
# Policies and interventions to improve the nutritional intake and physical activity levels of Europeans

Review of Scientific Evidence and Policies on Nutrition and Physical Activity-Objective A2: Effectiveness and Efficiency of Policies and Interventions on Diet and Physical Activity

**Summary Report**

Written by ICF Consulting Services Ltd

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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 the full literature review documents.

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.

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

This review presents the scientific evidence on effective and efficient obesity prevention policies and interventions that focus on improving the nutritional intake and physical activity levels of Europeans.

## 1.1 Scope of this review

While the review recognizes 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 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 used.

The review fully acknowledges the complexity of the causes of obesity and therefore the complexity of solutions to the issue: 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, particularly across different settings. This should be kept in mind when reading the review as many interventions may be ineffective alone but become highly effective when combined with certain other interventions. 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.

The review found an overall paucity of studies looking at the long-term outcomes and impacts of policies and interventions and evaluating the cost effectiveness 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). Evaluation difficulties and limitations also raise a number of questions regarding what constitutes "sufficient evidence" of effect. 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.

The following definitions have been used throughout the review:

- **Effectiveness** refers to the extent to which the desired results of a policy or intervention were achieved[1];
- **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 Centers 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:

[1] Section **Error! Reference source not found.** describes some of the difficulties in defining 'effectiveness' in relation to policies and interventions.

  - 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.
- **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).

## 1.2 Methodology

The review is based mainly on findings from peer reviewed literature which has been discussed first in all cases. Peer reviewed literature findings are followed by grey literature evidence which has been used to support findings, fill any evidence gaps and/or further explain data or trends. A full description of the methodology used for all literature reviews can be found in the original source documents. The review draws on evidence from a total of 103 peer reviewed articles and 75 grey literature references.

## 1.3 Research questions

In the review, we focus on the most current literature (peer-reviewed research and systematic reviews, as well as grey literature) to answer 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?

## What policies and interventions are more effective and efficient in this area?

This question explores the evidence to support the effectiveness of a range of interventions to tackle obesity. These sections start by discussing high-level policies and interventions, followed by community-level interventions, pre-school, school and workplace interventions and finally healthcare interventions.

### Systems/policy level

Governments have generally been more active in attempting to influence dietary behaviour than physical activity levels (McDaid, Sassi and Merkur 2015; PHEIAC 2013). Several policies and interventions targeting different aspects of the food production system have been implemented by governments including Common Agricultural Policy (CAP) reforms, developing public-private partnerships (PPPs) with food producers and retailers, taxation and subsidies and bans and reformulation initiatives. Governments and other stakeholders have also introduced large-scale mass media campaigns to drive population-wide behaviour change.

#### CAP reforms

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). 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

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 may be 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). 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

There is moderately strong evidence that taxes applied to nutritionally unbalanced foods can reduce consumption of these foods (Batis et al. 2016; Niebylski et al. 2014, Escobar et al. 2013; WHO Regional Office for Europe 2015, Tedstone et al. 2015, Loughnane and Murphy 2015, Traill 2013, WHO Regional Office for Europe 2006a). However, most evidence is restricted to experimental and modelling studies rather than real-world policy analysis (Traill 2013). Policy-makers should continue to prioritise evaluations of existing taxation policies to strengthen the evidence base (WHO Regional Office for Europe 2015). There is also an identified link between taxation of nutritionally unbalanced foods and a reduction in weight status, although this relationship appears weaker than the link between taxation and reduced consumption of taxed products (Niebylski et al. 2014; Escobar et al. 2013; Bes-Rastrollo et al. 2016).

There is some evidence that lower SES households may be more affected by the taxation of nutritionally unbalanced foods than higher SES households (Backholer et al. 2016; Batis et al. 2016).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 Regional Office for Europe 2015). However there is grey literature evidence that taxation and price policies may not be popular among stakeholders (Lobstein and Millstone 2006).

The review also identified a small body of literature (peer-reviewed and grey) focussing on price policies for SSB products including alcopops (Escobar et al. 2013; Bes-Rastrollo et al. 2016; Backholer et al. 2016; Tedstone et al. 2015; Sénat 2014; Anderson and Baumberg 2006). The findings largely mirrored the findings for taxation policies more generally.

Grey literature evidence identified taxation policies as being very cost effective (Traill 2013; McDaid, Sassi and Merkur 2015). The cost-effectiveness of such policies is particularly high when the dietary outcomes also have a strong link with preventing cardiovascular disease and cancer.

**Subsidies**

There is strong evidence that healthy food subsidies and financial incentives for products such as fruits and vegetables, low-fat snacks, fruit juice, vegetable soups and low fat milks can increase consumption of these foods (Niebylski et al. 2014; An 2013; 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). In general, the effect of subsides tended to be proportional to the price difference. However no evidence of the impact of subsidies on weight status was identified.

There is also peer reviewed evidence 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 (Niebylski et al. 2014).

**Bans**

This review only identified studies looking at the impact of trans-fat bans on consumption patterns. There is strong evidence that trans-fat bans can reduce the consumption of trans-fats (Downs, Thow and Leeder et al. 2013; WHO 2014) and have a positive impact on other related health outcomes such as a decrease in the mortality rate from cardiovascular disease (Stender, Astrup and Dyerberg 2012). No evidence was identified to assess the impact of trans-fat bans on weight status.

**Reformulation**

There is strong evidence to suggest that the reformulation of products high in calories, salt and sugar is linked with decreased consumption of these dietary components (Gressier et al. 2017; Ma et al. 2016; Puska, 2000, cited in Robertson et al. 2004; WHO 2014; Storcksdieck et al. 2014; Tedstone et al. 2015). However, there is a lack of research on the extent to which reformulation leads to replacement of one unhealthy ingredient with another (Brambila-Macias et al. 2011).

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

Most studies identified in the review focus on the effectiveness of marketing restrictions and bans among children. The term marketing is used broadly 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.

There is moderately strong evidence to support a link between marketing bans and restrictions and the reduced purchasing of nutritionally unbalanced foods (Dhar and Baylis 2011; Sjolin 2006; Traill 2013; Loring and Robertson 2014). Simulation studies suggest that marketing bans and restrictions could have a positive impact on weight and BMI (Veerman et al. 2009; OECD 2010), however more real-world studies are required.

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).

### Mass media campaigns

There is strong evidence to suggest that physical activity mass media campaigns can increase the awareness and attitudes of beneficiaries (Traill 2013; McDaid, Sassi and Merkur 2015) The impact on improving physical activity and healthy eating behaviours is more moderate but still positive (Department of Health 2010; Traill 2013). However, there is some evidence that mass media campaigns may be less effective among disadvantaged groups (Kuipers 2010).

Limited information on cost effectiveness was identified however Mass media campaigns for promoting physical activity were identified as providing excellent value for money (McDaid, Sassi and Merkur 2015).

## Retail settings

This section focusses on the effectiveness of 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

There is strong evidence that nutrition labelling can improve consumers' awareness of healthy food options (Cecchini and Warin 2016; Traill 2013. However mixed evidence was found on its impact on dietary outcomes: knowledge of nutritional information does not always influence consumer choice (Brambila-Macias et al. 2011; Aschemann-Witzel et al., 2013; Borgmeier and Westenhofer 2009; Bailey and Harper 2015; Nordic Council of Ministers, 2014). Nevertheless, limited but suggestive evidence was identified linking food labelling to changes in BMI (Cecchini and Warin 2016; Campos, Doxey and Hammond 2011; OECD 2010).

Front of pack labelling, particularly using colourful traffic light logos were identified as being the most effective form of labelling for conveying nutritional information (Aschemann-Witzel et al. 2013; Borgmeier and Westenhofer 2009; Babio et al. 2014) , and in some cases, driving consumer behaviour (Cecchini and Warin 2016; Engelhard and Garson 2009).

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 by Traill to support the finding.

There is limited evidence of the effectiveness of menu labelling in real-world settings (Sacco et al. 2016). However, there is some evidence that when labelling was combined with the provision of contextual information, it can drive consumer choice (Sinclair,

Cooper and Mansfield 2014; Kiszko et al. 2014). Menu-labelling may also be more effective in certain settings and among specific groups of individuals (Sacco et al. 2016; Sinclair, Cooper and Mansfield 2014; Kiszko et al. 2014).

**Other retail environment interventions**

The review identified the following findings for the effectiveness of other interventions in retail environments:

- Promotions in supermarkets, restaurants and cafes can successfully influence short-term dietary behaviour (Branca, Nikogosian and Lobstein 2007);
- There is strong evidence that point of sale labelling can influence consumer purchasing behaviour (Allan, Johnston and Campbell 2015; Skov et al. 2013);
- 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 (Skov et al 2013; Arno and Thomas 2016); and
- Product placement can be an effective strategy to influence consumer purchasing behaviour, particularly when combined with point-of-purchase labelling (Foster et al. 2014).

## Community settings

The focus of this section is on built-environment changes in the community and specific interventions delivered within a community setting.

There is strong evidence that neighbourhood design policies and interventions can influence physical activity levels (McCormack et al. 2011; Heath et al. 2006). Changing urban environments to ensure a safe environment for exercise were associated with increased physical activity levels (Audrey and Batista-Ferrer 2015; INPES 2015. Focussing on specific activities:

- There is evidence that investments in cycling infrastructure can increase the percentage of individuals cycling (Stewart, Anokye and Pokhrel 2015; McDaid, Sassi and Merkur 2015; C3 Collaborating for Health 2012).
- Built environment interventions can increase pedestrian activity, however this review found no evidence of by how much (C3 Collaborating for Health 2012; Edwards and Tsouros 2006). Organised participatory programmes, such as walking programmes, were also identified as an effective strategy for increasing physical activity levels (McDaid, Sassi and Merkur 2015; Phillips, Knox and Langley 2012).
- Stair prompts can be an effective way of increasing stair use (Soler et al. 2010; Lewis and Eves 2012; Branca, Nikogosian and Lobstein 2007).

Multi-level, multi-setting community interventions were identified as being most effective for tackling childhood obesity (Bemelmans et al. 2011), including childhood obesity among low SES groups (Loring and Robertson 2014; Branca, Nikogosian and Lobstein 2007). Limited information on the cost-effectiveness of community interventions was identified however travel/transport-related interventions and pedometer interventions were found to be cost-effective (McDaid, Sassi and Merkur 2015).

## Childcare and pre-school settings

Very few studies discussing the impact of nutrition and healthy eating interventions in childcare and pre-school settings were identified. The following key findings were reported:

- 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 (Wasilowska-Gregorowicz and Dudek 2016).
- There is moderately strong evidence that physical activity interventions in childcare settings can improve physical activity levels in children (Finch et al. 2016).
- Play equipment and facilities in the built environment can increase levels of physical activity in young children (Gubbels et al. 2012).
- 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. 2014; Zhou et al. 2014).

## School and university settings

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 (Branca, Nikogosian and Lobstein 2007; De Sa and Lock 2007; Ganann et al. 2014; INPES 2005; PHEIAC 2013). However interventions to increase fruit and vegetable availability may be less successful at increasing vegetable consumption (relative to fruit consumption) (Evans et al. 2012) and 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 (Storcksdieck genannt Bonsmann et al. 2014; Levy, Friend and Wang 2011; Sjolin 2006). Furthermore, information and knowledge campaigns and educational interventions in schools have been shown to be effective at improving dietary choices if they are highly interactive and have additional non-financial incentives (Lowe et al. 2006).

Offering physical activity breaks throughout the day (Liao et al. 2014; Barr-Anderson et al. 2011), encouraging active travel to and from school (Chillon et al. 2011; Smith et al. 2015) and providing after-school physical activity programmes (Beets et al. 2009) were identified as effective approaches to increasing physical activity levels.

Overall, the research reviewed suggests that multi-setting, multi-component programmes in schools that combine a focus on both nutrition and physical activity, span across home and school environments, and have an educational component combined with an aspect of environmental change, are particularly effective approaches to driving behaviour change and potentially reducing BMI (Brown et al. 2016; McDaid, Sassi and Merkur 2015; Branca, Nikogosian and Lobstein 2007; Storcksdieck genannt Bonsmann et al. 2014; Lowe et al. 2006). 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 (Plotnikoff et al. 2015). However more studies outside of the US are required to validate existing findings. Looking specifically at nutritional interventions, three peer reviewed primary research studies highlighted the effectiveness of increasing fruit and vegetable availability (Bucher, van der Horst and Siegrist 2011; Burns and Rothman 2015) and of using pre-paid debit cards restricted to healthy food selections (Just et al. 2008, reported in Skov et al. 2013). The review found no studies focussing on the impact of nutrition or physical activity.

## Worksite settings

Workplaces were identified as important settings for promoting better health and wellbeing given their potential to reach large numbers of individuals and, if required, target programmes at specific sub-populations (McDaid, Sassi and Merkur 2015).

Whole workplace interventions that target the entire office or company were found to be effective at improving physical activity levels (McDaid, Sassi and Merkur 2015). 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 (Mhurchu, Aston and Jebb 2010; Allan et al. 2016). Ergonomic workstation interventions that focus on reducing sedentary behaviour and/or promoting physical activity were found to have a positive effect on physical activity levels (Ben-Ner et al. 2014; Carr et al. 2016; Torbeyns et al. 2014), with some evidence that they may also lead to reductions in BMI (Koepp et al. 2013). There is also some evidence to support the effectiveness of point-of-decision prompts or motivational signs placed near stairwells or escalators in increasing stair use (Soler et al. 2010; Bellicha et al. 2015).

Multi-behaviour interventions, combining healthy eating information with activities to increase physical activity in the workplace may be more effective than single behaviour interventions (Thorndike 2011; Branca, Nikogosian and Lobstein 2007). Findings from systematic reviews highlighted longer-term interventions (Mache et al. 2015), high-frequency approaches (Anderson 2009) and taking a more personalised approach to support (György et al. 2015) as being particularly successful. Encouraging small but regular bouts of physical activity (Barr-Anderson et al. 2011; Oortwijn et al. 2011) and implementing group-based interventions with set targets (C3 Collaborating for Health, 2012) were also identified as effective ways to improve physical activity outcomes.

## 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.

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 (Vine et al. 2013). Among adults, there is evidence of the effectiveness of primary care counselling for improving physical activity and nutritional behaviour in adults, however no evidence of its impact on weight status was identified (Lin et al. 2010; Franklin and Vanhecke 2008; Orrow, Kinmonth and Sanderson 2012; McDaid, Sassi and Merkur 2015). Despite its wide promotion in the UK, more evidence on the effectiveness of social prescribing interventions on behavioural and weight changes is required (Bickerdike et al. 2017). A lack of information was also found relating to interventions in secondary healthcare settings.

Grey literature findings suggest that remote health interventions can be effective in increasing physical activity levels and improving dietary behaviour (INPES 2014). The role of technology in obesity interventions will be an important area for future research. Grey literature also reported that primary care interventions could be a cost-effective approach to reducing and preventing adult obesity (OECD 2010; McDaid, Sassi and Merkur 2015).

## How do differences in the context and design of intervention and policies lead to different 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 those using innovative study designs, are required in this area. Nevertheless, the following findings were identified.

The setting of an intervention and the target/intervention group can impact effectiveness. Focussing on setting, the presence of other complimentary or overlapping interventions can positively or negatively impact effectiveness. For example, introducing taxation policies for nutritionally unbalanced foods alongside subsidies for nutritionally balanced foods was found to be more effective than the implementation of taxation policies alone. In childcare settings, organisational structures, levels of buy-in from senior staff and other stakeholders (Neelon et al. 2016; Nonas, Silver and Khan 2014) and, within a school setting, the amount of time in the curriculum and for staff training (Greaney et al. 2014), 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. For example: women were found to be more likely to use menu labelling to inform their food selections than men (Sinclair, Cooper and Mansfield 2014); menu-labelling was found to be more effective when used by children and adolescents than when used by adults (Sacco et al. 2016); and, compared to other groups, the provision of educational information without any other support/interventions was found to be relatively ineffective among lower income groups and may increase socio-economic inequalities (Robertson, Lobstein & Knai 2007).

Several general design aspects of interventions have been linked to their increased effectiveness including: ensuring the complementarity of different components (Mikkelsen et al. 2016); developing strong stakeholder partnerships (Mikkelsen et al. 2016); including participants in planning (Branca et al. 2007); upskilling existing staff to support with implementation; using a theoretical framework for interventions (Finch et al. 2016; Lai et al. 2014) and tailoring interventions for a specific target group (Phillips et al. 2012) or context (de Sa & Lock 2007).

## What are the key elements of effective and efficient interventions?

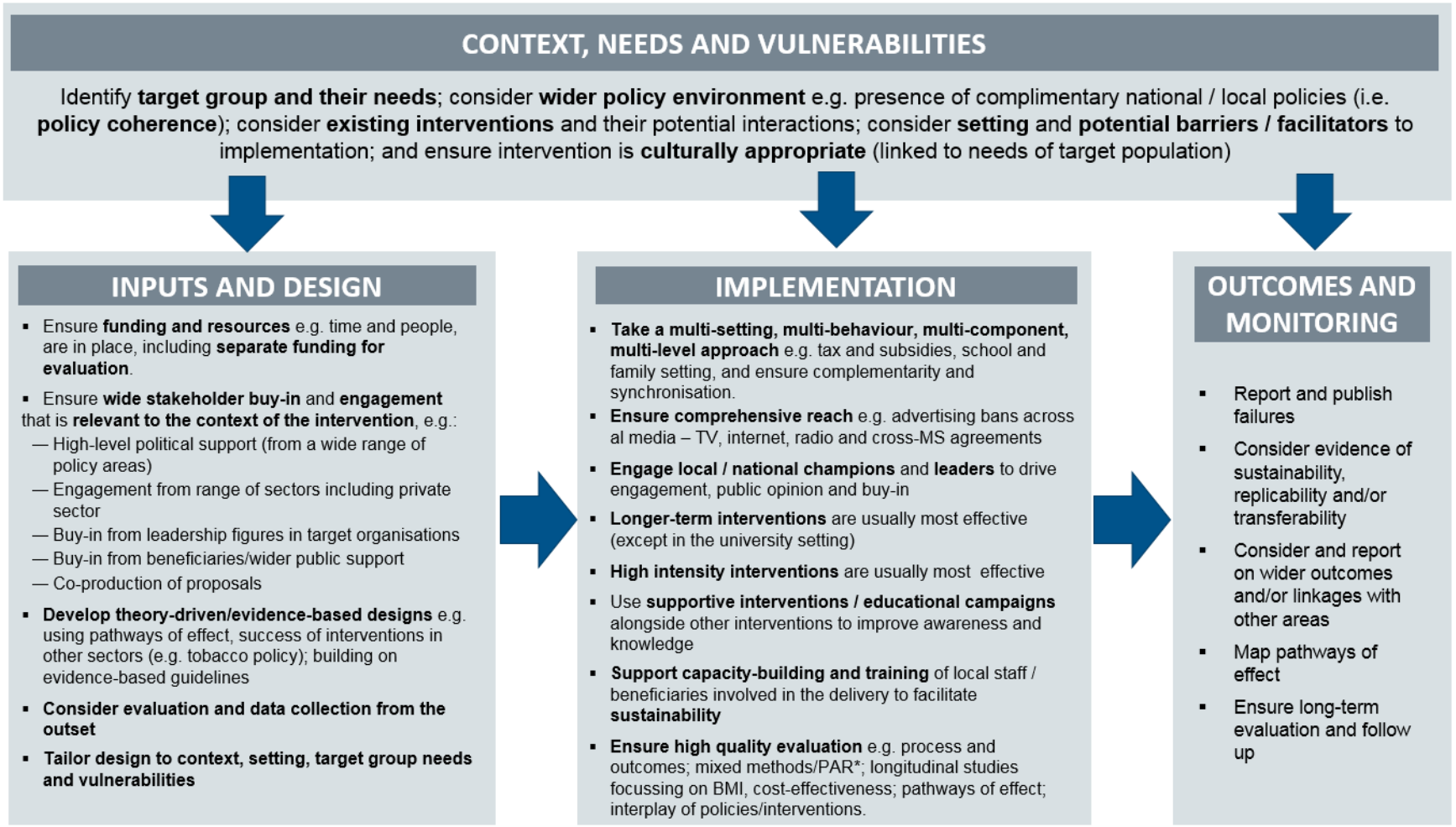
For each setting, the literature highlighted several important elements of successful interventions. This section of the review provides a summary of factors or components of interventions identified as important by the authors of studies referenced in other parts of the review. It should be noted that the elements reported are by no means exhaustive nor have they been critically assessed in order of the most effective. Tables in the main review document provide a more detailed summary of findings, however common key elements identified across settings 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.

## How would the ideal intervention be designed?

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, as highlighted in Figure x below. Findings for this research question have been drawn from the literature identified for other research questions and searches specific to the design of obesity-prevention interventions.

*Figure 1. The ideal intervention*




*Participatory Action Research

## Conclusion

Given the complex and multi-faced nature of obesity, 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. Identifying the most effective interventions and combinations of interventions is difficult given the quality and range of existing evidence: 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, their longer-term impacts on weight status and cost effectiveness.

Nevertheless, this review identified effective policies and interventions at all levels. On the basis of existing evidence, the following policies and interventions are recommended for implementation: CAP reforms; taxation of nutritionally unbalanced foods; subsidisation of nutritionally balanced food; trans-fat bans; product reformulation; comprehensive marketing bans and restrictions; awareness-raising mass media campaigns; nutrition labelling; point of sale retail interventions; neighbourhood design changes; cycling interventions; walking interventions; stair climbing prompts; multi-level, multi-setting community interventions for increasing physical activity among children; physical activity and combined physical activity and nutritional interventions in childcare and pre-school settings; improving the food environment in schools through focussing on one aspect of the diet; creating an active environment in schools; multi-behaviour, multi-component, multi-setting interventions based in schools; short-term behavioural interventions in universities; whole workplace interventions and workplace environmental change interventions.

The review highlighted several examples of where the context and design of interventions impacted their effectiveness, emphasising the need for policy-makers to carefully consider the target audience of any policies or interventions and the wider context, and tailor the design of interventions or policies accordingly.

For each setting, several important elements of successful interventions were identified. 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 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.

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## Annex 3 Glossary

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

*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. | 5. 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 | There are different systems available to measure child or adolescent obesity for different ages.<br>Children under 5 obesity is weight-for-height greater than 3 standard deviations above WHO Child Growth Standards median;<br>Children aged 5-19 overweight is BMI-for-age greater than 2 standard deviation above the WHO | WHO http://www.who.int/mediacentre/factsheets/fs311/en/<br>(Other definitions are available for different national and international systems). |

| Term | Definition | Source |
|---|---|---|
| | Growth Reference median. | |
| Child/adolescent overweight | There are different systems available to measure child or adolescent overweight for different ages.<br><br>Children under 5 overweight is weight-for-height greater than 2 standard deviations above WHO Child Growth Standards median;<br><br>Children aged 5-19 overweight is BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median. | WHO<br><br>http://www.who.int/mediacentre/factsheets/fs311/en/<br><br>(Other definitions are available for different national and international systems). |
| Exercise | 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. | WHO<br><br>(http://www.who.int/dietphysicalactivity/pa/en/) |
| Insufficient physical activity | 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 adults. | WHO<br><br>http://www.who.int/mediacentre/factsheets/fs385/en/ |
| Physical activity | Any bodily movement produced by skeletal muscles that requires energy expenditure. | WHO<br><br>(http://www.who.int/topics/physical_activity/en/) |
| Physical inactivity | A lack of physical activity | WHO<br><br>(http://www.who.int/dietphysicalactivity/pa/en/) |
| Sedentary behaviour | Any waking behaviour characterized by an | Tremblay, M. S., et al. (2017). Sedentary |

| Term | Definition | Source |
|---|---|---|
| | energy expenditure ≤1.5 metabolic equivalents (METs) while in a sitting or reclining posture. | Behavior Research Network (SBRN) – Terminology Consensus Project process and outcome. *The International Journal of Behavioral Nutrition and Physical Activity*, *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. *US Department of Health and Human Services. Dietary guidelines for Americans, 2010.* 7th edition, Washington (DC): US Government Printing Office |

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