for children to wear and wall charts in classrooms. • Identifying local champions and school intervention coordinators to drive buy-in and coordination. • Using parents and/or peers as role models. Children have been shown to respond well to peer-to-peer role models and parents can act as important role models in the home environment. • Including parents in the intervention. Interventions that also target, and rely on, parents can be more successful in facilitating sustainable behaviour change. Examples include delivering education sessions at parent evenings and introducing goal settings for parents. • Making an intervention fun. For example, having humorous messaging, providing healthy foods in novelty shapes and delivering fun and non-competitive PA interventions (e.g. dance clubs). 	
Nutrition	Physical Activity
<ul style="list-style-type: none"> • Focussing on one aspect of diet, particularly increasing fruit and vegetable availability or limiting availability of high sugar, salt and fat products. • Successful vending of healthy alternatives should facilitate student involvement, continuous provision and ensure vending machines are located close to dining areas. 	<ul style="list-style-type: none"> • Giving children choice and control. Children are more willing to participate in a physical activity if they have control over the type of activity they participate in and what clothes they wear. • Offering physical activity breaks throughout the day. • Promoting active travel. • Providing afterschool physical activity programmes. <p>Delivering longer-term</p>

interventions. Interventions lasting one year or more are more likely to result in BMI improvements.

Table 11. University setting interventions

Overall key elements of university interventions	
<ul style="list-style-type: none"> • Delivering shorter interventions e.g. one university semester or less. • Embedding interventions into existing courses and ensuring frequent face-to-face contact with professionals/facilitators. • Considering gender preferences. • Targeting students' self-efficacy to improve health behaviours. • Delivering interventions where students receive feedback on their progress rather than simply attending lectures or receiving educational resources. 	
Nutrition	Physical Activity
<ul style="list-style-type: none"> • Targeting only nutrition (e.g. fruit and vegetable consumptions) rather than targeting PA, weight or multiple behaviours. 	None identified in literature searched.

Table 12. Worksite settings interventions

Overall key elements of worksite interventions	
<ul style="list-style-type: none"> • Delivering high intensity interventions. High intensity programmes requiring regular participation were identified as effective, particularly in reducing rates of absenteeism and increasing productivity. • Structured programmes were identified as being more effective than unstructured programmes. • Implementing multi-component interventions e.g. information plus counselling could be more effective than information alone. • Implementing multi-behaviour interventions tackling physical activity and nutrition together. Interventions that include multiple lifestyle components could be more effective and increase chances of continued participation in the programme. For example, interventions that are integrated into one's lifestyle and weekly routine. • Ensure tailoring and individualisation. Interventions that are tailored to individuals are likely to improve participant motivation e.g. individual counselling, computer programmes that give tailored feedback and education, and, personalised tracking materials. Health risk assessments could also be an effective way of tailoring interventions to the most in need. • Designing interventions with employers, senior managers and wider staff. • Delivering interventions over longer timescales. 	
Nutrition	Physical Activity

<p>None identified in literature searched.</p>	<ul style="list-style-type: none"> • Promoting group interventions could improve participation e.g. friendly competition may motivate employees to achieve certain goals. • Implementing environmental changes in workplaces is a particularly effective approach e.g. standing stations, treadmills, and bicycle work stations. • Implementing interventions delivering small bouts of PA is an effective approach.
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Table 13. Healthcare interventions

Overall key elements of healthcare interventions
<ul style="list-style-type: none"> • Providing primary care PA and healthy eating counselling/advice. • Delivering remote healthcare interventions using technology. • Delivering longer-term support e.g. 6-12 months.

3.4 Research question 4: How would the ideal intervention be designed?

From the

Considerations for Developing the Ideal Obesity Prevention Strategic Plan and/or intervention:

- Involve multiple stakeholder groups in the planning and design of interventions
- Use scientifically-based guidelines as the platform for interventions
- Use a multi-component (nutrition and physical activity) approach
- Implement interventions at multiple levels (county, cite/local and setting)
- Implement interventions in the settings where people live, learn, work and play
- Consider SES, ethnic, gender differences and how to reach all groups /impact of intervention on different groups, particularly high risk groups.
- Use supportive interventions such as social marketing/media campaigns alongside other interventions to raise awareness and educate the public about healthy eating and physical activity. This includes awareness-raising and education about guidelines.
- Tailor interventions to policy and organisational contexts
- Develop evaluation plans early in the process and ensure data will be available to assess outcomes and impact

literature cited in the sections above and searches specific to the design of obesity-prevention interventions, the review team identified a number of factors that should be considered when developing a strategic plan for improving nutrition and physical activity and designing the ideal intervention. A summary of the factors identified are provided in the summary box below and are explained in further detail in the sections that follow. Where applicable, the review also identified how the ideal PSE intervention could be designed by intervention types and setting. On the basis of all the information identified in this review, Figure 3 provides a diagrammatic representation of the 'ideal' intervention.

3.4.1 Involve multiple stakeholder groups in the planning and design of interventions and understand their priorities and opinions

In general, partnerships between a wide range of public and private actors are important (Kuipers 2010) and ethical and transparent public health commitments are required from all sectors to ensure the successful reduction of obesity prevalence. This might be in the form of governments incentivising businesses to nudge consumers towards healthier options, or working with industry to lower the prices of healthier options i.e. making it easier for people to change their consumption habits. Working with retailers to improve consumer access to fruit and vegetables, creating and/or strengthening partnerships between farms and retail outlets and creating and/or strengthening local actions to

support agricultural production were also identified as effective collaborative interventions to support healthier diets (INPES 2005). However, as discussed above, more research is needed to determine the most effective ways to engage with private partners.

Results from a European Commission-funded study called PorGrow, which interviewed a wide range of stakeholders³⁰ about their views on different policy options for tackling obesity (Lobstein & Millstone opt. cited) found that a broad range of stakeholders support for a policy intervention is needed. The study also notes that stakeholders must recognise the need for action and accept the costs of interventions for policies to be developed/enacted. However, most stakeholders require a justification of the wider health and social benefits of “upstream” policy interventions such as marketing controls, fiscal measures and changing planning and transport policies.

In particular, Kuipers (2010) notes the importance of ensuring the co-production of policies and interventions with beneficiaries throughout the development, implementation and evaluation stages. Numerous other studies cited earlier in this report also speak to the importance of engaging stakeholders early in the planning and design of PSE interventions.

3.4.2 Use scientifically-based guidelines as the platform for interventions

The WHO (2010, op.cit.) study from the grey literature emphasised that scientifically-informed recommendations on physical activity (for children, adolescent, adults and older people) are essential for planning among policy makers. In particular, guidelines should highlight the benefits, type, amount, frequency, intensity, duration and total amount of physical activity necessary. The authors state that the development and publication of science-based national or regional physical activity guidelines can:

1. Inform national physical activity policies and other public health interventions;
2. Provide the starting point to the establishment of goals and objectives for physical activity promotion at national level
3. Foster intersectoral collaboration and contribute to setting up national goals and objectives regarding physical activity promotion
4. Provide a foundation for physical activity promotion initiatives
5. Justify the allocation of resources to physical activity promotion interventions
6. Create a framework for joint action for all other relevant stakeholders around the same goal
7. Provide an evidence-based document that enables all relevant stakeholders to transfer policy into action with the allocation of the appropriate resources
8. Facilitate national surveillance and monitoring mechanisms to monitor population levels of physical activity

A policy paper from Age Platform Europe (AGE) (2006) also stresses the need to have nutrition guidelines targeting both children and older people and the necessity to reach vulnerable groups in the society. The policy recommendations are directed at EU institutions but also other policy makers and actors involved in improving the nutritional behaviours of the population. A coordinated approach using dietary guidelines as the foundation is suggested including:

1. Awareness campaigns for schools, parents and older people on healthy diets and nutritional needs

³⁰ The project interviewed food producers, manufacturers and retailers, advertisers and caterers, life insurers, pharmaceutical companies, teachers, sport and physical activity organisations, public health experts, town planners, advocacy organisations and consumer groups across nine countries (Cyprus, Finland, France, Greece, Hungary, Italy, Poland, Spain and the UK.).

2. Communication campaigns, using different dissemination channels, targeting the most vulnerable groups of society, adjusting them to the needs, literacy, culture and eating habits
3. Involving the communities and target groups at which the campaigns are directed, in order to allow individuals to digest, have ownership of information and act accordingly;
4. Providing education on food labels, in schools, day-care centres, canteen hospitals, older people nursing homes, and in any food and beverages establishment
5. Involving healthcare professionals (especially GPs), but also social and family carers in the communication and dissemination of nutrition guidelines. GPs should include regular check-ups on diets and physical activity, especially for older people
6. Communicating dietary guidelines to consumers in a simple, understandable and interactive way
7. Adopting a multi-stakeholder approach to nutrition, involving institutions, national governments, food manufacturers, experts, regulatory bodies, insurers and public services.

Nevertheless, the UK Department of Health (2011, op. cit.) stresses that guidelines alone cannot change people behaviours. It therefore underlines the importance of accompanying guidelines with concerted and committed actions that create environments and conditions that make it easier for people to be more active and less sedentary.

3.4.3 Use a multi-behaviour (nutrition and physical activity) approach

As noted in the findings from the first review question, multi-behaviour interventions that tackle both nutrition and physical activity have demonstrated effectiveness and are considered an evidence-based approach for obesity prevention.

3.4.4 Implement interventions at multiple levels (country, city/local and setting)

Again, as noted in the findings from the first review question, no single policy or intervention is effective: multiple complementary policies and interventions are required that cover the individual, community, environment and societal levels (Inchley et al. 2016; Branca et al. 2007). Other references (Senat 2005; Woynarowska 2011; INPES 2015; and DESTATIS 2015) also emphasise the importance of multi-layered interventions or groups of interventions to maximise effectiveness, for example using a combination of national policy interventions (top-down) combined with local efforts by public/private actors (bottom-up), and targeting individuals, higher risk groups *and* whole populations.

3.4.5 Implement interventions in the settings where people live, learn, work and play.

As highlighted in question one, interventions and policies should be implemented across a wide range of settings. For example, Wang et al. (2015) identified 139 studies focused on childhood obesity prevention programmes conducted in high-income countries, most of which were school-based and conducted in the U.S. The study includes articles examining school based interventions on their own as well as articles with a school and home component, a school and community component, a school, home and community component, a school and consumer health informatics component and school, home and consumer informatics components. The authors concluded that a greater proportion of multi-setting studies had significant and positive impact on BMI-related outcomes (e.g. overweight, obesity, adiposity, BMI z-scores, skin-fold thickness), compared with single-setting interventions.

3.4.6 Consider SES, ethnic, gender differences and how to reach all groups /impact of intervention on different groups, particularly high risk groups.

As discussed in the second research question, the effectiveness of an intervention can be affected by the demographics of the intervention group. These findings illustrate the importance of designing interventions tailored to the target audience and ensuring populations with the greatest risk of obesity have been identified.

3.4.7 Use supportive interventions such as social marketing/media campaigns to raise awareness and educate the public about healthy eating and physical activity.

Brambila-Macias et al. (2011), summarised previous systematic reviews, academic papers, and institutional reports that evaluated the effectiveness of policy interventions. The authors reviewed studies and literature that focused on Europe and other developed countries, and the analysis included reviews carried out by the EU HOPE project and the Organisation for Economic Co-operation and Development (OECD), in addition to relevant articles published in 2009 and 2010. They found that multiple EU and other developed countries outside of the EU have implemented social marketing campaigns to improve diets by educating the public about dietary guidelines. One example is the UK's "5 A Day campaign". These campaigns aim to increase awareness of dietary guidelines and the health benefits of fruit and vegetable consumption. Reviews of these types of interventions show that they can increase consumption of fruit and vegetables; however, the authors note that social marketing requires a long period of time to achieve attitude and behavioural changes and impacts on weight outcomes.

Gortmaker et al., (2011) also note that media and marketing campaigns can be used to support the policy change efforts and interventions. The author's note these marketing efforts can include being sure that:

1. National guidelines for individuals on healthy eating and physical activity are available, communicated and regularly updated
2. National targets for the food industry on food composition, marketing to children, and food claims are established and communicated
3. Effective social marketing communications provide consistent messages that motivate individuals to adopt healthy lifestyles and create healthy environments for others, especially children

Several of the studies included in the findings under the first research question also speak to the importance of using education and/or campaigns along with policy or environmental change.

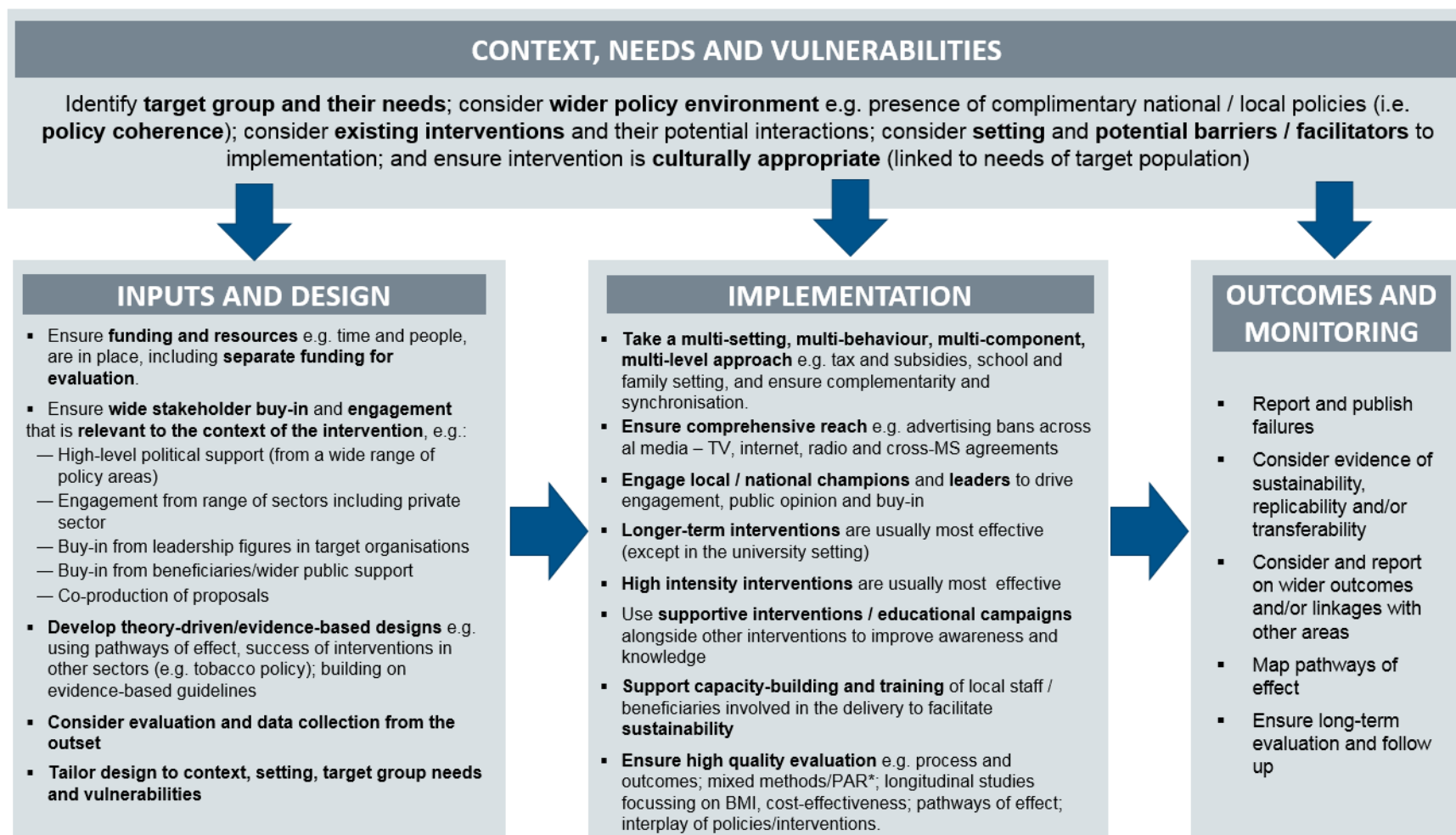
3.4.8 Tailor interventions to policy and organizational contexts

As highlighted in the findings under the second research question, the context of the intervention can affect outcomes. It is therefore important to assess the policy and organisational context of an intervention prior to design and delivery. However, as highlighted above, more information is required regarding how the context, design and delivery of an intervention can affect outcomes.

3.4.9 Develop evaluation plans early in the process and ensure data will be available to assess outcomes and impact

Several of the studies examining lessons learned from school and childcare intervention design and implementation note the importance of thinking about evaluation early. Engaging evaluators during early planning stages can help identify gaps in the implementation plan. Furthermore, it can help ensure data are being collected or are available and can facilitate the team monitor progress (process evaluation) and assess the impact/effectiveness of the intervention.

Figure 3. The ideal intervention



*Participatory Action Research

4 Conclusion

Given the complex and multi-faced nature of obesity, it is clear that no policy or intervention can solve the problem alone. A complementary range of actions that are population-wide, integrated, multi-layered, multi-disciplinary and comprehensive is required. However, identifying the most effective combination of interventions is difficult due to the quality of evidence available: most studies focus on assessing the effectiveness of a single intervention rather than combinations of interventions. More studies are required that focus on identifying and assessing the effectiveness of complimentary groups of interventions.

Further limitations of this field of study relate to evaluation designs and their ability to identify longer-term outcomes, adequately capture wider contextual factors present in real-world scenarios and assess cost-effectiveness. There is a real need to develop new and innovative evaluation designs and methodologies to support the analysis of the effectiveness and efficiency of a broad range of real-world policies and interventions and their longer-term impacts and sustainability.

Considering these limitations, at the core of this review lies a difficult question to be answered by policymakers and academics: what constitutes “sufficient evidence” of effect? At what point does the evidence base become sufficient to recommend a certain approach? In this review, we recommend the implementation of a range of interventions and policies while acknowledging the limitations of the evidence base and the need for further study. In most cases, evidence of short-term behavioural outcomes has led to a recommendation for implementation despite the current lack of conclusive evidence of longer-term outcomes.

The review identified effective policies and interventions at all levels (systems/policy, retail, community, childcare and pre-school, school and university, worksite and healthcare settings).

Systems/policy

At a systems/policy level, CAP reforms combined with other supply chain initiatives, price policies combining taxation of unhealthy foods and subsidisation of healthy foods, trans-fat bans, and wide-reaching and comprehensive marketing bans and restrictions (particularly when combined with other changes to the food environment) were all identified as positively influencing consumption patterns, with some evidence to suggest longer-term impacts on weight gain. Fiscal measures were also identified as being very cost effective and particularly effective for targeting individuals of lower SES.

Mass media campaigns were identified as successfully increasing the awareness of the importance of nutrition and physical activity, and, when combined with environmental changes, may impact behaviour. However, they may be less effective among disadvantaged groups. Further research on the consumer impact of PPPs and the most effective approaches is required, as well further research on the impact of substitution on reformulation interventions, before they can be recommended.

Retail settings

In retail settings, there is strong evidence that nutrition and menu labelling can improve nutritional awareness of consumers. There is some evidence that front-of-pack traffic light labels and the provision of additional contextual information may also drive consumer behaviour, although effectiveness may vary by consumer group. Other retail interventions including promotions in supermarkets, restaurants and cafes, point-of-sale labelling, portion size and product placement can influence dietary behaviour.

Community settings

In community settings, there is strong evidence that neighbourhood design policies and interventions can positively impact physical activity levels. Investment in cycling infrastructure, built environment interventions to increase pedestrian activity, organised participatory programmes to increase walking levels and stair prompts were all identified as effective. There is some evidence that travel/transport-related interventions and pedometer-based interventions may be cost-effective. Among children, multi-level, multi-setting community interventions were identified as most effective for tackling childhood obesity.

Childcare and pre-school settings

A general paucity of evidence was found for the effectiveness of interventions in childcare and pre-school settings. Inconclusive evidence was found for the effectiveness of nutritional interventions. However moderately strong evidence was found supporting the use of physical activity interventions and changing the built environment (e.g. through the provision of play equipment and facilities) for increasing physical activity levels. Multi-component interventions that tackle both nutrition and physical activity were identified as more successful than interventions tackling physical activity or nutrition alone.

School and university settings

A wide range of studies have assessed the effectiveness of school-based interventions. There is strong evidence that increasing the availability of fruit and vegetables can lead to increased consumption, although increases in vegetable consumption were found to be smaller than for fruit. Reducing access to foods high in fats, sugar or salt and/or promoting the consumption of alternative 'healthier' foods was also identified as an effective strategy for improving the dietary quality of school students. .

Offering physical activity breaks to children throughout the day, encouraging active travel and delivering after-school physical activity programmes were all identified as increasing physical activity levels among children. However, multi-level, multi-component programmes combining both nutrition and physical activity aspects were identified as particularly successful for driving behavioural change.

Universities provide an effective setting for implementing nutritional and physical activity interventions, particularly course-embedded interventions and those that target student self-efficacy. However more studies outside of the US are required to validate existing findings. More studies are also required that focus on the impact of nutrition or physical activity interventions on attrition, retention and academic performance.

Workplace settings

Whole-workplace interventions that target the entire office or company were identified as effective in improving physical activity levels. However not enough evidence was identified to support the effectiveness of whole-workplace interventions in improving dietary behaviour. Worksite health promotion interventions with an environmental change component have demonstrated small but positive effects on dietary behaviour (e.g. changing the availability of fruit and vegetables). Environmental change approaches such as the introduction of ergonomic workstations were identified as being effective in reducing sedentary behaviour. Similarly to educational settings, multi-behaviour interventions were identified as more effective than single behaviour interventions.

Healthcare settings

Despite the presence of a number of studies looking at the effectiveness of primary care interventions for clinical groups, there is limited information on the use of primary care interventions as a way of preventing overweight and obesity in general population groups. There is some evidence that primary care providers could play an important role in preventing childhood obesity and, among adults, there is evidence

for the effectiveness of primary care counselling in improving physical activity levels and dietary behaviour. However, given its growing importance, more evidence is required on the role of technology in primary care obesity intervention. Further research is also required on the effectiveness of social prescribing interventions and interventions in secondary care.

The context and design of interventions

The setting of an intervention and the target/intervention group can impact effectiveness. For example, the presence of other complimentary or overlapping interventions in a setting can positively or negatively impact effectiveness. Varying organisational structures, levels of buy-in from senior staff and other stakeholders and, within a school setting, time in the curriculum and for staff training, can also impact intervention outcomes. Focussing on the target population, there is some evidence that the gender, age and SES of individuals or groups receiving an intervention may impact on intervention effectiveness, but more research is required.

Several general design aspects of interventions have been linked to their increased effectiveness including: ensuring the complementarity of different components; developing strong stakeholder partnerships; including participants in planning; upskilling existing staff to support with implementation; using theory-based components of interventions; and tailoring interventions for a specific target group or context.

Key elements of effective interventions

For each setting, the literature highlighted several important elements of successful interventions. These include: ensuring the consideration of the broader impacts of interventions or policies; combining interventions with other complimentary policies or interventions; considering the proportional effect on disadvantaged groups; ensuring interventions are wide-reaching and comprehensive; implementing mandatory rather than voluntary initiatives; developing effective partnerships; implementing interventions across multiple levels and settings; adapting interventions to different administrative or policy contexts; and determining the most effective duration and intensity for an intervention.

The ideal intervention

The final question in this review focussed on designing an "ideal intervention". Given the diverse nature of interventions, the review identified several general factors or a high-level 'tool-kit' that can be used by stakeholders when designing a policy or intervention. Key factors to consider include:

- the wider context of the intervention and the needs and vulnerabilities of the target group;
- the inputs available in terms of sufficient resources, funding and buy-in and a strong intervention design;
- aspects of implementation covering the mix of components, intervention reach, duration and intensity, and the mix of complimentary activities; and
- ensuring high quality evaluation is considered from the outset to facilitate the collection of comprehensive evidence of impact and sustainability.

Annex 1 Peer reviewed literature review methodology

This sub-section describes the approach taken between March 2016 and January 2018 to gather and synthesise the evidence.

A1.1 Research questions for this review

In this comprehensive review, current literature was gathered and synthesised to address objective A2. This literature review provides a review of relevant, recent studies using the methodology presented below to summarise this topic. While the methods to conduct this comprehensive literature review are systematic it is not a systematic review. Note that unlike a systematic review, this review does not systematically analyse literature to identify *all* relevant published data and/or appraise its quality.

To explore the topic objective A2, the literature review was conducted around the following agreed upon questions.

1. What policies/interventions are more effective and efficient in this area (information, advertising, taxation, reformulation, regulations, partnerships, etc.)?
 - a) Systems/policy
 - b) Retail settings
 - c) Community settings
 - d) Childcare settings
 - e) School settings
 - f) Worksite settings
 - g) Healthcare settings
2. How do differences in the context and design of interventions lead to differences in outcome?
3. What are the key elements of effective and efficient interventions?
4. How would the ideal intervention be designed?

The methodology for the peer-reviewed literature is described in brief below, with greater detail on search terms provided in other Annexes.

A1.2 Peer-Reviewed Literature

Methods to conduct the literature review consisted of five steps: (1) refining the research questions, (2) developing a search approach and databases, (3) conducting literature searches (Stage 1 below), (4) screening articles for inclusion (Stage 2 below); and (5) abstracting and synthesizing relevant data (Stage 3 below).

In step 1, in partnership with DG SANTE the research questions above were confirmed. In step 2, the 3 stage approach noted below and databases were confirmed. To minimise bias, the literature search approach included identification of a priori search parameters (also considered first level inclusion and exclusion criteria) to guide searches and inform screening and selection processes for data inclusion. Steps 3, 4 and 5 followed the process below:

1. Conduct searches and document results (Stage 1)
2. Screening search results (title and abstract) for relevance (Stage 2)
3. Review full publication and abstract key characteristics and study findings (Stage 3)

Searches were conducted in multiple databases and screened following the procedures below.

Following the literature review pilot, it was agreed to merge Stages 1 and 2.

A1.3 Stage 1: Conduct Searches and Document Results

In Stage 1, searches were conducted using search terms and criteria agreed with DG SANTE, with filters set for databases to ensure accurate inclusion and exclusion of literature, as shown in tables below. The search terms used were specific to each of the first 3 research questions. Literature searches were conducted in PubMed, EBSCO (CINAHL, ERIC, PsycInfo) and Embase. Searches included publications with all availability types (i.e. free full text and pay/subscription access).

Table 1. Inclusion and Exclusion Criteria Applied at Stage 1

Set Database Filter to Include:	Set Database filters to exclude:
Published between 1/1/2005-5/31/2016 ³¹	Articles published before 1/1/2005
Peer-reviewed scientific publications	Editorial comments/commentaries
Original research	Dissertations
Systematic reviews	Theses
Meta-analyses	Opinion articles
Article published in English, French, German, Italian Polish and/or Spanish	Article not published in English, French, German, Italian Polish and/or Spanish

In addition to reviewing studies in databases noted above, in order to help ensure inclusion of high quality literature (e.g., literature having gone through more formal quality assessments) systematic reviews and meta-analyses were reviewed for inclusion in the literature review. Searches for systematic reviews were conducted in Cochrane Review and healthvidence.org.

As noted a separate search was carried out for the first three research questions, resulting in 3 groups of publications for screening for A2. After the searches, the results were reviewed to ensure they accurately met search parameters and duplicates were removed for screening in Stage 2.

A1.4 Stage 2: Screening search results (title and abstract) for relevance

At stage 2, two screening levels were used: level 1 quality check and level 2 screening. Stage 2 screenings were done simultaneously. These screening inclusion and exclusion criteria are shown below.

A1.4.1 Stage 2 Level 1 Initial Screening (Quality check)

Search hits from all databases searched in Stage 1 were grouped by the three research questions and search terms to which they were related. Duplicate hits were deleted, and search hits by research question were organised from the most recent publications in 2016 going back in time to 2005, saved in an Excel file for that specific research question, and provided to reviewers for screening. These date parameters were agreed with DG SANTE as part of the pragmatic approach to managing the review material.

Using screening criteria in Table 2 reviewers screened the title and abstract of up to the first 200 hits per research question in each Excel file to identify literature to move

³¹ During screening, publications prior to 2005, and publications such as commentaries, dissertations or editorials were screened out, as were publications focusing on animals (rather than humans). Also note that ad hoc searches conducted post screening to supplement screened literature could have include literature post 2016.

forward for review. This was done to ensure the screening process was manageable given project timelines yet captured the most recent and relevant literature.³²

A1.4.2 Stage 2 Level 2 Subsequent Screening

Simultaneous with the Level 1 initial screening check, more detailed overall inclusion and exclusion criteria were applied by the reviewers to the title and abstract to screen publications. These criteria, which were used for reviews of all objectives, are shown in Table 3 below under Level 2.

Table 2. Stage 2 Inclusion/Exclusion Criteria: Levels 1 and 2 Screening

Stage 2 – Level 1		
Category	Inclusion Criteria	Exclusion Criteria
Date	Published between 1/1/2005-5/31/2016 ³³	Articles published before 1/1/2005
Publication Type	Peer-reviewed scientific publications Original research Systematic reviews Meta-analyses	Editorial comments/commentaries Dissertations Theses Opinion articles Non-academic journal
Language	Article published in English, French, German, Italian Polish and/or Spanish	Articles in all other languages

Table 3. Overall screening criteria for stage 2

Stage 2 – Level 2		
Category	Inclusion Criteria	Exclusion Criteria
Geography	Studies conducted in America, Australia, Canada, European Countries, Great Britain, Mexico or Brazil	Studies in all other countries
Human subject	Human-focused research	Animal-focused research
Behaviour/ Outcome	Studies specific to how an environmental or policy intervention affects healthy eating or physical activity OR Studies specific to an outcome of interest overweight/obesity in relation to an environmental or policy intervention	Studies specific to individual-level interventions Studies specific to an outcome that was not related to healthy eating, physical activity, or obesity/being overweight (e.g. improved cognitive function) Specific to methods for

³² Results for each research question were screened separately, however, as screening took place, team members considered if articles might be relevant to other research questions, and if so, coded the article as such.

³³ During screening, publications prior to 2005, and publications such as commentaries, dissertations or editorials were screened out, as were publications focusing on animals (rather than humans). Also note that ad hoc searches conducted post screening to supplement screened literature could have include literature post 2016.

Stage 2 – Level 2		
		assessing outcomes (e.g. reliability and/or validity of overweight/obesity measures) or whose goal is to improve methodology.
Population	Studies where the population of focus includes children, adults or older adults in the general population	Studies where the population of focus is a narrow population such as critically ill, hospitalized patients, people with a chronic condition or terminal illness, those incarcerated, etc.
Measure	Studies that examine the association of behavior with weight status or BMI	Studies that examine the association of behavior with metabolic indicators (adiponectin, ghrelin, LDL, etc.), environment or genetics

From 1,008 publications screened in stage 2, 75 publications were deemed of potential relevance, coded as “Include” and selected for full article review after stage 2 screening.

A1.4.3 Stage 3: Full Article Review and Synthesis

75 publications were exported for review of full text in this A2 literature review. After reading the full text, if the article was still deemed relevant for inclusion (based on consideration of the objective and if the article helped answer research questions), it was saved for use and reference in the bibliography. Following reading articles full text in this stage, 55 publications were selected for inclusion.

At each stage in this process, the team met to discuss successful strategies, challenges, and recommendations to improve the literature review processes. Note that although this is a comprehensive literature review and does not include a formal quality assessment process commonly conducted in systematic reviews, the team documented study designs (e.g., cross sectional, experimental) and the articles were checked by reviewers for signs of bias and poor quality research design. Further, the lead reviewer for each objective area conducted blind quality assurance checks for up to 10% of the coded articles. Any disagreements were discussed as a group and resolved with the review task lead.

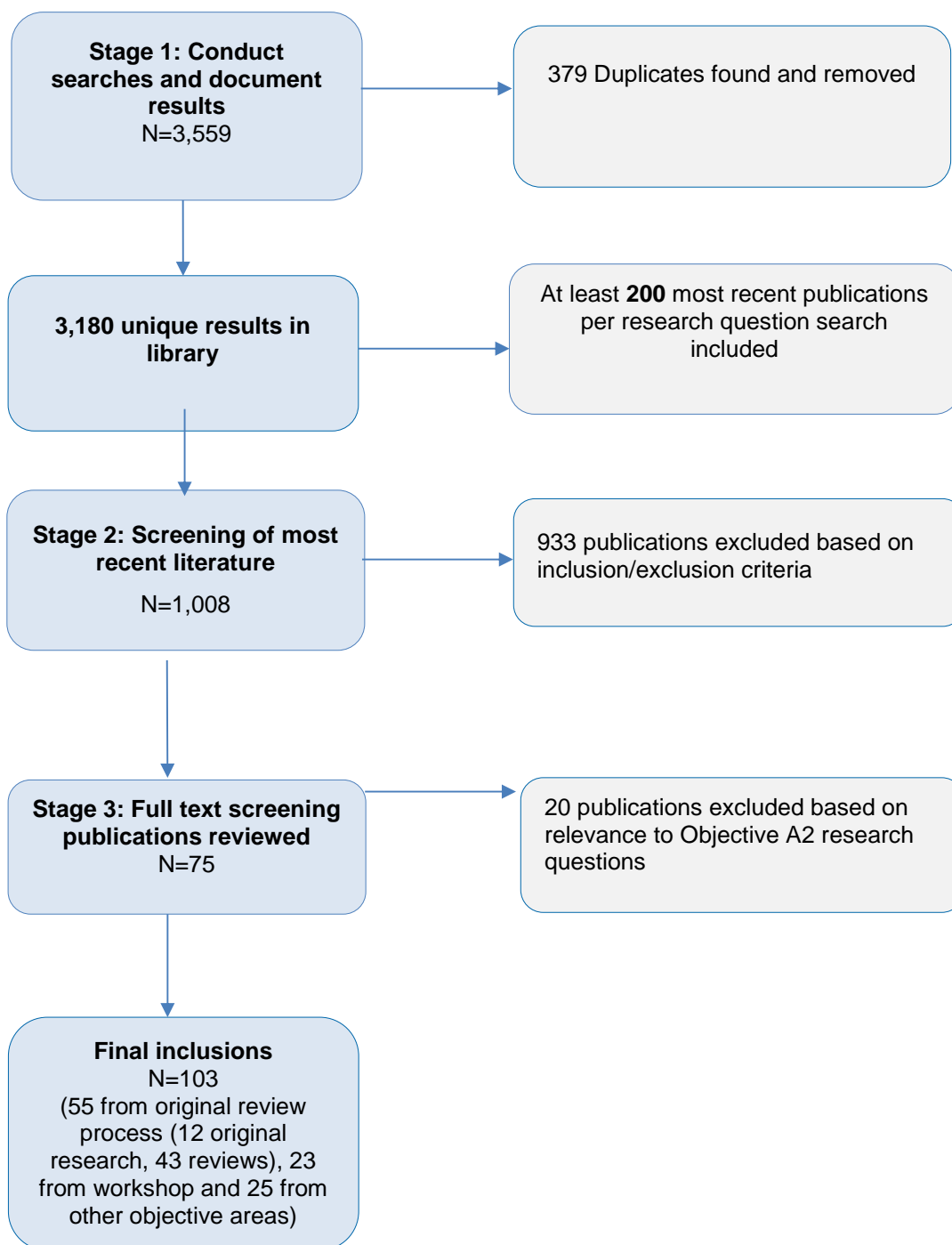
A1.4.4 External expert reviews and input and inclusion of references from other objective areas

Upon completion of the draft set of comprehensive literature reviews, subsequent to review by DG SANTE and the Joint Research Centre (JRC), expert workshops were organised to discuss findings, highlight additional relevant sources to fill gaps and improve the series of reviews. Experts were carefully selected from academic and policy-making fields, based on expertise of the specific topics addressed. As a result of this exercise, 23 additional references were screened and incorporated into these reviews.

Finally, peer reviewed literature identified in other objective areas, where relevant to A2 was drawn across and added into this review. A total of 25 peer review references were incorporated into A2 from other objective areas.

The diagram in Figure 4 below shows the number of articles identified in peer-reviewed literature searches, and the filtering out of literature at successive stages to arrive at the final number of 103 publications whose full text was reviewed and summarised for this review. The diagram also includes additional relevant references proposed by external experts, and incorporated into this final comprehensive review.

Figure 4. Diagram showing number of included and excluded publications at each stage – peer reviewed literature



As shown in Figure 4, a total of 3,559 search hits were retrieved. A total of 379 duplicates were found and removed from the search hits resulting in 3,180 search results as data for A2. From the 3,180 articles, the team screened 1,008 of the most recent titles and abstracts. From the 1,008 most recent titles and abstracts screened 75 were deemed of potential relevance and reviewed as full texts. From the 75 deemed relevant and reviewed as full texts, 55³⁴ publications were selected for inclusion in this final review. Search terms for the research questions are shown in Annex 2. 23 references were added following feedback from the expert workshop and 25 references were included from other objective areas bringing the total number of peer references used for A2 to 103.

³⁴ The full list of references included from the peer-reviewed literature can be found in Annex 3 and includes five publications recommend by the external expert review panel and carried over from other objective areas.

Annex 2 Search terms

Objective A2 Search Terms: Effect of policy interventions on diet and physical activity

RQ1: What policies are effective and efficient?

Primary Term		Combined with:	
Body Mass Index	[mh]	Policy	[tiab]
Obesity	[mh]	policies	[tiab]
Sweetening-Agents	[mh]	Legislation	[tiab]
Body-Mass-Index	[tiab]	Tax	[tiab]
Fitness	[tiab]	Taxes	[tiab]
Food-access	[tiab]	Regulation*	[tiab]
Food-retail	[tiab]	Television-advertising	[tiab]
Fruit*	[tiab]	Marketing	[tiab]
High-Fructose-Corn-Syrup	[tiab]	Reformulation	[tiab]
Junk food	[tiab]	Zoning	[tiab]
Obese	[tiab]	Subsidies	[tiab]
Obesity	[tiab]	Subsidy	[tiab]
Physical-activity	[tiab]	Nutrition-Policy	[Mh]
Physical-education	[tiab]		
Physical-inactivity	[tiab]		
Saturated-fat*	[tiab]		
Soda	[tiab]		
Sugar	[tiab]		
Trans-fat*	[tiab]		
Vegetable*	[tiab]		

RQ2: What interventions are effective and efficient, and what are their key elements?

Primary Term		Combined with:	
Body Mass Index	[mh]	Intervention*	[tiab]
Obesity	[mh]	environmental-change	[tiab]
Sweetening-Agents	[mh]	Policy	[tiab]
Body-Mass-Index	[tiab]	policies	[tiab]
Fitness	[tiab]	Legislation	[tiab]
Food-access	[tiab]	Tax	[tiab]
Food-retail	[tiab]	Taxes	[tiab]
Fruit*	[tiab]	Regulation*	[tiab]

High-Fructose-Corn-Syrup	[tiab]		Television-advertising	[tiab]
Junk food	[tiab]		Marketing	[tiab]
Obese	[tiab]		Reformulation	[tiab]
Obesity	[tiab]		Zoning	[tiab]
Physical-activity	[tiab]		Subsidies	[tiab]
Physical-education	[tiab]		Subsidy	[tiab]
Physical-inactivity	[tiab]		Nutrition-Policy	[Mh]
Saturated-fat*	[tiab]			
Soda	[tiab]			
Sugar	[tiab]			
Trans-fat*	[tiab]			
Vegetable*	[tiab]			

RQ3: How do differences in the context and design of interventions and policies lead to different outcomes and health impacts?

Primary Term

Combined with:

Body Mass Index	[mh]		Intervention	[tiab]
Obesity	[mh]		Environmental-change	[tiab]
Sweetening-Agents	[mh]			
Body-Mass-Index	[tiab]			
Fitness	[tiab]			
Food-access	[tiab]			
Food-retail	[tiab]			
Fruit*	[tiab]			
High-Fructose-Corn-Syrup	[tiab]			
Junk food	[tiab]			
Obese	[tiab]			
Obesity	[tiab]			
Physical-activity	[tiab]			
Physical-education	[tiab]			
Physical-inactivity	[tiab]			
Saturated-fat*	[tiab]			
Soda	[tiab]			
Sugar	[tiab]			

Trans-fat*	[tiab]	
Vegetable*	[tiab]	

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Annex 4 Grey literature review

This sub-section describes the approach taken between March 2016 and January 2018 to gather and synthesise the evidence.

A4.1 Detailed search and review methodology

The review followed a process with four main stages:

- Searching for publications using set keywords and databases;
- Screening of search results and exclusion of irrelevant literature;
- Extraction and review of remaining documents; and
- External expert reviews and input.

A4.2 Stage 1: Conducting searches and documenting results

A4.2.1 Searching for grey literature

The search terms initially used for objective A2 were agreed upon in the inception phase (Table 4). The main key words were either specific to the objective or broader thematic terms. A second list of search terms was also used – these combination words were used to guide the search and produce the most relevant results.

Table 4. Search terms used for objective A2 grey literature review

Suggested Search Parameters	
Parameters	
Grey literature	
Published in English, French, German, Italian, Polish and/or Spanish	
Date range (1995 – 2017)	
Key Words and Suggested Combinations of Search Terms	
Key Words	Combined With
Nutrition	Prevention programmes/programs
Physical activity	Preventative programmes
Exercise	Prevention policies
Active living	Prevention interventions
Health outcomes	Preventative interventions
School nutrition policy	Policy interventions
School physical activity policy	Behavioural interventions
School physical education policy	Evaluation
Child care (or early care) nutrition policy	Policy evaluations
Child care (or early care) physical activity policy	Socio-economic terms: living conditions, employment, poverty, low income
Food advertising restriction	Scientific base
Fast food zoning	Leadership
	Hierarchy support
	Stakeholder engagement
	User participation

Cross-sectoral/horizontal approach
Budget
Sustainability
Multi-year planning
Member States (of the EU) / Country (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom)

A4.2.2 Using set key words in databases, search engines and websites

In order to appropriately link and define the relationship between the key and combination search terms, the Boolean operators 'AND', 'NOT' and 'OR' were used in the search engines. In particular, the use of 'AND' helped to narrow the number of hits to ensure that only documents which included all the search terms showed up. Further, if a search led to a high number of irrelevant hits, a repeat search was conducted and key words which were separated by spaces or other characters (e.g. Health impacts) were enclosed in quotation marks (e.g. "health impacts") to return only those documents that matched the search terms exactly.

The set key words and combination words were used to generate results in databases, search engines and websites recommend by the pilot review:

- Search Europa
- European Sources
- Eurostat
- NICE
- Open grey
- WHO websites

Search Europa and NICE Evidence Database yielded the most results for objective A2.

The grey literature review was a dynamic and fluid process. After the initial searches and extraction of sources, hand searching on Google was used to produce specifically relevant results. This is described further in the section below.

A4.2.3 Additional hand searching

As per the recommendation made in the pilot review, hand searching was also used to supplement the key word searches. Hand searching involved extending the basic key word searches by using additional, contextual information. For example, in objective A2, phrases such as "policy evaluations of nutrition interventions" were used to generate the most applicable results. This process ensured that highly-focused and relevant search results were generated for the original key words, in this case, "policy evaluation" and "nutrition". All hand searches for this objective were completed on Google.

A4.3 Stage 2: Screen Search Results for Relevance

Most databases, search engines and websites offered the use of a relevancy filter³⁵ which automatically sorts results in order of their applicability to the key terms in the search engine. When a relevancy filter was not available, the links were manually screened by the appearance of the key search terms in the title of the source and the abstract (where available). For database and search engines, initially the top 50 most relevant search results were looked at per search string. If there were less than 50 results, all were looked at. The titles and abstracts were then examined for key search terms in the grey literature and relevance to the research questions.

Extra hand searching was conducted when search strings did not produce enough relevant information, and/or, when the top 50 results did not produce the most relevant literature. Hand searching involved extending the basic key word searches by using additional, contextual information.

Following the expert workshop (see stage 5 below), experts recommend further sources which were reviewed in the final redraft of the review.

Overall 172 results from the searching for objective A2 were saved into a library.

A4.4 Stage 3: Screen results against inclusion/exclusion criteria, quality and relevance

Results were then screened against agreed inclusion and exclusion criteria detailed in Table 5 below.

Table 5. Grey literature inclusion and exclusion criteria

Inclusion	Exclusion
Published between 1995-2017	Published or enacted prior to 1995
Government reports from European Commission, European Parliament and EU Member States.	Non-nutrition and physical activity themed/focused
Think tank reports/publications	Industry-produced publications
Academic papers, conference papers and abstracts	Industry-produced project evaluation reports
Bibliographies	Industry-produced good practice reports
Programme evaluation reports ³⁶	Publications focusing on animal nutrition and physical activity
Standard/best practices documents	Blog or personal think thought pieces
Policy initiatives at European and/or national level- run by governments, not-for profit organisations	Newsletters or news articles
Industry funded publications (As	Theses and dissertations (2010 and

³⁵ 'Sorting by relevance' on databases and search engines enables a connection to be established between the information in the database, the search string entered and any search filters chosen. If the keywords appear in a Title or Author field, the system shows these results first in the list of search returns. Less relevant articles e.g. ones where the keyword appears less often or may only appear in the actual content, appear later in the list of search results.

³⁶ For example: Hallsworth M, Ling T. (2007) *The EU platform on diet, physical activity, and health: second monitoring progress report*. Cambridge: RAND Corporation, http://www.rand.org/content/dam/rand/pubs/technical_reports/2008/RAND_TR609.pdf

Inclusion	Exclusion
regards the grey literature reviews, particular care will be exerted in assessing any inclusion of industry-funded literature. These will be justified and discussed with the client).	older)
Primary theme/focus is human nutrition and physical activity	
Publication available via accessible databases	
Published in English, French, German, Italian, Polish and/or Spanish	
Theses and dissertations (post-2010 only)	

Due to the large number of results still returned after this screening the data parameters were further refined to only include those reports published 2005-2017.

Following this criteria screening and exclusion of search results, the remaining results were checked for quality and relevance.

A4.4.1 Exclusion based on quality checklist

The quality check was based on the AACODS checklist (AACODS)³⁷ which included:

- Authority
 - Is the author credible?
- Accuracy
 - Is the document supported by documented and authoritative references?
 - Is there a clearly stated methodology?
 - Is the document representative of work in the field?
- Coverage
 - Have limitations been imposed and are they clearly stated?
- Objectivity
 - Can bias be detected (if so the bias was clearly stated in the extraction form)?
- Date
 - Does the document have a clearly stated date relating to the content?
- Significance
 - Is the document relevant?
 - Would the document enrich the findings?

³⁷ Please see the full outline of the AACODS checklist here: https://dspace.flinders.edu.au/jspui/bitstream/2328/3326/4/AACODS_Checklist.pdf

A4.4.2 Exclusion based on relevance to research questions

The remaining grey literature was examined further so that only results most relevant to the objective were extracted. In particular, each article was examined for text relating to the key terms and questions under the objective. For example, in objective A2, the text was examined for reference to the research question '*What interventions are more efficient and effective in increasing physical activity levels, as well as the consumption of healthier diets?*'.

A4.5 Stage 4: Extraction of full texts and final screening process

A data extraction template in Excel was used to capture the following categories of information: 1) identifying information for each publication, 2) study design characteristics, 3) sample characteristics, 4) intervention characteristics, 5) content (behaviour/outcome) focus, 6) description of results, 7) assessment of rigour/bias and 8) objective specific information. In total 109 results were excluded during this screening process; 64 results were extracted.

After extraction, the review author read through all of the extracted data and a final screening process excluded more results due to quality or a lack of enough relevant information, now made obvious after extraction. Sources were also excluded from the grey literature where this was superseded by either more rigorous peer reviewed research on the same theme, or more recent statistics. In total, 32 results were excluded.

A thematic analysis was applied to the remaining extracted data and their findings synthesised with those of the peer reviewed literature. Any identified bias in sources which passed the inclusion criteria is highlighted in the analysis.

A4.6 Stage 5: External expert reviews and input and addition of references from other objective areas

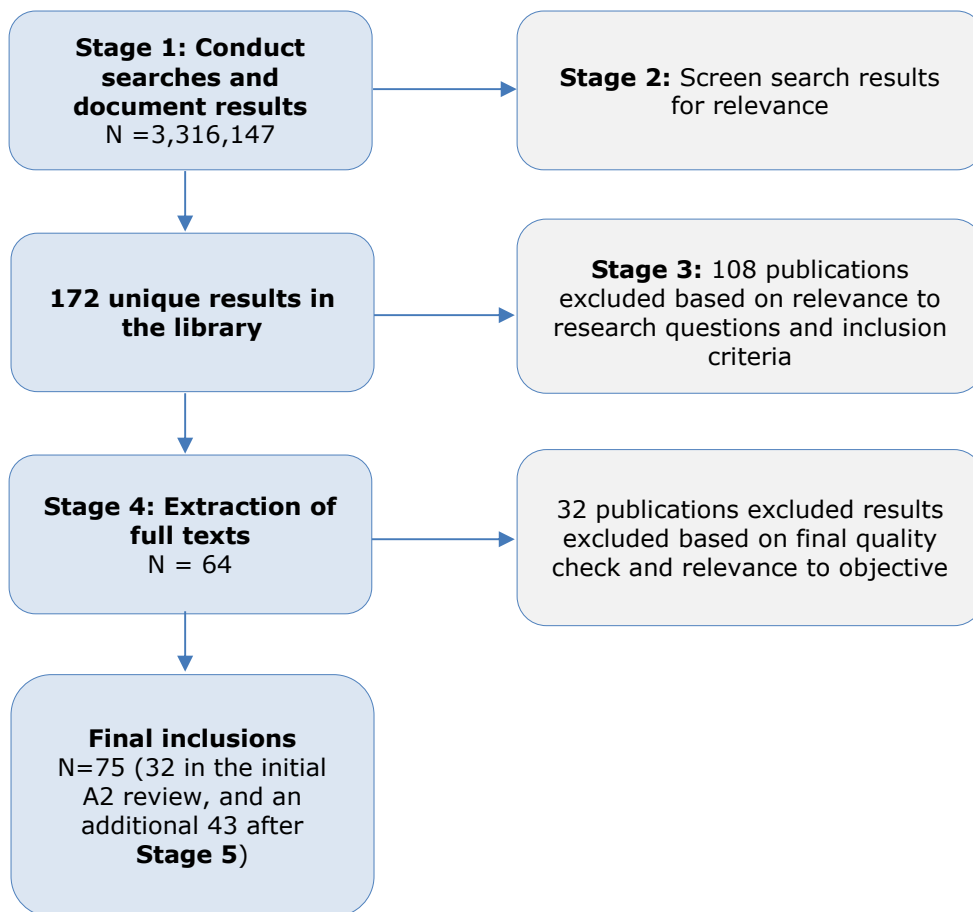
Upon completion of the draft set of comprehensive literature reviews, expert workshops were organised to discuss findings, highlight additional relevant sources to fill gaps and improve the series of reviews. Experts were carefully selected from academic and policy-making fields, based on expertise of the specific topics addressed. No additional grey references were suggested by experts for A2.

Finally, grey literature references identified under the policy questions from other objective areas were drawn across into A2. 43 references were drawn across from other reviews, bringing the total number of references to 75.

A4.7 Number of included and excluded references

The diagram in Figure 5 below shows the number of articles identified in grey literature searches, and the filtering out of literature at successive stages to arrive at the final number of 32 publications whose full text was reviewed and summarised for this review. The diagram also includes additional relevant references proposed by external experts and incorporated into this final comprehensive review and references drawn across from other objective areas.

Figure 5. Diagram showing number of included and excluded grey literature publications at each stage



Annex 5 Bibliography (grey literature)

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