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## **Altering the availability or proximity of food, alcohol, and tobacco products to change their selection and consumption (Review)**

Hollands GJ, Carter P, Anwer S, King SE, Jebb SA, Ogilvie D, Shemilt I, Higgins JPT, Marteau TM

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# Altering the availability or proximity of food, alcohol, and tobacco products to change their selection and consumption

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## ABSTRACT

### Background

Overconsumption of food, alcohol, and tobacco products increases the risk of non-communicable diseases. Interventions to change characteristics of physical micro-environments where people may select or consume these products - including shops, restaurants, workplaces, and schools - are of considerable public health policy and research interest. This review addresses two types of intervention within such environments: altering the availability (the range and/or amount of options) of these products, or their proximity (the distance at which they are positioned) to potential consumers.

### Objectives

1. To assess the impact on selection and consumption of altering the availability or proximity of (a) food (including non-alcoholic beverages), (b) alcohol, and (c) tobacco products.
2. To assess the extent to which the impact of these interventions is modified by characteristics of: i. studies, ii. interventions, and iii. participants.

### Search methods

We searched CENTRAL, MEDLINE, Embase, PsycINFO, and seven other published or grey literature databases, as well as trial registries and key websites, up to 23 July 2018, followed by citation searches.

### Selection criteria

We included randomised controlled trials with between-participants (parallel group) or within-participants (cross-over) designs. Eligible studies compared effects of exposure to at least two different levels of availability of a product or its proximity, and included a measure of selection or consumption of the manipulated product.

## Data collection and analysis

We used a novel semi-automated screening workflow and applied standard Cochrane methods to select eligible studies, collect data, and assess risk of bias. In separate analyses for availability interventions and proximity interventions, we combined results using random-effects meta-analysis and meta-regression models to estimate summary effect sizes (as standardised mean differences (SMDs)) and to investigate associations between summary effect sizes and selected study, intervention, or participant characteristics. We rated the certainty of evidence for each outcome using GRADE.

## Main results

We included 24 studies, with the majority (20/24) giving concerns about risk of bias. All of the included studies investigated food products; none investigated alcohol or tobacco. The majority were conducted in laboratory settings (14/24), with adult participants (17/24), and used between-participants designs (19/24). All studies were conducted in high-income countries, predominantly in the USA (14/24).

Six studies investigated availability interventions, of which two changed the absolute number of different options available, and four altered the relative proportion of less-healthy (to healthier) options. Most studies (4/6) manipulated snack foods or drinks. For selection outcomes, meta-analysis of three comparisons from three studies ( $n = 154$ ) found that exposure to fewer options resulted in a large reduction in selection of the targeted food(s): SMD  $-1.13$  (95% confidence interval (CI)  $-1.90$  to  $-0.37$ ) (low certainty evidence). For consumption outcomes, meta-analysis of three comparisons from two studies ( $n = 150$ ) found that exposure to fewer options resulted in a moderate reduction in consumption of those foods, but with considerable uncertainty: SMD  $-0.55$  (95% CI  $-1.27$  to  $0.18$ ) (low certainty evidence).

Eighteen studies investigated proximity interventions. Most (14/18) changed the distance at which a snack food or drink was placed from the participants, whilst four studies changed the order of meal components encountered along a line. For selection outcomes, only one study with one comparison ( $n = 41$ ) was identified, which found that food placed farther away resulted in a moderate reduction in its selection: SMD  $-0.65$  (95% CI  $-1.29$  to  $-0.01$ ) (very low certainty evidence). For consumption outcomes, meta-analysis of 15 comparisons from 12 studies ( $n = 1098$ ) found that exposure to food placed farther away resulted in a moderate reduction in its consumption: SMD  $-0.60$  (95% CI  $-0.84$  to  $-0.36$ ) (low certainty evidence). Meta-regression analyses indicated that this effect was greater: the farther away the product was placed; when only the targeted product(s) was available; when participants were of low deprivation status; and when the study was at high risk of bias.

## Authors' conclusions

The current evidence suggests that changing the number of available food options or altering the positioning of foods could contribute to meaningful changes in behaviour, justifying policy actions to promote such changes within food environments. However, the certainty of this evidence as assessed by GRADE is low or very low. To enable more certain and generalisable conclusions about these potentially important effects, further research is warranted in real-world settings, intervening across a wider range of foods - as well as alcohol and tobacco products - and over sustained time periods.

## PLAIN LANGUAGE SUMMARY

### Altering the availability or proximity of food, alcohol, and tobacco products to change their selection and consumption

Unhealthy patterns of consumption of food, alcohol, and tobacco products are important causes of ill health. Changing the availability (the range or amount of options, or both) of these products or their proximity (the distance at which they are positioned) to potential consumers could help people make healthier choices.

#### What is the aim of this review?

This review investigated whether altering the availability or proximity of food (including non-alcoholic beverages), alcohol, and tobacco products changed people's selection (such as purchasing) or consumption of those products. We searched for all available evidence from randomised controlled trials (a type of study in which participants are assigned to one of two or more treatment groups using a random method) to answer this question, and found 24 studies, all of which were conducted in high-income countries.

#### What are the main results of the review?

Six studies involved availability interventions, of which four changed the relative proportion of less-healthy to healthier options, and two changed the absolute number of different options available. In statistical analyses that combined results from multiple studies, it was found that reducing the number of available options for a particular range or category of food(s) reduced selection of those food products (from analysing 154 participants) and possibly reduced consumption of those products (from 150 participants). However, the certainty of the evidence for these effects was low.

Eighteen studies involved proximity interventions. Most (14/18) changed the distance at which a snack food or drink was placed from the participants, whilst four studies changed the order of meal components encountered along a line. One study found that this reduced selection of food (from analysing 41 participants), whilst in a statistical analysis combining results from multiple studies, it was found that placing food farther away reduced consumption of those food products (from analysing 1098 participants). However, the certainty of the evidence for these effects was very low and low, respectively.

### **Key messages**

Mindful of its limitations, the current evidence suggests that changing the number of available food options or changing where foods are positioned could contribute to meaningful changes in behaviour, justifying policy actions to promote such changes to food environments. However, more high-quality studies in real-world settings are needed to make this finding more certain.

### **How up-to-date is this review?**

The evidence is current to 23 July 2018.

## SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [\[Explanation\]](#)

Lower versus higher availability of food products for changing quantity of food selected or consumed					
<b>Population:</b> Adults and children <b>Setting:</b> Field and laboratory settings <b>Intervention:</b> Lower availability of food products (fewer options) <b>Comparison:</b> Higher availability of food products (more options)					
Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	Number of participants (studies; comparisons)	Certainty of evidence (GRADE)
	Assumed risk: higher availability of food products (more options)	Corresponding risk: lower availability of food products (fewer options)			
Selection	Mean energy selected on an average snack occasion of 200 (±63) kcal <sup>1</sup>	Mean energy selected on an average snack occasion would be 71 kcal (35.6%) less with lower availability (120 kcal fewer to 23 kcal fewer; 59.9% less to 11.7% less)	Mean selection in the lower availability group was 1.13 standard deviations lower (1.90 lower to 0.37 lower)	154 (3 RCTs; 3 comparisons)	⊕⊕○○ LOW <sup>23</sup>
Consumption	Mean energy intake on an average snack occasion of 200 (±63) kcal	Mean energy intake on an average snack occasion would be 35 kcal (17.3%) less with lower availability (80 kcal fewer to 11 kcal more; 40% less to 5.7% more)	Mean consumption in the lower availability group was 0.55 standard deviations lower (1.27 lower to 0.18 more)	150 (2 RCTs; 3 comparisons)	⊕⊕○○ LOW <sup>24</sup>
The basis for the assumed risk is provided in Footnotes. <sup>5</sup> The corresponding risk (and its 95% confidence interval) is based on the assumed risk and the relative effect of the intervention (and its 95% CI). The relative effect is derived from the primary random-effects meta-analysis for the outcome <b>CI:</b> confidence interval; <b>kcal:</b> kilocalories; <b>RCT:</b> randomised controlled trial					

#### GRADE Working Group grades of evidence

**High certainty:** The current evidence provides a very good indication of the likely effect, and the likelihood that the actual effect will be substantially different is low.

**Moderate certainty:** The current evidence provides a good indication of the likely effect, and the likelihood that the actual effect of the treatment will not be substantially different is moderate.

**Low certainty:** The current evidence provides some indication of the likely effect, but the likelihood that the actual effect will be substantially different is high.

**Very low certainty:** The current evidence does not provide a reliable indication of the likely effect, and the likelihood that the actual effect will be substantially different is very high

<sup>1</sup>Assumes that all foods selected are consumed.

<sup>2</sup>Downgraded by one level for study limitations: study-level estimates of this effect were judged to have significant concerns related to risk of bias.

<sup>3</sup>Downgraded by one level for imprecision: the number of participants (effective sample size) incorporated into analysis is less than the number of participants required by a conventional sample size calculation for a single adequately powered trial (optimal information size), and confidence intervals are wide.

<sup>4</sup>Downgraded by one level for imprecision: the number of participants (effective sample size) incorporated into analysis is less than the number of participants required by a conventional sample size calculation for a single adequately powered trial (optimal information size). The confidence intervals are wide and include the possibility of a small effect on increasing consumption.

<sup>5</sup>Estimates of variance are based on data from a representative sample of UK adults, from the UK National Diet and Nutrition Survey Years 7-8 ([Public Health England 2018a](#)); see [Effects of interventions](#) for details.



## BACKGROUND

### Description of the condition

Non-communicable diseases, principally cardiovascular diseases, diabetes, certain forms of cancer, and chronic respiratory diseases, accounted for an estimated 68% of all deaths worldwide in 2012 (WHO 2016). Major risk factors for non-communicable diseases include metabolic and dietary risk factors linked to food consumption (e.g. high body mass index, high systolic blood pressure), as well as smoking and alcohol use - risks that are, in principle, modifiable. These are also amongst the most significant risk factors for total disease burden, both globally and in high-income countries specifically (GBD 2018). Identifying interventions that are effective in achieving sustained health behaviour change across populations and countries is therefore one of the most important public health challenges of the 21st century.

### Description of the intervention

It is increasingly recognised that the physical environments that surround us can exert considerable influences on our health-related behaviours and that altering these environments may provide a catalyst for behaviour change (Cohen 2016; Marteau 2012; Stok 2017). We have previously described a set of interventions that involve altering small-scale physical environments - or micro-environments - with the intention of changing health-related behaviours (Hollands 2013a; Hollands 2017a), which have also been described as 'choice architecture' (or 'nudge') interventions (Cadario in press; Szasz 2018; Thaler 2008). These interventions involve changing characteristics of, or cues within, environments where people may select or consume food, alcohol, or tobacco including restaurants, workplaces, schools, homes, bars, pubs, supermarkets, or shops. They have received increased policy and research interest in recent years as a result of several factors (Marteau 2015), including shifts in theoretical understanding, supportive empirical evidence, political acceptability (with governments preferring 'light-touch' rather than legislative or regulatory approaches), and public acceptability (with evidence suggesting these types of interventions are relatively acceptable) (Petrescu 2016; Reisch 2016; Reynolds 2019). Perceived feasibility and low cost, whereby such interventions may be viewed as easily implemented at scale without complex legislative or regulatory processes or the need for individual delivery, may also contribute.

The placement of food, alcohol, and tobacco products within the physical environment can influence their selection and consumption. Within the Typology of Interventions in Proximal Physical Micro-Environments (TIPPM) intervention typology (Hollands 2017a), a framework developed for characterising interventions in physical micro-environments, 'placement' interventions comprise two key, more specific intervention types: first, interventions

that target the 'availability' of food, alcohol, or tobacco products within a specific environment - essentially, what is made available for selection or consumption, or both; and second, interventions focused on how available products are positioned within a specific environment. Our specific focus with respect to how products are positioned is on the 'proximity' of food, alcohol, or tobacco products to and from people, which can be altered by moving the products nearer or farther away to make them more or less accessible. Availability and proximity interventions are described further below.

#### Interventions that alter availability

These interventions involve manipulating the available food, alcohol, or tobacco product options in an environment such as a shop, bar, or restaurant. This can be achieved by providing, either: a) a greater or lesser range of different product options (within a targeted range or category), for example:

- food - providing a wider range of healthier meal options, or a reduced number of less-healthy meal options in a restaurant or cafeteria; or a reduced range of snacks in vending machines;
- alcohol - providing a wider range of different low-alcohol options in a bar or pub; or a reduced range of types of wine or beer in a restaurant; and
- tobacco - providing a reduced range of types of tobacco product in a shop.

b) a greater or lesser amount (number) of discrete units of a product. In this case, the range of different product options might not be changed, but the number of available units of the existing product options is manipulated. For example:

- food - making a lesser amount of (a range of) chocolate bars on display in a supermarket;
- alcohol - making a greater amount of (a range of) low-alcohol beer bottles available in a bar or pub; and
- tobacco - making a lesser amount of (a range of) cigarettes available in a shop.

c) a combination of a) and b).

These possible manipulations can concern changes in the absolute number of different options available, or changes in relative proportions, such as the relative number (proportion) of less-healthy (to healthier) options that are available.

#### Interventions that alter proximity

These interventions concern the positioning of products that are available within that environment. The term we have used - 'proximity' - reflects the fact that the predominant intervention of this type within the current context involves moving food, alcohol, or tobacco products closer to or farther away from people, such as placing a healthier product such as fruit in a more proximal (and therefore convenient) position within a shop to encourage its purchase (Kroeze 2016). By reducing or increasing the distance

to be traversed or reached, such interventions can alter the degree of convenience, and of effort required for potential consumers to select or consume these products.

The proximity of a product (how close or far away it is) is altered in relation to key physical features in environments, such as typical or expected walking routes, building entrances, checkouts in supermarkets or shops, or seating. Examples include positioning a display of food products close to a shop's entrance (e.g. 1 m), aiming to enable convenient selection of the products, versus this being located at a distance that requires customers to walk a greater distance to engage with the display (e.g. 20 m). Alternatively, it could involve altering the positioning of a food product to be within arm's reach of a potential consumer (e.g. placed 20 cm from seating) versus requiring them to leave their seating and walk to take the food product (e.g. placed 2 m from seating).

A detailed conceptual framework for these interventions has been developed ([Pechey under review](#)).

## How the intervention might work

There are considerable influences on behaviour that are beyond individuals' deliberative control. Indeed, it has been suggested that much human behaviour occurs outside of awareness, cued by stimuli in environments and resulting in actions that may be largely unaccompanied by conscious reflection ([Marteau 2012](#); [Neal 2006](#)). This proposition has led to increasing policy and research attention being placed on interventions with mechanisms of action that may be less dependent on the conscious engagement of the recipients ([Hollands 2016](#)), including interventions that involve altering the placement of objects within the physical environments that surround and cue behaviour.

Various underlying mechanisms of action have been proposed for both availability and proximity interventions ([Pechey under review](#)), although it is difficult to assess these outside of artificial, controlled environments. In relation to availability, whether options are available (or absent) within a given environment inevitably shapes and constrains people's possible responses. The more product options that are available, the more likely it is that an actor will encounter an option they are willing to select or consume ([Chernev 2011](#)). Exposure may also increase the salience of, and the attention directed towards, products and elicit a 'mere-exposure' effect - whereby repeated exposure to a product can elicit increased liking ([Dalenberg 2014](#)). Altering a range of available products could also have the effect of implying a new social norm about which types of products are acceptable or commonplace, and this could influence selection and consumption. Whilst currently largely unexplored, the sum of these potential mechanisms is that increasing the range of options for a given product or category should increase its selection or consumption, albeit subject to people engaging with the product in the first place. This will be influenced by many factors, including characteristics of the person (such as hunger) and of the product (such as its attractiveness or

palatability). In addition, it has been suggested that if the range of available products is increased, choosing between these options becomes more reliant on a reasoning process, meaning that people may make different choices based on what they are most able to justify ([Sela 2009](#)). Furthermore, if the range of available product options remains the same, but the number of units of these products increases, this may increase their visibility or salience and therefore encourage selection or consumption.

In relation to proximity, the central role of physical and mental effort has been highlighted ([Bar-Hillel 2015](#)). Humans tend to take the least effortful course of action without the need for conscious deliberation, and so physical environments can shape responses by capitalising on this phenomenon. Consequently, products placed nearer an actor require less effort to obtain than those placed farther away, and this may correspondingly impact on motivation to select or consume them ([Hunter 2018](#)). Other than the effort needed (or perceived as such), more distal products may also be less visible and less salient ([Maas 2012](#)). Increasing physical distance may also increase 'psychological distance' - the subjective experience of distance from the self in that time and place - and so more distal products may be focused upon in a less detailed way or be subject to more deliberation or rationalisation, which may impact one's behaviour ([Trope 2010](#)).

## Why it is important to do this review

A systematic scoping review of evidence for the effects of physical micro-environment interventions identified a substantial number of studies that have investigated the effects of altering the availability and proximity of products on health-related behaviours ([Hollands 2013b](#)). The majority of these studies focused on food products, where interventions have significant potential given the necessity of consumption of these products and their ubiquity within many environments. However, because both tobacco and alcohol use also involve the selection and consumption of products, such interventions may also have the potential to change these behaviours via similar mechanisms. We have synthesised evidence for the effects of availability and proximity interventions within a single systematic review because we conceptualise them both as interventions that alter the placement of products within physical micro-environments. To our knowledge, evidence from these studies has yet to be synthesised using rigorous systematic review methods that include quantitative synthesis, assessment of risk of bias, and investigation of potential effect modifiers, or to encompass alcohol and tobacco use, although parts of this evidence base have been reviewed. As such, we do not yet have reliable estimates of the effects of these types of interventions on product selection and consumption, nor of the influence of factors that may modify any such effects. Both are necessary to inform the selection and design of effective public health interventions, particularly given increasing research and policy interest in interventions that alter the physical environment to make unhealthier behaviours less likely

and healthier behaviours more likely. This interest is evidenced by the substantial public and policy interest in a previous Cochrane Review on portion, package, and tableware size (Hollands 2015), which has influenced policy debate in the UK and Australia (Jones 2016).

Poor diet, harmful alcohol use, and smoking are socially patterned, being more common amongst those in lower socioeconomic positions, thereby contributing to the increased morbidity and premature mortality observed in these groups (Stringhini 2010). Behaviour change interventions that focus on the provision of educational information to individuals and encouragement for them to make active choices, potentially widen health inequalities (Lorenc 2013; McGill 2015). Interventions that instead aim to alter the environments that people are exposed to and therefore may be less reliant on conscious, reflective engagement (Hollands 2016), could have a greater potential to reduce, or at least not increase, health inequalities. It has been suggested that this may be because they rely less on recipients' cognitive resources including levels of literacy, numeracy, and cognitive control, which on average are lower in population subgroups experiencing higher levels of social and material deprivation (Hall 2014). The current review sought to identify evidence for differential effects of exposure to these interventions between socioeconomic groups. To our knowledge, no studies of the effects of these interventions have been conducted in low- and middle-income countries (LMICs) that would enable a comparison of effects between studies in high-income countries (HICs) and LMICs, but we sought to identify such evidence. Purposely considering socioeconomic status and country context factors in our analysis (and highlighting gaps in the evidence base) enabled the opportunity to assess the potential impact such interventions could have upon health inequalities.

## OBJECTIVES

1. To assess the impact on selection and consumption of altering the availability or proximity of (a) food (including non-alcoholic beverages), (b) alcohol, and (c) tobacco products.
2. To assess the extent to which the impact of these interventions is modified by characteristics of: i. studies, ii. interventions, and iii. participants.

## METHODS

### Criteria for considering studies for this review

#### Types of studies

Randomised controlled trials (RCTs) or cluster-RCTs with between-participants (parallel group) or within-participants (cross-over) designs, conducted in laboratory or field ('real-world') settings. We excluded non-randomised studies because, first, a scoping review indicated that a sufficient number of eligible randomised studies were likely available to enable quantitative synthesis of evidence for intervention effects (Hollands 2013a). Second, compared with RCTs, non-randomised studies rely on more stringent and sometimes non-verifiable assumptions in order to confer confidence that the risk of systematic differences between comparison groups beyond the intervention of interest (i.e. confounding) is sufficiently low to permit valid inferences about causal effects. If randomised assignment was not clear in studies otherwise considered eligible for inclusion at the full-text assessment stage, we only included the study if study authors had confirmed that randomisation occurred. We also excluded randomised studies that had only a single participating site in the intervention or the comparator group, or both, because this would result in the treatment effect being completely confounded with the site characteristics.

#### Types of participants

Adults and children exposed to the interventions. We defined adults as those 18 years of age or over, and children as those under 18 years (United Nations 1989). We excluded studies where the product was selected and fed directly by one person to another (e.g. mother-child dyads). No other exclusion criteria in relation to demographic, socioeconomic, or clinical characteristics were set. We excluded studies involving non-human participants (i.e. animal studies).

#### Types of interventions

Eligible interventions were those that involved altering the availability or proximity of food (including non-alcoholic beverages), alcohol, or tobacco products within 'physical micro-environments', defined here as small-scale physical environments where people gather for specific purposes and activities, such as restaurants, workplaces, schools, homes, bars, pubs, supermarkets, or shops (Hollands 2017a; Swinburn 1999). Availability interventions and proximity interventions are defined in the [Description of the intervention](#) section, and details of specific eligibility criteria for each intervention type are provided below.

#### Availability interventions

'Availability interventions' eligible for consideration in this review were those that involved comparing the effects of exposure to at least two differing (i.e. higher versus lower) levels of availability of a manipulated food, alcohol, or tobacco product. This allowed us to examine whether, for example, making a food product more available increases its consumption, or making a food product less available decreases its consumption. The 'product' can be operationalised as applying to types of a specific product (e.g. fruit,

chocolate bars) or to broader ranges or categories of products (e.g. energy-dense snack foods; low-fat meals). For alcohol and tobacco products, we also considered including interventions in which the availability of specific recognised alternatives to those products that are not themselves alcohol and tobacco products is manipulated within alcohol or tobacco selection and consumption contexts (e.g. alcohol-free variants in the case of alcohol, or e-cigarettes in the case of tobacco).

### Additional inclusion criteria

1. The comparison of different levels of availability must be explicitly described, as opposed to this being inferred by the review team. For example, a review author could infer that a supermarket sales promotion would increase the number of products on display in store, but a study would only be included if this was clearly stated by the authors.

2. We included multicomponent interventions in which there were concurrent intervention components that were unrelated to availability, providing those additional components were implemented wholly within the same physical micro-environment as in the availability intervention, involving changes to the product itself or its proximal physical environment. Examples include nutritional labelling on the product itself, or promotional signage placed near to the product. We planned to treat confounded and unconfounded components differently (see [Data synthesis](#)).

We excluded the following interventions.

1. Multicomponent interventions in which there were concurrent intervention components that were unrelated to availability, where those additional components were not implemented wholly within the same micro-environment as in the availability intervention, involving changes to the product itself or its proximal physical environment. Examples of such ineligible intervention components include health education programmes or marketing campaigns.

2. Interventions in which availability may be altered indirectly as a result of a higher-level intervention but is not directly and systematically altered (e.g. organisational-level interventions to encourage the wider availability of healthier products within a workplace or set of workplaces, or national- or regional-level policy interventions to encourage schools to modify their environments). Whilst availability may be changed as a result of the higher-level intervention, this is not directly manipulated to safeguard implementation fidelity.

3. Interventions within analogue studies that do not manipulate real food, alcohol, or tobacco products but instead may use written vignettes, computer or questionnaire tasks, or mock products to assess the impact of altering availability.

4. Interventions in which the range of product options is unchanged (as regards being perceptible prior to selection) in terms of the different types or categories of products that are available, but changes are made in the range of ways in which

those same products are formulated (as regards being perceptible prior to selection) or presented, such as flavour, colour, size, or shape.

5. Interventions in which the environmental contexts or opportunities for selection and consumption are not comparable between intervention and control groups. We therefore excluded interventions that involved removing (or adding) the entire range of food, alcohol, or tobacco products within a given micro-environment (e.g. studies examining the effectiveness within a specified environment of complete smoking or alcohol bans), as well as those that involved substantial changes to its infrastructure (such as building new shops or restaurants) or its furniture (e.g. adding or removing fixtures and fittings). We also excluded interventions in which availability differed between intervention and control arms due to: additional exposure to foods via assigned dietary programmes (e.g. prescribed diets); education (e.g. taste-testing sessions, cooking lessons, or food education); or other means of prescribed distribution of products to participants.

6. Interventions in which the availability of a product was not altered in terms of its range or amount but as a result of temporal (e.g. changing hours of sale or altering a range of available products over time) or spatial (e.g. changing the places in which a product can be selected or consumed) factors ([Han 2014](#); [Sherk 2018](#)).

### Proximity interventions

‘Proximity interventions’ eligible for consideration in this review were those that involved comparing the effects of exposure to at least two differing (i.e. higher versus lower) levels of proximity of a manipulated food, alcohol, or tobacco product. Whilst there may be other ways of altering the positioning of products that do not impact on their proximity, we have purposefully limited our scope to proximity interventions. This is because any other such studies would be difficult to assess within the same framework specified for use in the current review, which focuses on the effects of altering the quantity or degree (i.e. increase versus decrease) of a specific property (i.e. proximity).

### Additional inclusion criteria

1. The comparison of different levels of proximity had to be explicitly described, as opposed to this being inferred by the review team. For example, a review author could infer that a redesigned layout of a cafeteria or restaurant might increase or decrease proximity from a given point of reference, but a study would only be included if this change in proximity was clearly stated by authors.

2. As per availability interventions, we included multicomponent interventions in which there were concurrent intervention components that were unrelated to proximity, providing those additional components were implemented

wholly within the same physical micro-environment as in the proximity intervention, involving changes to the product itself or its proximal physical environment. Examples include nutritional labelling on the product itself, or promotional signage placed near to the product.

We excluded the following interventions.

1. As per availability interventions, multicomponent interventions in which there were concurrent intervention components that were unrelated to proximity, where those additional components were not implemented wholly within the same micro-environment as in the proximity intervention, involving changes to the product itself or its proximal physical environment.

2. Interventions in which proximity may be altered indirectly as a result of a higher-level intervention but was not directly and systematically altered (e.g. organisational-level interventions to encourage the redesign of the layout of school or workplace cafeterias). Whilst proximity may be changed as a result of the higher-level intervention, this is not directly manipulated to safeguard implementation fidelity.

3. Interventions within analogue studies that do not manipulate real food, alcohol, or tobacco products but instead may use written vignettes, computer or questionnaire tasks, or mock products to assess the impact of altering proximity.

4. Interventions in which the proximity of text, symbols, or images that relate to products is altered (e.g. on a sign, advertisement, poster, menu, leaflet, or computer screen (e.g. online supermarket)), but the proximity of the actual products to be selected or consumed is not.

5. Interventions in which the environmental contexts or opportunities for selection and consumption are not comparable between intervention and control groups. We therefore excluded interventions that involved substantial changes to the infrastructure of the environment or its furniture. Studies including both availability and proximity intervention components were eligible for inclusion in the review.

## Types of outcome measures

Eligible studies had to incorporate one or more objective measures of unconstrained selection (with or without purchasing) or consumption of the manipulated food, alcohol, or tobacco product(s). For example, a study investigating the effects of increasing the availability or proximity of fruit within a shop on healthier purchasing could include a specific measure of fruit (i.e. the manipulated product) selected only, or a broader measure at category level that encompasses both fruit selection and selection of non-fruit options available in the shop (e.g. a measure of selection of all healthier food options). Either would represent an appropriate primary outcome. Studies may additionally include measures that relate specifically to non-manipulated products - in the given example there may also be a measure of selection of non-fruit op-

tions only. Such measures would represent appropriate secondary outcomes.

Objective measurement may involve sales data or calculating the amount of a product consumed by subtracting the amount remaining after consumption from the total amount presented to the participant. Alternatively, it may involve direct observation of selection or consumption behaviour by outcome assessors. Subjective measurement would involve participant self-report. By unconstrained, we refer to behaviour of participants that is not constrained or regulated by either explicit instructions or some other action of the researcher. For example, we excluded studies that manipulated the availability of foods that are not selected, plated, or served under the direction of the participant, but where foods were presented to them individually with the instruction to select or consume.

Quantities selected or consumed may have been measured over a time period less than or equal to one day (immediate) or exceeding one day (longer term). Our choice of eligible outcome constructs reflects a focus on the assessment of the effects of eligible interventions in terms of the types and amounts of food, alcohol, and tobacco people consume, coupled with recognition that the amount selected (with or without purchasing) is an important intermediate endpoint in pathways to consumption.

## Primary outcomes

Measures of unconstrained selection (with or without purchasing) or consumption of the manipulated food, alcohol, or tobacco product(s). We anticipated encountering a range of measures of these outcome constructs amongst included studies, and present the following examples of likely measures below.

1. Selection of a product (a) without purchase, or b) with purchase. Assessment of the amounts of products (e.g. food, drink, alcohol, or tobacco products), energy or substances (e.g. saturated fat, alcohol, carbon monoxide) selected, measured in applicable natural units (e.g. kilojoules, grams). Depending on the study setting, a product may be selected with or without this involving a purchase, that is a transfer of money to the vendor. In cases where there is no purchasing, selection may be comparable to typical purchasing (e.g. products being selected in a restaurant or bar where there is no charge for them) or it may be behaviour that necessarily precedes consumption in that context, such as serving an amount of a food product onto a plate or pouring an amount of drink into a glass.

2. Consumption (intake) of a product.

As per selection, assessment of the amounts of products (e.g. food, drink, alcohol, or tobacco products), energy, or substances (e.g. saturated fat, alcohol, carbon monoxide) consumed, measured in applicable natural units (e.g. kilojoules, grams).

## Secondary outcomes

As with the specified primary outcomes, secondary outcomes are also measures of unconstrained selection (with or without purchasing) or consumption of food, alcohol, or tobacco products. However, secondary outcomes apply to other products that are available in the same micro-environment at the same point of selection or consumption as the manipulated product(s), but that are not themselves manipulated as regards to their availability or proximity.

Due to the nature of the interventions, we anticipated that adverse effects (other than unwanted health-harming effects on selection or consumption, which would be captured by the specified primary and secondary outcomes) were unlikely to occur, be assessed or reported. However, any adverse events or harms reported in the included studies were noted.

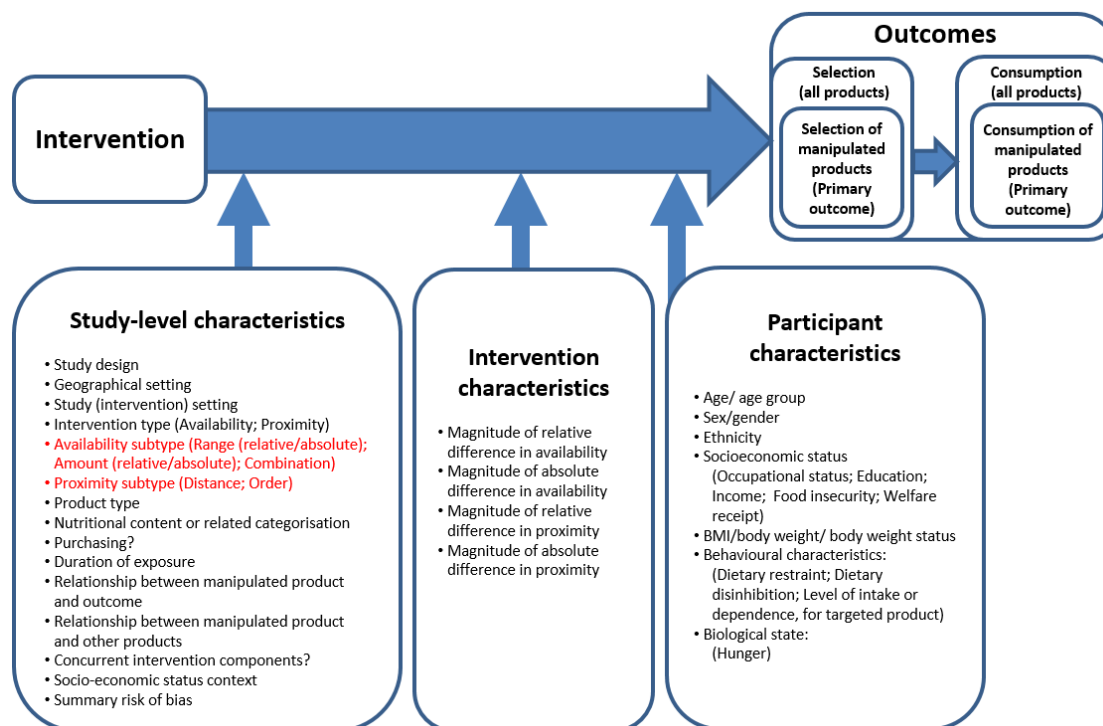
### Conceptual model

To supplement study eligibility criteria, we developed a provisional conceptual model that was published in the protocol for this review (Hollands 2017b). The conceptual model was design-oriented in the sense that it was intended to help direct the review process by

providing a simplified visual representation of the causal system of interest (Anderson 2011), that is the proposed causal pathway between eligible interventions and their outcomes (behavioural endpoints), and potential moderators of that relationship (effect modifiers) given that differential effects are plausible (Anderson 2013). We used the provisional conceptual model to inform the development of search strategies, data extraction forms, and a provisional framework for the statistical analysis of the data collected from the eligible studies (see [Search methods for identification of studies](#) and [Data collection and analysis](#)).

We revised the conceptual model iteratively, as we encountered evidence from eligible studies during the course of the review process, and documented revisions. We used the iterations of the conceptual model as a reference point for the design (in the protocol), conduct, and reporting (postprotocol) of the systematic review (Anderson 2013). In practice, iterative refinement of the conceptual model involved incorporating further potential effect modifiers identified during the data collection process, which were then considered in the analysis and reporting of these data. The final version of the conceptual model is shown in Figure 1, with details of its development in [Data collection and analysis](#).

**Figure 1. Final conceptual model. Changes from the provisional conceptual model (Hollands 2017b), comprising two additions, are shown in red type.**





## Search methods for identification of studies

### Electronic searches

We developed a MEDLINE search strategy by combining sets of controlled vocabulary and free-text search terms based on the eligibility criteria described above (see [Criteria for considering studies for this review](#)). It was developed with the intention of being highly sensitive (at the expense of precision) to give confidence in its ability to detect potentially eligible title and abstract records. This search strategy was externally peer-reviewed by an information retrieval specialist and co-convenor of the Cochrane Information Retrieval Methods Group and revised based on their peer-review comments. We tested and calibrated the MEDLINE search strategy for its sensitivity to retrieve a reference set of 24 records of reports of potentially eligible studies that were identified within a preceding, broader scoping review of interventions within physical micro-environments ([Hollands 2013a](#)). The search strategy was then reviewed by the Information Specialist of the Cochrane Public Health Group and revised further based on their comments. We adapted our final MEDLINE search strategy for use in searching the other databases listed based on close examination of the database thesauri and scope notes. There were no restrictions on publication date, publication format, or language. No study design filters were incorporated. The full details of the final search strategies are provided in [Appendix 1](#).

We conducted electronic searches for eligible studies within each of the following databases:

- Cochrane Central Register of Controlled Trials (CENTRAL) (1992 to 23rd July 2018);
- MEDLINE (including MEDLINE In-Process) (OvidSP) (1946 to 23rd July 2018);
- Embase (OvidSP) (1980 to 23rd July 2018);
- PsycINFO (OvidSP) (1806 to 23rd July 2018);
- Applied Social Sciences Index and Abstracts (ASSIA) (ProQuest) (1987 to 24th July 2018);
- Science Citation Index Expanded (Web of Science) (1900 to 24th July 2018);
- Social Sciences Citation Index (Web of Science) (1956 to 24th July 2018); and
- Trials Register of Promoting Health Interventions (EPPI Centre) (2004 to 27th July 2018).

### Searching other resources

We conducted electronic searches of the following grey literature databases using search strategies adapted from the final MEDLINE search strategy, as described above:

- Conference Proceedings Citation Index - Science (Web of Science) (1990 to 24th July 2018);
- Conference Proceedings Citation Index - Social Science & Humanities (Web of Science) (1990 to 24th July 2018); and

- OpenGrey (1997 to 24th July 2018).

We searched trial registers (US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov ( [www.clinicaltrials.gov/](http://www.clinicaltrials.gov/)), the World Health Organization International Clinical Trials Registry Platform ( [apps.who.int/trialsearch/](http://apps.who.int/trialsearch/)), and the EU Clinical Trials Register ( [www.clinicaltrialsregister.eu/](http://www.clinicaltrialsregister.eu/))) to identify registered trials (up to 25th July 2018), and the websites of key organisations in the area of health and nutrition, including the following:

- UK Department of Health;
- Centers for Disease Control and Prevention (CDC), USA;
- World Health Organization (WHO);
- International Obesity Task Force; and
- EU Platform for Action on Diet, Physical Activity and Health.

In addition, we searched the reference lists of all eligible study reports and undertook forward citation tracking (using Google Scholar) to identify further eligible studies or study reports (up to 25th July 2018). When we found non-English language articles, we used Google Translate in the first instance to determine potential eligibility. We intended that if an article appeared to be eligible, we would have the article translated by a native language speaker or professional translation service, however no articles needed translating.

## Data collection and analysis

### Selection of studies

Title and abstract records retrieved by the electronic searches were imported into EPPI Reviewer 4 (ER4) systematic review software ([Thomas 2010](#)). Duplicate records were identified, reviewed manually, and removed using ER4's automatic de-duplication feature. In relation to the electronic searches, search terms based on relevant intervention and comparator concepts (e.g. availab\$, increas\$, add\$, introduc\$, close\$, near\$, far\$) are unlikely to be specific to title-abstract records of eligible studies (even when configured in multistrand search strategies), and are also likely to feature frequently in irrelevant title-abstract records. This is likely to result in large numbers of records being retrieved by electronic searches, which need to have sufficient sensitivity to capture all eligible studies. To address this challenge, we developed a semi-automated screening workflow to manage the title-abstract screening stage, deployed in ER4, which uses machine learning to assign title-abstract records for duplicate manual screening ([O'Mara-Eves 2015](#)). This workflow was designed to maximise recall of eligible studies while reducing screening workload to match the available resource, which we expected to allow for duplicate manual screening of up to a maximum of one-third of retrieved records (the 'overall screening budget'). Further details of the semi-automated screening workflow are provided in [Appendix 2](#).

Two review authors independently undertook duplicate screening of title and abstract records retrieved by the electronic searches. We coded title and abstract records as ‘provisionally eligible’, ‘excluded’, or ‘duplicate’ by applying the eligibility criteria described above (see [Criteria for considering studies for this review](#)). Any disagreements in the coding of title and abstract records were identified and resolved by discussion to reach a consensus between the two review authors. When they were unable to reach a consensus, a third review author acted as an arbiter.

We obtained full-text copies of corresponding study reports for all records coded as ‘provisionally eligible’ at the title and abstract screening stage. Two review authors independently undertook duplicate screening of full-text study reports, coding them as ‘eligible’ or ‘excluded’ by applying the eligibility criteria described above (see [Criteria for considering studies for this review](#)), with reasons for exclusion recorded. Any disagreements in the coding of full-text study reports or reasons for exclusion were identified and resolved by discussion to reach consensus between the two review authors. In the event that any coding disagreements could not be resolved, a third review author acted as an arbiter. Bibliographic details of study reports excluded at the full-text screening stage are provided, along with the primary reason for exclusion, in the [Characteristics of excluded studies](#) table. If we identified multiple full-text reports of the same study, we linked and treated them as a single study. Some full-text reports comprising multiple eligible studies were identified, and each study was treated separately. We documented the flow of records and studies through the systematic review process and have reported this using a PRISMA flow diagram ([Moher 2009](#)).

## Data extraction and management

An electronic data extraction form was developed based on the Cochrane Public Health template and the form used in a previous Cochrane Review ([Hollands 2015](#)), modified to allow extraction of all data required for this review. An initial draft of this form was piloted using a selection of included studies, to ensure that it enabled reliable and accurate extraction of appropriate data, and was amended in consultation with the review team. One review author extracted data pertaining to the characteristics of included studies. Two review authors independently extracted outcome data in duplicate. When a study with more than two intervention arms was included, only outcome data pertaining to the intervention and comparison groups that met the eligibility criteria described above were included in the review, but the [Characteristics of included studies](#) table includes details of all intervention and comparison groups present in the study. Any discrepancies in extracted outcome data were identified and resolved by checking against the study report, and by discussion and consensus, with a third review author acting as an arbiter if necessary. We contacted study authors for key unpublished data that were missing from reports of included studies.

We collected the data summarised below, comprising 28 constructs. The 26 constructs in plain type represent the maximum core dataset that at the outset we anticipated would be required based on our study eligibility criteria and the design-oriented conceptual model. It was intended that this dataset would evolve as necessary through the review process, corresponding with revisions made to the conceptual model (see [Types of outcome measures](#)), resulting in the inclusion of two additional study characteristics in italicised text. These concerned basic subtype categorisations of availability and proximity interventions, reflecting that in the review protocol, [Hollands 2017b](#), we had presented possible subtype categorisations that would be subject to iteration or confirmation as a result of the review process. Such categorisations may be subject to further elaboration in future as the empirical or theoretical basis develops ([Pechey under review](#)).

## Study characteristics

1. Study design: between-participants or within-participants design; individually or cluster-randomised
2. Geographical setting: country
3. Study (intervention) setting: laboratory; field
4. Intervention type: availability; proximity
5. *Availability subtype: range of different options (relative/absolute); amount of product units (relative/absolute); combination*
6. *Proximity subtype: distance from set point; order encountered along line*
7. Product type: food; alcohol; tobacco
8. If applicable, energy (calorie) or macronutrient content of product, and/or related categorisation (healthier versus less healthy versus mixed)
9. If applicable, selection with purchasing or selection without purchasing
10. Duration of exposure
11. Relationship between manipulated product and outcome (how outcome maps onto manipulated product)
12. Relationship between manipulated product and other available products
13. Concurrent intervention component in factorial design
14. Concurrent intervention components confounded with comparison of interest
15. Socioeconomic status context
16. Summary ‘Risk of bias’ assessments
17. Information on funding source and potential conflicts of interest from funding

## Intervention characteristics

1. Magnitude of relative difference in availability (range, amount)
2. Magnitude of absolute difference in availability (range, amount)
3. Magnitude of relative difference in proximity



#### 4. Magnitude of absolute difference in proximity

#### Participant characteristics

1. Age/age group
2. Sex/gender (e.g. male, female)
3. Ethnicity
4. Socioeconomic status (e.g. occupational status; education; income; food insecurity; welfare receipt)
5. Body mass index (BMI); body weight; body weight status
6. Behavioural characteristics (e.g. dietary restraint; dietary disinhibition; level of intake or dependence, for targeted product)
7. Biological state (e.g. hunger)

These participant characteristics cover several categories of social differentiation relevant to health equity. Collecting study-level data on these participant characteristics enabled the potential to draw inferences within our analysis concerning any differential effects of the intervention on health equity (Welch 2012). For example, proxy measures of socioeconomic status function as participant characteristics that may moderate the observed effects of the intervention on product selection and consumption. In addition, to complement investigations based on participant characteristics, we constructed a binary study-level covariate of 'socioeconomic status context' based on authors' explicit descriptions of the study sample and/or setting (see 'Study characteristics' above) that served as a proxy for the overall study context in terms of baseline levels of social and material deprivation amongst study participants. Analysis of this study-level covariate as a potential effect modifier enabled the potential to investigate specifically whether eligible interventions were more or less effective in a study context characterised by high versus low levels of social and material deprivation.

#### Outcome data

We anticipated that some eligible primary studies would include more than one eligible measure of selection or consumption. We used the measure of selection or consumption that mapped most closely onto the focus of the intervention, for example where only fruit products were manipulated, we used a measure that related specifically to fruit selection or consumption only. Where multiple products were manipulated concurrently, we used a measure that either related specifically to one of those products (if it was discernible that that product was the primary intervention focus), or captured selection or consumption of all manipulated products. If a study included only a category-level measure that captured selection or consumption of a wider set of products beyond those that have been manipulated (but including the manipulated product), this still represented an eligible outcome for the purposes of this review providing it could be meaningfully interpreted at category level, but was considered less desirable because it required assumptions to be made about the direction of effect in relation to the manipulated product itself. Following the application of these criteria, if there remained multiple eligible outcome measures, we

selected the single measure of selection or consumption that had been (pre)specified by the study authors as the primary outcome. If no primary outcome had been specified by study authors, we selected the measure of selection or consumption most proximal to health outcomes in the context of the specific intervention. For example, if a study reported measures of both energy intake and the amount of food eaten (in grams), we selected energy intake as the measure most proximal to diet-related health outcomes, and where measures were reported relating to both intake of a healthier (e.g. low energy density) product and intake of a less-healthy (e.g. high energy density) product, we prioritised the latter.

For all outcome data, we collected information on: outcome variable type (dichotomous, continuous); outcome variable definition; unit of measurement (if relevant); timing of measurement (immediate ( $\leq 1$  day) or longer term ( $> 1$  day)); and type of measure (objective, self-report). For dichotomous outcomes, we extracted event rates in each comparison group. For continuous outcomes, we extracted mean differences, or mean changes in final measurements from baseline measurements, for each comparison group with associated standard deviations (or if standard deviations were missing, standard errors, 95% confidence intervals or relevant t-statistics, F-statistics, or P values). For included studies using factorial designs to investigate the effects of multiple experimental manipulations, we combined groups to capture the main effects of each relevant randomised comparison.

#### Assessment of risk of bias in included studies

We assessed risk of bias in the included studies using the revised Cochrane 'Risk of bias' tool for randomised trials (RoB 2.0) (Higgins 2016a), employing the additional guidance for cluster-randomised and cross-over trials (Eldridge 2016; Higgins 2016b). RoB 2.0 addresses five specific domains: (1) bias arising from the randomisation process; (2) bias due to deviations from intended interventions; (3) bias due to missing outcome data; (4) bias in measurement of the outcome; and (5) bias in selection of the reported result. Two review authors independently applied the tool to each included study, and recorded supporting information and justifications for judgements of risk of bias for each domain (low; high; some concerns). Any discrepancies in judgements of risk of bias or justifications for judgements were resolved by discussion to reach consensus between the two review authors, with a third review author acting as an arbiter if necessary. Following guidance given for RoB 2.0 (Section 1.3.4) (Higgins 2016a), we derived an overall summary 'Risk of bias' judgement (low; some concerns; high) for each specific outcome, whereby the overall RoB for each study was determined by the highest RoB level in any of the domains that were assessed.

#### Measures of treatment effect

For continuous outcomes, we calculated the standardised mean difference (SMD) with 95% confidence intervals (CIs) to express

the size of the intervention effect in each study relative to the variability observed in that study. For dichotomous outcomes, we calculated the odds ratio (OR) for each included study to express the size of the relative intervention effect between comparison groups, with the uncertainty in each result being expressed by the CI. We then re-expressed the OR as an SMD by applying the formula described in Section 9.4.6 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Deeks 2011). We calculated SMDs and sampling variances using means, standard deviations (SDs), and sample sizes and the corresponding equations for continuous and dichotomous data. We extracted means and SDs from published figures if they had not been reported numerically. If SDs were not reported or available from authors, they were obtained using the first appropriate rule from the following:

- (a) by direct calculation from statistics such as standard errors or CIs, if available;
- (b) by imputation, by assuming that the ratio of SD to mean for the outcome is equal to the ratio of SD to mean calculated using raw data available for other outcomes in the same study;
- (c) by imputation, by assuming that the ratio of SD to mean is equal to the ratio of SD to mean observed in other similar studies that reported both means and SDs.

### Unit of analysis issues

In the case of cluster-randomised trials, where an analysis was reported that accounted for the clustered study design, we estimated the effect on this basis, using reported test statistics (t-statistics, F-statistics or P values) to calculate standard errors. When this was not possible and the information was not available from the authors, we carried out an 'approximately correct' analysis according to current guidelines in Section 16.3 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). We imputed estimates of the intracluster correlation (ICC) using estimates derived from similar studies or by using general recommendations from empirical research. In cases where it was not possible to implement these procedures, we gave the effect estimate as presented but have reported the unit of analysis error.

For included studies with a within-participants design, we aimed to account for the design by calculating the SMD for continuous outcomes using the methods described in Section 16.4 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011), where standard errors for outcome data are computed using reported test statistics or estimates of correlations. However, adjustments could not be made to standard errors to account for within-subject designs as suitable information about within-person correlations was not available in the studies. None of the within-subject studies reported SDs directly, and we were already making strong assumptions to estimate the missing SDs. In order to adjust for the within-subject design, additional unsupported assumptions regarding the correlations would need to have been made.

Final outcome values served as the primary unit of analysis. For studies assessing changes from baseline as a result of an experimental manipulation, we calculated final values based on either reported data or supplementary data obtained by contacting the study authors.

In relation to potential unit of analysis issues arising from studies with multiple eligible comparison groups, our plans are provided below in the [Data synthesis](#) section.

### Dealing with missing data

We sought data that were missing from reports of included studies by contacting the study authors. Where data were missing due to participant dropout, we conducted available-case analyses and recorded any issues related to missing data within the 'Risk of bias' assessment.

### Assessment of heterogeneity

We assessed statistical heterogeneity in results by inspecting a graphical display of the estimated treatment effects from included studies along with their 95% CIs, and by formal statistical tests of homogeneity ( $\chi^2$ ) and measures of inconsistency ( $I^2$ ) and heterogeneity ( $\tau^2$ ).

### Assessment of reporting biases

We drew funnel plots (plots of effect estimates versus the inverse of their standard errors) to inform assessment of reporting biases. We conducted statistical tests to formally investigate the degree of asymmetry using the method proposed by Egger and colleagues (Egger 1997). Results of statistical tests were interpreted based on visual inspection of the funnel plots. Asymmetry of the funnel plot may indicate publication bias or other biases related to sample size, though it may also represent a true relationship between trial size and effect size.

### Data synthesis

We described and summarised the findings of included studies to address the objectives of the review. We provided a narrative synthesis describing the interventions, participants, study characteristics, and effects of eligible interventions upon prespecified outcomes (see [Criteria for considering studies for this review](#)). Our statistical analysis of the results of included studies used a series of random-effects and fixed-effect models to estimate summary effect sizes as SMDs with 95% CIs in terms of each specified outcome. Our planned statistical analysis comprised the following stages:

- Stage 1: conduct separate meta-analyses for each product type (food, alcohol, and tobacco) and, within each product type, conduct separate meta-analyses for (i) availability interventions and (ii) proximity interventions.

Then for each meta-analysis:

- Stage 2: conduct a meta-regression analysis with study characteristics (including summary risk of bias) as covariates;
- Stage 3: conduct a meta-regression analysis with intervention characteristics as covariates;
- Stage 4: conduct a meta-regression analysis with participant characteristics as covariates.

Study-level effect sizes calculated based on outcome data from independent within-study comparisons were directly incorporated into Stage 1 meta-analyses. For studies that included three or more eligible comparison groups (e.g. a study of a proximity intervention placing a food product either 1 m, 2 m, or 3 m from participants), we treated each eligible within-study comparison as providing independent outcome data, but adjusted those data to account for the dependency between multiple comparisons as described in the following paragraph. We planned to analyse data from multi-arm studies based on incremental comparisons only. We followed this for availability interventions, whilst for the analysis of proximity interventions, we decided to consider the shortest distance as a comparator against which all other intervention arms would be compared (e.g. 1 m versus 2 m, 1 m versus 3 m, but not 2 m versus 3 m), to allow meta-regression analyses to investigate the impact of increasing differences in proximity and because the nearest point to the participant is the logical comparator in any comparison given the mechanisms posited to underlie the intervention.

For studies contributing multiple pairwise comparisons to a meta-analysis, provided the sample size was large enough, each pairwise comparison was included separately. We adjusted the study weights to account approximately for the statistical dependencies between comparisons by dividing the sample size of the common intervention group as evenly as possible between the comparisons. If the sample size for the common intervention group was 1 for any comparison after dividing the common intervention group, we combined intervention groups to give a single pairwise comparison. If there was an even number of groups, we divided the groups in half based on the level (i.e. low or high) of the intervention type (i.e. proximity and availability). If the number of groups was odd, the group left over as the 'middle' level was incorporated into the higher-level group. We did not undertake multivariate analysis to deal with studies with multiple treatment arms as had been proposed as a possibility in the protocol, since the studies with multiple treatment arms had different numbers of arms that were not directly comparable across studies. As a post hoc sensitivity analysis, we repeated meta-analyses but instead entered a single effect estimate for each multi-arm study, obtained using the mean SMD and the mean variance across the multiple comparisons from that study (a conservative approach that will underestimate precision). We planned to exclude a covariate from Stages 2, 3, or 4 of a meta-regression analysis if useable data were available from fewer than 10 eligible studies incorporated into the corresponding Stage 1 meta-analysis and/or covariate values did not enable sufficient discrimination between studies (e.g. if covariates are identical, with all included studies using a between-participants design and randomis-

ing individual participants). Within each stage of a meta-regression analysis, we proposed to test each covariate separately to identify those variables statistically associated with each outcome. Finally, we planned to estimate and present a meta-regression model that incorporated the set of covariates that best explained statistical heterogeneity observed in the corresponding Stage 1 meta-analysis. We planned to use the following procedure to select and incorporate covariates into this multivariable model:

1. rank those covariates identified as potentially important predictors of the outcome in Stages 2, 3, or 4 in order of the corresponding adjusted  $R^2$  values;
2. starting with the top-ranked covariate, use a stepwise procedure to add each consecutively ranked covariate into the multivariable meta-regression model; and
3. retain a covariate in the multivariable model only if it increases the adjusted  $R^2$  for the multivariable and no collinearity or multicollinearity with other retained covariates is detected.

In practice, we conducted meta-regression only on the consumption outcome for proximity interventions, as there were insufficient data (fewer than 10 comparisons) for all other interventions/outcomes. Furthermore, we conducted only univariate meta-regression analyses. Multivariate analyses were not possible due to a lack of data and given that there were not variables identified that modified the intervention effect within each stage of the analysis. Additional details and results of the meta-regression analyses are reported in the [Effects of interventions](#) section.

Statistical analyses were conducted in R (version 3.4.2) and metafor (version 2.0-0) ([Viechtbauer 2010](#)).

### Treatment of multicomponent studies

For included studies using factorial designs to investigate the effects of multiple experimental manipulations, we combined outcome data across groups to capture the main effect attributable to each 'availability' or 'proximity' comparison. For studies of interventions with concurrent components that were unrelated to but intrinsically confounded with the manipulations of interest (namely product availability or proximity), we treated the presence of concurrent components as a study characteristic, indicating the presence or absence of one or more additional intervention components. An example of such confounded concurrent components would be when a product is made less available but also has warning labels added to its packaging (relative to that product being more available and having no additional warning labels). Our primary analyses excluded comparisons where confounded concurrent intervention components were present. We subsequently conducted sensitivity analyses whereby these comparisons were reinstated, in order to assess their impact on the results.

### Certainty of evidence

We used the GRADE framework to rate the certainty of each body of evidence incorporated into meta-analyses for (1) selection (with

or without purchasing) and (2) consumption outcomes, to indicate the confidence that can be placed in summary estimates of effect (Guyatt 2011; Schünemann 2011). This is an assessment of the likelihood that the true effect will not be substantially different from what the research found. Within the GRADE approach, the certainty of a body of evidence for intervention effects is assessed based on the design of the underlying studies - with RCTs initially considered high certainty - and on a number of factors that can decrease or increase certainty. GRADE criteria for downgrading certainty of evidence encompass study limitations, inconsistency, imprecision, indirectness, publication bias, and other considerations (Balslem 2011). If such a criterion is identified, it is classified either as serious (leading to downgrading by one level) or very serious (downgrading by two levels). The four possible certainty ratings that can be applied range from high certainty (meaning that current evidence provides a very good indication of the likely effect, and the likelihood that the actual effect will be substantially different is low) through to moderate certainty (current evidence provides a good indication of the likely effect, and the likelihood that the actual effect of the treatment will not be substantially different is moderate); low certainty (current evidence provides some indication of the likely effect, but the likelihood that the actual effect will be substantially different is high); and very low certainty (current evidence does not provide a reliable indication of the likely effect, and the likelihood that the actual effect will be substantially different is very high). Two review authors independently undertook duplicate assessment of GRADE, with any disagreements resolved by discussion or by consulting a third review author if necessary to reach consensus.

#### **'Summary of findings' tables**

We developed 'Summary of findings' tables using GRADEpro GDT (GRADEpro GDT 2015). These tables comprise summaries of the estimated intervention effect and the number of participants and studies for each primary outcome, and include justifications underpinning GRADE assessments. We planned to present separate summary effect sizes and certainty of evidence ratings for food, alcohol, and tobacco products, and for availability and proximity interventions within each of these product types, but in practice no eligible alcohol or tobacco studies were identified.

Results of random-effects meta-analyses are presented as SMDs with 95% CIs. To facilitate interpretation of these estimated effect sizes, we re-expressed them employing selected familiar metrics of selection or consumption using observational data from a population-representative sample (see [Effects of interventions](#) for details) (Hollands 2015; Schünemann 2011).

#### **Sensitivity analysis**

In addition to the aforementioned treatment of studies featuring confounded additional intervention components, we also conducted sensitivity analyses to explore the impact of any outcome data that were imputed due to missing data.

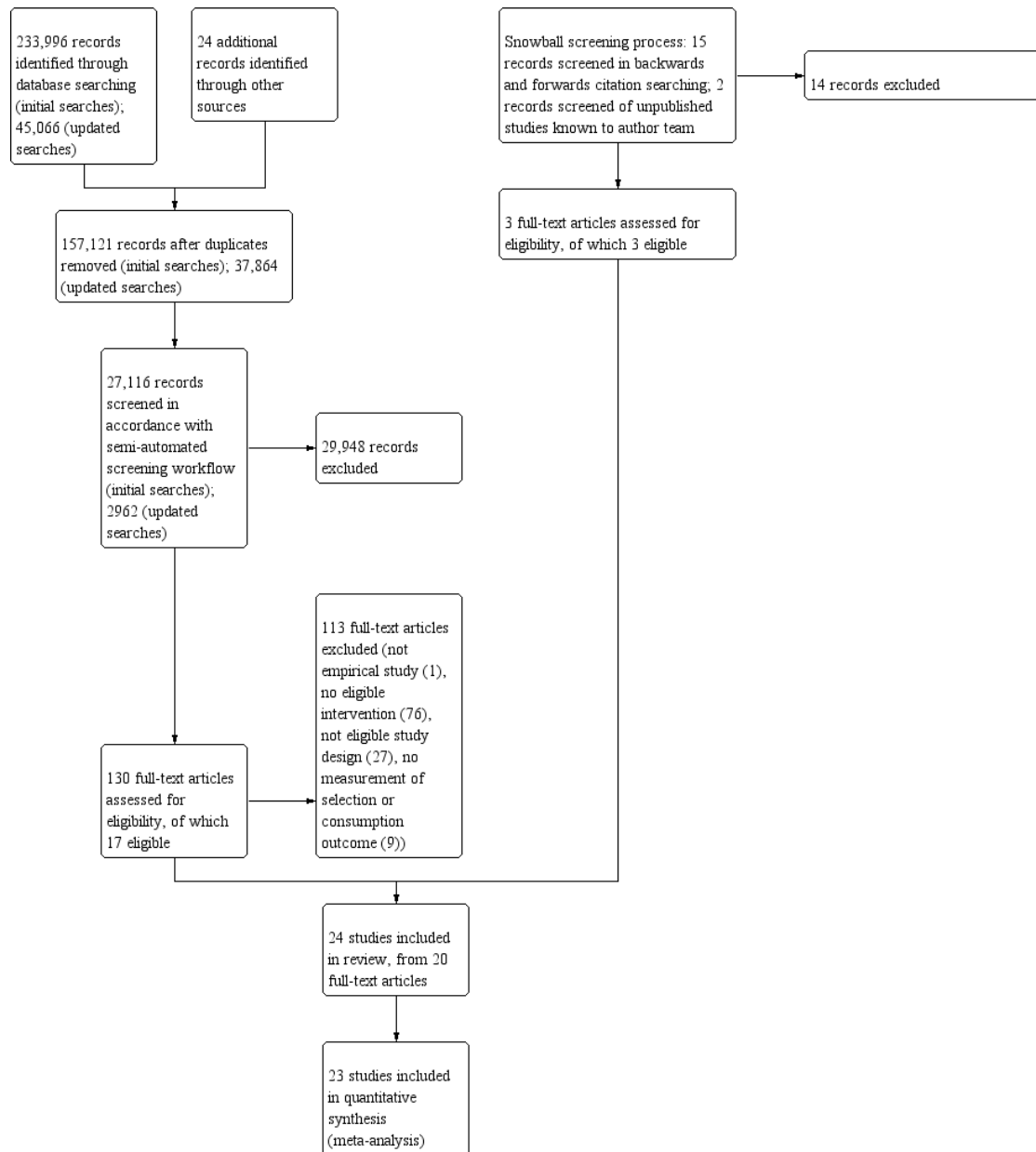
## **RESULTS**

### **Description of studies**

#### **Results of the search**

The flow of studies through the systematic review process is shown in [Figure 2](#). Electronic database searches were initially run between 1 and 4 March 2016. These retrieved a total of 233,996 study records, including duplicates. Twenty-four additional records in the review had been previously identified from other sources, functioning as a reference set, resulting in a total of 234,020 records. Following removal of duplicates (76,899 records), 157,121 title-abstract records were processed in accordance with the semi-automated screening workflow described in [Appendix 2](#). As a result of this process, 27,116 title and abstract records were screened, of which 121 articles were subject to full-text screening. The electronic database searches were updated between 23 and 27 July 2018. For these updated searches, following removal of 7202 duplicate records, 37,864 title-abstract records were processed in accordance with the semi-automated workflow. This resulted in 2962 title-abstract records being screened, with a further nine articles subject to full-text screening.

**Figure 2. Study flow diagram.**





At full-text screening stage, we excluded 113 articles and assessed 17 articles assessed as eligible for inclusion in the review. These 17 articles represent 20 unique studies (6 availability: Fiske 2004; Foster 2014; Kocken 2012; Pechey 2019; Roe 2013; Stubbs 2001; and 14 proximity: Cohen 2015; Engell 1996 (S1); Engell 1996 (S2); Greene 2017; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Painter 2002; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Wansink 2006; Wansink 2013a). Snowball screening conducted between 31 October and 2 November 2016 and again between 9 and 12 November 2018 resulted in the identification of four further studies from three full-text articles, with one study of proximity identified through backward and forward citation searching (Kongsbak 2016), and three studies of proximity identified due to two review authors being authors on those studies, which have subsequently been published (Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019). We included a total of 24 studies in the review.

We identified registered protocols for four ongoing studies (see [Characteristics of ongoing studies](#)), and there were insufficient details available to determine eligibility for a further two studies (see [Characteristics of studies awaiting classification](#)).

## Included studies

We included 24 studies involving a total of 3052 participants in the review. Fourteen studies were conducted in the USA (Cohen 2015; Engell 1996 (S1); Engell 1996 (S2); Fiske 2004; Foster 2014; Greene 2017; Musher-Eizenman 2010; Painter 2002; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Roe 2013; Wansink 2006; Wansink 2013a); five in the UK (Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Pechey 2019; Stubbs 2001); three in the Netherlands (Kocken 2012; Maas 2012 (S1); Maas 2012 (S2)); one in Denmark (Kongsbak 2016); and one in Sweden (Langlet 2017). We identified no eligible studies conducted in LMICs.

The majority (14/24) of the included studies were conducted in laboratory settings (Engell 1996 (S1); Engell 1996 (S2); Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Kongsbak 2016; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Stubbs 2001); the remaining 10 studies (five availability, Fiske 2004; Foster 2014; Kocken 2012; Pechey 2019; Roe 2013, and five proximity, Cohen 2015; Greene 2017; Painter 2002; Wansink 2006; Wansink 2013a) were conducted in a wide range of field settings including shops, restaurants/cafeterias, offices, and vending machines in schools. Study participants in 17 studies were - or were assumed to be - adults (Engell 1996 (S1); Engell 1996 (S2); Fiske 2004; Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Kongsbak 2016; Maas 2012 (S1); Maas 2012 (S2); Painter 2002; Pechey 2019; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Stubbs 2001; Wansink 2006; Wansink 2013a),

and in six studies children under 18 years (Cohen 2015; Greene 2017; Kocken 2012; Langlet 2017; Musher-Eizenman 2010; Roe 2013). Ages were not sufficiently specified in one study to allow classification (Foster 2014). The sex of participants was reported in 15 studies (ranging from 0% female (Engell 1996 (S1); Engell 1996 (S2); Kongsbak 2016; Stubbs 2001), to 100% female (Maas 2012 (S1); Maas 2012 (S2); Wansink 2006)), with this unspecified in nine studies (Fiske 2004; Foster 2014; Greene 2017; Kocken 2012; Musher-Eizenman 2010; Pechey 2019; Privitera 2012 (S1); Privitera 2012 (S2); Wansink 2013a). Eleven studies reported BMI. Mean BMI of the sample was < 25 in six studies (Hunter 2018 (S1); Kongsbak 2016; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010), and between 25 and 30 in the remaining five studies (Hunter 2018 (S2); Hunter 2019; Privitera 2012 (S1); Privitera 2012 (S2); Stubbs 2001).

In terms of socioeconomic status context of the study samples, five studies were conducted in samples purposefully comprising both high and low deprivation (Greene 2017; Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Pechey 2019); three were conducted in high-deprivation contexts (Cohen 2015; Foster 2014; Kocken 2012); and the remaining 16 studies were conducted in low deprivation contexts (Engell 1996 (S1); Engell 1996 (S2); Fiske 2004; Kongsbak 2016; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Painter 2002; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Roe 2013; Stubbs 2001; Wansink 2006; Wansink 2013a).

All 24 included studies involved manipulations of food products, with no eligible studies focused on alcohol or tobacco products. Six of the included studies concerned manipulations of availability (Fiske 2004; Foster 2014; Kocken 2012; Pechey 2019; Roe 2013; Stubbs 2001). In terms of the types of availability interventions used, two studies changed the absolute number of different options available (Roe 2013; Stubbs 2001), and four studies changed the relative number (proportion) of less-healthy (to healthier) options (Fiske 2004; Foster 2014; Kocken 2012; Pechey 2019). Of the two studies that changed absolute numbers of options, Roe 2013 decreased the number of different fruit and vegetables options offered at a snack occasion, and Stubbs 2001 decreased the total number of different meal options available to participants. Of the four studies that changed relative proportions, two studies decreased (Fiske 2004; Kocken 2012), respectively, the number of high-fat and high-calorie options available in vending machines (with corresponding increases in low-fat and low-calorie options). One study decreased the number of higher-calorie (relative to lower-calorie) beverages on display within supermarket checkout refrigerators (Foster 2014). The remaining study decreased the proportion of less-healthy (i.e. higher-energy) cooked meal, snack, cold drink, and sandwich options, with a corresponding increase in healthier (i.e. lower energy) options (Pechey 2019). Two availability studies

were confounded to some degree with other concurrent interventions within the same physical environment (Fiske 2004; Foster 2014), the former also manipulating the addition of labels, and the latter additionally manipulating the visibility of products (but not meeting our criteria for a proximity intervention). It should be noted that, in order to ensure consistency in treatment and interpretation of effects, the comparisons within our analysis were always coded as reducing the availability of products, irrespective of whether the intervention was conceptualised by the authors as concerning increasing or decreasing availability. Most studies (4/6) manipulated snack foods or drinks (Fiske 2004; Foster 2014; Kocken 2012; Roe 2013). The included studies of availability investigated intervention exposures over extended time periods varying between 27 days (Stubbs 2001), and six months (Foster 2014). Three availability studies used randomised between-participants designs (Fiske 2004; Foster 2014; Kocken 2012), and three used randomised within-participants designs (Pechey 2019; Roe 2013; Stubbs 2001).

Eighteen of the included studies concerned manipulations of proximity (Cohen 2015; Engell 1996 (S1); Engell 1996 (S2); Greene 2017; Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Kongsbak 2016; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Painter 2002; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Wansink 2006; Wansink 2013a). In terms of the types of interventions used, most studies (14/18) increased the distance at which the product was placed from a set point, in all cases being the distance from a chair, table, or desk where a participant was positioned (Engell 1996 (S1); Engell 1996 (S2); Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Painter 2002; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Wansink 2006). All of these studies manipulated snack foods or drinks intended for immediate consumption. In these studies, the comparisons concerned relatively small distances, with the greatest distance products were placed at ranging from 0.7 m, Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019, to 12.2 m, Engell 1996 (S1). Four further studies manipulated the order of products encountered along buffet or lunch lines to increase the distance of the product upon entering that line (Cohen 2015; Greene 2017; Kongsbak 2016; Wansink 2013a), all of which manipulated components of breakfast or lunch meals. Three proximity studies were confounded to some degree with other concurrent interventions within the same physical environment (Cohen 2015; Greene 2017; Kongsbak 2016). Cohen 2015 additionally manipulated placing fruit in attractive containers and other fruit options next to the cash registers, as well as prominently displaying signage promoting fruits and vegetables. Greene 2017 made various changes including to the way in which fruits were presented and labelled. Kongsbak 2016 also manipulated whether salad components were mixed together or placed separately. Similar to our availability analysis, comparisons were always coded as reducing the proximity of prod-

ucts, irrespective of whether the intervention was conceptualised by the authors as concerning increasing or decreasing proximity. The included studies of proximity focused on a range of products that can be characterised as healthier in six studies (fruit, vegetables, water) (Cohen 2015; Engell 1996 (S1); Engell 1996 (S2); Greene 2017; Privitera 2012 (S1); Privitera 2012 (S2)); less healthy in six studies (chocolate) (Hunter 2018 (S1); Hunter 2018 (S2); Maas 2012 (S1); Maas 2012 (S2); Painter 2002; Wansink 2006); and a mix of healthier and less healthy in five studies (Hunter 2019; Kongsbak 2016; Langlet 2017; Musher-Eizenman 2010; Privitera 2014; Wansink 2013a). Studies typically investigated intervention exposures that were one-off or, if repeated, were repeated over relatively short time periods. Only four studies involved exposing participants to interventions for a period of more than one day (Cohen 2015; Greene 2017; Painter 2002; Wansink 2006). Sixteen proximity studies used randomised between-participants designs (Cohen 2015; Engell 1996 (S1); Engell 1996 (S2); Greene 2017; Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Kongsbak 2016; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Wansink 2013a), and two used randomised within-participants designs (Painter 2002; Wansink 2006).

The majority of studies (15/24) reported sources of funding. There was no apparent conflict of interest in the funding of 12 studies, given explicit statements denying involvement by agencies with possible commercial conflicts of interest in their results (Cohen 2015; Foster 2014; Greene 2017; Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Langlet 2017; Pechey 2019; Privitera 2012 (S1); Privitera 2012 (S2); Roe 2013; Wansink 2013a). This was unclear in the remaining 12 studies.

Further details on characteristics of interventions and comparators are provided in the [Characteristics of included studies](#) section.

We contacted the authors of eight studies with requests for data or clarifications on presented data (Fiske 2004; Langlet 2017; Musher-Eizenman 2010; Painter 2002; Pechey 2019; Stubbs 2001; Wansink 2006; Wansink 2013a). We received data from Langlet 2017 and Pechey 2019, while we included Musher-Eizenman 2010 in analysis using data provided in the report. Regarding the remaining five studies, we imputed standard deviations for four studies using methods described in the [Measures of treatment effect](#) section (Fiske 2004; Painter 2002; Stubbs 2001; Wansink 2006). We excluded Wansink 2013a from the analysis due to reporting data that were modelled, with the raw data based on observations unobtainable.

## Excluded studies

We excluded 113 studies at the full-text screening stage. Of these, we excluded 76 studies for not featuring an eligible intervention; 27 for not using an eligible study design; nine for not assessing selection or consumption as defined; and one study for not being a report of an empirical study. Excluded studies are listed in the

Characteristics of excluded studies section.

## Risk of bias in included studies

We used the RoB 2.0 tool to assess risk of bias for each of the included studies. A summary of these assessments is provided in Table 1. In terms of overall risk of bias, there were concerns about risk of bias for the majority of studies (20/24), with two of these assessed as at high risk of bias (Musher-Eizenman 2010; Wansink 2013a). A text summary is provided below for each of the six individual components of the 'Risk of bias' assessment.

*Bias arising from the randomisation process.* This was the most common criterion for which risk of bias was apparent, with significant concerns regarding 19/24 studies (Cohen 2015; Engell 1996 (S1); Engell 1996 (S2); Fiske 2004; Greene 2017; Kocken 2012; Kongsbak 2016; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Painter 2002; Pechey 2019; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Roe 2013; Stubbs 2001; Wansink 2006), due primarily to an absence of detail in describing the randomisation and allocation concealment processes. We considered one study as at high risk of bias because it could not be ruled out based on the description that participants were allocated to intervention in an alternating sequence rather than as a result of randomisation (Wansink 2013a).

*Bias arising from the timing of identification and recruitment of individual participants in relation to timing of randomisation.* This assessment only applied to cluster-randomised trials (Cohen 2015; Fiske 2004; Foster 2014; Kocken 2012; Langlet 2017), and all five such studies were considered as at low risk of bias for this domain.

*Bias due to deviations from intended interventions.* We judged all studies to be at low risk of bias on this domain, apart from two studies for which significant concerns were identified (Painter 2002; Wansink 2006). These two studies used cross-over designs with short wash-out periods, meaning that it is likely that participants were aware of being exposed to the intervention and the possibility of carry-over effects could not therefore reasonably be dismissed.

*Bias due to missing outcome data.* This was typically judged to be at low risk. There were substantive concerns about risk of bias for one study in which there were substantial missing data (Musher-Eizenman 2010). Additionally, the assignment and effect of missing participants was not detailed.

*Bias in measurement of the outcome.* All of the included studies used objective measures of behaviour, an inclusion criterion for the review. We judged this domain as low risk for all studies.

*Bias in selection of the reported result.* We judged this domain as low risk for all studies. However, it is notable that, to our knowledge, only five of the included studies were preregistered with publicly available study protocols (Cohen 2015; Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Pechey 2019).

## Effects of interventions

See: **Summary of findings for the main comparison** Lower versus higher availability (i.e. fewer versus more options) of food products for changing quantity of food selected or consumed; **Summary of findings 2** Lower versus higher proximity (i.e. placed farther away versus placed nearer) of food products for changing quantity of food selected or consumed

We have reported results separately for both availability interventions and proximity interventions, for both selection and consumption outcomes. As we identified no study in which alcohol or tobacco products were the target of the intervention, the results of this review relate solely to food. Results of meta-analyses are presented as standardised mean differences (SMDs) with 95% confidence intervals (CIs). Using a similar approach to re-expressing effect sizes in a more familiar metric as we have used previously (Crockett 2018; Hollands 2015), we have also re-expressed SMDs based on estimated average (mean) consumption levels and standard deviations (SDs) among representative samples of the UK population. For this translation, we calculated an estimate of the percentage reduction in energy consumed over a typical snack occasion, given that the included studies typically manipulated snack foods intended for immediate consumption. For selection outcomes, it was assumed that all food that is selected is consumed. We used a mean (SD) of 200 ( $\pm 63$ ) kilocalories(kcal) as a baseline value, given guidance concerning a 200 kcal threshold for energy consumption from snacks (NHS 2018). These figures were based on daily energy intake from food among UK adults (aged 19 to 64) estimated at  $1773 \pm 561$  kcal by the most recent available years (7-8, i.e. 2014/15 to 2015/16) of the UK National Diet and Nutrition Survey (Public Health England 2018a). However, it is important to note the limitations of such translations (Hollands 2015). Firstly, these re-expressed values relate to UK populations (although readers could translate the results in similar fashion using representative survey data from other countries). Secondly, because such translations necessarily extrapolate beyond the scope of the included studies and data therein, they are intended only to be illustrative for guiding interpretation of the meta-analyses. In this particular case, there is additional extrapolation in assuming that the variance associated with total daily energy intake will be proportionate for lower levels of energy intake.

### Effect on selection of lower availability of food products

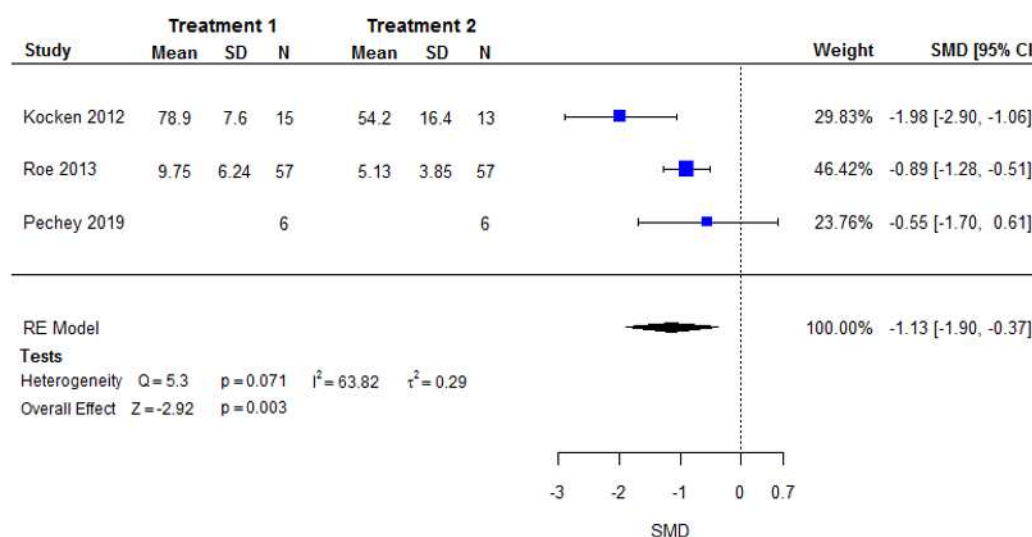
For our primary analysis, useable outcome data were available for three comparisons involving 154 participants and identified from three food studies that changed either the relative number (proportion) of less-healthy (to healthier) options, or changed the absolute number of different options available (Kocken 2012; Pechey 2019; Roe 2013). Kocken 2012 decreased the number of high-calorie options available in vending machines (with corresponding increases in low-calorie options). Pechey 2019 changed the relative proportion of less-healthy (i.e. higher energy) cooked meal,



snack, cold drink, and sandwich options, with a corresponding change in healthier (i.e. lower energy) options. Roe 2013 changed the absolute number of different fruit and vegetable options. Random-effects meta-analysis produced a summary mean effect size (SMD) of  $-1.13$  (95% CI  $-1.90$  to  $-0.37$ ,  $P = 0.003$ ), meaning that lower availability of a targeted range or category of food(s) - here being a lower proportion of less-healthy (to healthier) options or a lower absolute number of different options - decreased the amount that was selected, with a large relative effect size (Figure 3; Summary of findings for the main comparison). Our interpretation of the size of this summary effect suggests that if availability

was reduced for an assumed average snack occasion of 200 ( $\pm 63$ ) kcal, adults would select 71 kcal fewer, reducing energy selected by 35.6% (59.9% to 11.7% less). The  $I^2$  statistic (64%) indicates that a substantial amount of the total variance in study-level estimates of this effect was attributable to statistical heterogeneity, which was consistent with differences in the characteristics of the studies within this analysis. When a fixed-effect model was used, the effect was similar: SMD  $-1.01$  (95% CI  $-1.35$  to  $-0.67$ ,  $P < 0.001$ ).

**Figure 3. Forest plot of the standardised mean difference (SMD) in selection with higher (intervention 1) versus lower (intervention 2) availability of food products (i.e. more versus fewer options).**



Assessing evidence of possible publication bias via funnel plots was not appropriate due to the low number of studies. We were unable to conduct meta-regression analysis due to the lack of studies, with fewer than 10 data points for all variables.

GRADE assessment indicated that the evidence for this outcome is of low certainty, meaning that current evidence provides some indication of the likely effect, but the likelihood that the actual effect will be substantially different is high. We reached this judgement through consideration of the following criteria. We downgraded the current evidence by one level (i.e. serious limitations) due to study limitations because we judged the study-level estimate of this effect to have significant concerns related to risk of bias. We also downgraded the evidence by one level due to imprecision, be-

cause even though the lower CI value indicated a small-moderate effect, the CIs were wide, and the number of participants (sample size) incorporated into this meta-analysis was notably small and did not exceed the optimal information size (i.e. the number of participants generated by a conventional sample size calculation for a single adequately powered trial powered conservatively to detect a small effect size). We did not downgrade the evidence for inconsistency (effect sizes were in a consistent direction with some overlap of CIs, although heterogeneity was considerable), indirectness, or for other considerations including publication bias. No data were imputed for studies included in the primary analysis, therefore the planned sensitivity analysis concerning imputed data

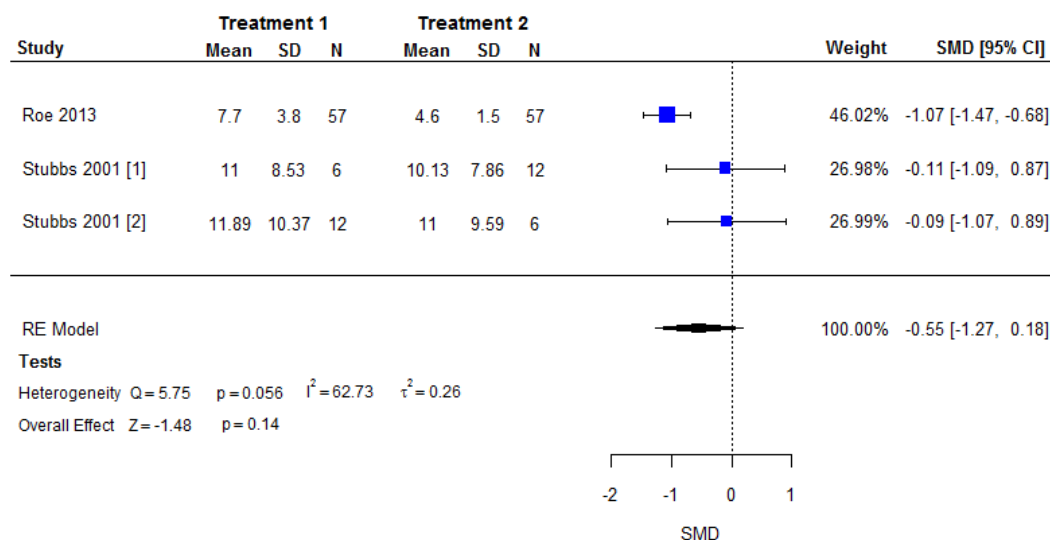
was not applicable. We excluded data from two additional studies from the primary analysis for this outcome due to the intervention effect being confounded as part of multicomponent interventions (Fiske 2004; Foster 2014). In a prespecified sensitivity analysis, we reinstated these data, resulting in an analysis of five comparisons, involving 172 participants, identified from five food studies (Fiske 2004; Foster 2014; Kocken 2012; Pechey 2019; Roe 2013). This did not alter the result or interpretation, with point estimates and 95% CIs being similar for both random-effects and fixed-effect models (random-effects SMD:  $-1.01$  (95% CI  $-1.57$  to  $-0.45$ ,  $P < 0.001$ ); fixed-effect SMD:  $-0.97$  (95% CI  $-1.30$  to  $-0.65$ ,  $P < 0.001$ )).

### Effect on consumption of lower availability of food products

For our primary analysis, useable outcome data were available for three comparisons involving 150 participants in two food studies that changed the absolute number of different options available (Roe 2013; Stubbs 2001). Roe 2013 changed the absolute number of different fruit and vegetable options, whilst Stubbs 2001 altered the absolute number of different meal options. Random-

effects meta-analysis produced a summary mean effect size (SMD) of  $-0.55$  (95% CI  $-1.27$  to  $0.18$ ,  $P = 0.14$ ) (Figure 4; Summary of findings for the main comparison). This result indicated uncertainty about the effect of lower availability - here being a lower absolute number of different options of a targeted range or category of food(s) - on amount consumed, with the point estimate indicating a moderate reduction in consumption, and wide CIs that included the possibility of a small increase in consumption. When a fixed-effect model was used, the mean effect size was larger, with CIs not including zero:  $-0.84$  (95% CI  $-1.18$  to  $-0.49$ ,  $P < 0.001$ ). Our interpretation of the size of the summary effect from the random-effects model suggests that if availability was reduced for an assumed average snack occasion of 200 ( $\pm 63$ ) kcal, adults would consume 35 kcal fewer, reducing energy consumed by 17.3% (40% less to 5.7% more). The  $I^2$  statistic (63%) indicates that a substantial amount of the total variance in study-level estimates of this effect was attributable to statistical heterogeneity, which was consistent with differences in the characteristics of the two studies within this analysis. A sensitivity analysis in which a single average SMD was computed for each multi-arm study produced SMD  $-0.69$  (95% CI  $-1.63$  to  $0.24$ ,  $P = 0.15$ ) in a random-effects analysis based on two results.

**Figure 4. Forest plot of the standardised mean difference (SMD) in consumption with higher (intervention 1) versus lower (intervention 2) availability of food products (i.e. more versus fewer options).**



Assessing evidence of possible publication bias via funnel plots was not appropriate due to the low number of studies. We did not conduct meta-regression analyses due to the lack of studies, with fewer than 10 data points for all variables.

GRADE assessment indicated that the evidence for this outcome is of low certainty, meaning that current evidence provides some indication of the likely effect, but the likelihood that the actual effect will be substantially different is high. We reached this judgement through consideration of the following criteria. We downgraded the current evidence by one level (i.e. serious limitations) due to study limitations, as we judged all study-level estimates of this effect to have significant concerns related to risk of bias. We also downgraded the evidence by one level due to imprecision. Whilst the point estimate indicated a moderate effect on reducing consumption, the CIs were wide and included the possibility of a small effect on increasing consumption. Furthermore, the number of participants (sample size) incorporated into this meta-analysis was notably small and did not exceed the number of participants generated by a conventional sample size calculation for a single adequately powered trial, powered conservatively to detect a small effect size (optimal information size). We did not downgrade the evidence for inconsistency, as whilst statistical heterogeneity was substantial (although not considerable), effect sizes were in a consistent direction, and the meta-analysis result was driven mainly by a single study (Roe 2013). We also did not downgrade the evidence for indirectness, as all included studies assessed participants, interventions, comparators, and outcomes that met the eligibility criteria for this review. We did not specify that any particular characteristics were more informative than others in addressing the objectives of the review, such as those conducted in particular settings, although the included studies for this outcome were from both field, Roe 2013, and laboratory, Stubbs 2001, settings. Finally, we did not downgrade the evidence for other considerations including publication bias because there was no clear evidence of such bias, and we judged that there were no applicable reasons to consider upgrading the certainty of the evidence.

Our prespecified sensitivity analyses concerning imputed data meant the removal of data from Stubbs 2001, with only the Roe 2013 data remaining, resulting in an effect size (SMD) of  $-1.07$  (95% CI  $-1.47$  to  $-0.68$ ). This analysis did not significantly alter interpretation, and represents only a single study, but relative to our primary analysis, the point estimate indicated a larger reduction in consumption, with wide CIs that no longer include the possibility of an increase in consumption. The planned sensitivity analysis concerning additional confounded intervention components was not applicable for this outcome.

### Effect on selection of lower proximity (i.e. food products placed farther away)

For our intended primary analysis of selection outcomes for proximity interventions, we identified only one study (Langlet 2017). One comparison (41 participants) found that exposure to food

placed farther away resulted in a moderate reduction in its selection: SMD  $-0.65$  (95% CI  $-1.29$  to  $-0.01$ ,  $P = 0.045$ ), equivalent to adults selecting 20.5% less energy (40.6% to 0.3% less) (Summary of findings 2).

Assessing evidence of possible publication bias via funnel plots was not appropriate due to insufficient studies. Meta-regression analysis could also not be conducted due to insufficient studies, with fewer than 10 data points for all variables.

GRADE assessment indicated that the evidence for this outcome is of very low certainty, meaning that the current evidence does not provide a reliable indication of the likely effect, and that the likelihood that the actual effect will be substantially different is very high. We reached this judgement through consideration of the following criteria. We downgraded the current evidence by one level (i.e. serious limitations) due to study limitations because we judged the study-level estimate of the effect to have significant concerns related to risk of bias. We also downgraded the evidence by one level for imprecision because the effect estimate derived from a single small study. We downgraded the evidence a further level for indirectness, because all the data derived from a study conducted in a laboratory setting, meaning that it may be less directly informative to real-world implementation of the intervention. We did not downgrade the evidence for inconsistency or publication bias.

The planned sensitivity analysis concerning imputed data was not applicable for this outcome. There were additional useable outcome data from three food studies that were excluded from the primary analysis for this outcome due to the intervention effect being confounded as part of multicomponent interventions (Cohen 2015; Greene 2017; Kongsbak 2016). In a prespecified sensitivity analysis, we reinstated these data, resulting in an analysis of four comparisons (1703 participants). This did not result in an interpretation that differed from the primary analysis. Random-effects meta-analysis produced a summary mean effect size (SMD) of  $-0.71$  (95% CI  $-1.08$  to  $-0.33$ ,  $P < 0.001$ ), meaning that food products placed farther away resulted in a moderate decrease in selection equivalent to 22.4% less energy (34% to 10.4% less) being selected by adults on each 200 kcal snack occasion. This result was identical when a fixed-effect model was used. The  $I^2$  statistic (0%) indicates that none of the total variance in study-level estimates of this effect was attributable to statistical heterogeneity.

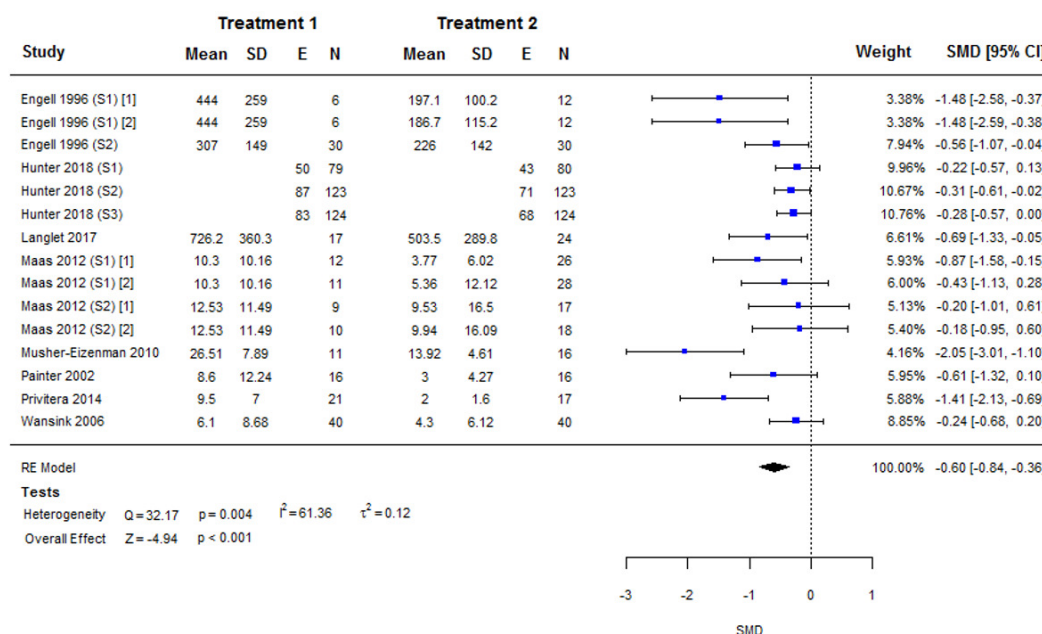
### Effect on consumption of lower proximity (i.e. food products placed farther away)

For our planned primary analysis, outcome data were available for 17 comparisons, involving 1194 participants, identified from 14 food studies (Engell 1996 (S1); Engell 1996 (S2); Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Painter 2002; Privitera 2012 (S1); Privitera 2012 (S2); Privitera 2014; Wansink

2006). All of these studies increased the distance at which the product was placed from a set point, in all cases being the distance between a chair, table, or desk and where a participant was positioned. Random-effects meta-analysis produced a summary mean effect size (SMD) of  $-1.30$  (95% CI  $-2.13$  to  $-0.46$ ,  $P = 0.002$ ), meaning that placing food products farther away decreased the amount that was consumed, with a large relative effect size. This result differed in magnitude when a fixed-effect model was used, showing a reduced summary mean effect size (SMD) of  $-0.55$ , with narrower CIs (95% CI  $-0.68$  to  $-0.42$ ,  $P < 0.001$ ). However, the  $I^2$  statistic (97%) indicates that most of the total variance in study-level estimates of this effect was attributable to statistical heterogeneity, suggesting that the source of this heterogeneity should be identified. Two studies were responsible for a significant proportion of the observed heterogeneity as a result of their outlying respective summary effect sizes of (SMD)  $-5.34$  and  $-6.96$  (Privitera 2012 (S1); Privitera 2012 (S2)). We have found no clear explanation for why these studies would have generated such extreme, heterogeneous estimates: study, intervention, and participant characteristics did not differ notably from other studies included in the analysis. The estimated effect sizes are larger than we consider to be plausible, therefore these data were removed from the main analysis. Removing these two studies meant that this

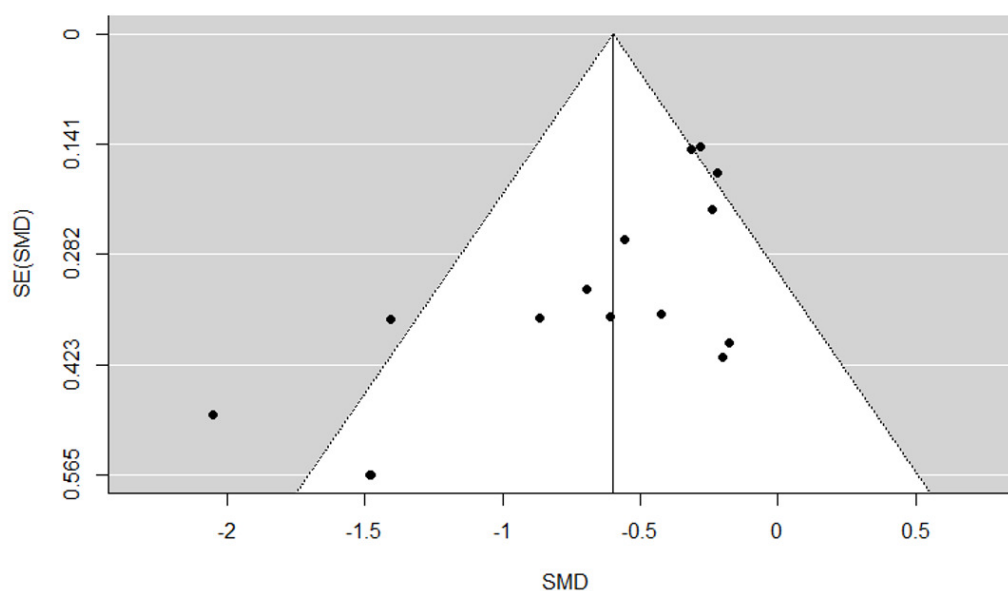
principal analysis involved 15 comparisons (1098 participants) identified from 12 food studies (Engell 1996 (S1); Engell 1996 (S2); Hunter 2018 (S1); Hunter 2018 (S2); Hunter 2019; Langlet 2017; Maas 2012 (S1); Maas 2012 (S2); Musher-Eizenman 2010; Painter 2002; Privitera 2014; Wansink 2006). This resulted in a reduced but still moderate effect size for a random-effects model, with a reduced  $I^2$  statistic value of 61%: SMD  $-0.60$  (95% CI  $-0.84$  to  $-0.36$ ,  $P < 0.001$ ) (Figure 5; Summary of findings 2). Our interpretation of the size of this summary effect suggests that that if proximity was reduced for an assumed average snack occasion of 200 ( $\pm 63$ ) kcal, adults would select 38 kcal less, reducing energy consumed by 18.9% less energy (26.5% to 11.3% less). We consider this revised analysis of 15 comparisons with outlier values excluded to be the primary analysis for this outcome, and is the result reported in the corresponding Summary of findings 2 and used as the basis for subsequent meta-regression analyses and sensitivity analyses described below. A similar effect was estimated when a fixed-effect model was used: SMD  $-0.45$  (95% CI  $-0.58$  to  $-0.32$ ,  $P < 0.001$ ). A sensitivity analysis in which a single average SMD was computed for each multi-arm study produced SMD  $-0.59$  (95% CI  $-0.85$  to  $-0.33$ ,  $P < 0.001$ ) in a random-effects analysis based on 12 results.

**Figure 5. Forest plot of the standardised mean difference (SMD) in consumption with higher (intervention 1) versus lower (intervention 2) proximity of food products (i.e. placed nearer versus farther away).**



An asymmetrical funnel plot was observed for this analysis (Figure 6), with Egger's test giving a  $P < 0.001$  ( $Z = -4.0853$ ), suggesting the possible presence of publication bias (since the larger studies have SMD estimates nearer 0). The determination of possible publication bias informed the GRADE assessment for this outcome.

**Figure 6. Funnel plot for meta-analysis of consumption with higher versus lower proximity.**



#### Potential modifiers of the effect on consumption (meta-regression analyses)

For the effect of proximity on consumption, there were sufficient data as per our criteria (i.e. data points from at least 10 studies for at least some extracted variables) to conduct meta-regression analyses to investigate potential effect modifiers. Whilst the majority of candidate variables were excluded due to either insufficient data or the absence of variability in data values between studies, univariable meta-regression analysis was possible for 10 extracted variables, with numerical results presented in full in [Appendix 3](#). We observed that four of these covariates were associated with the effect of proximity on consumption. We have outlined the stages of the meta-regression analyses below (as described in [Data synthesis](#)), and for each stage, have highlighted any variables observed to be associated with the intervention effect.

At Stage 1, we conducted the meta-analysis described above, followed at each subsequent stage with a meta-regression analysis.

At Stage 2, where we examined study characteristics as covariates,

the following three variables were significantly associated with the intervention effect.

- Product-outcome relationship. Effect sizes for lower (versus higher) proximity were larger when the specific product(s) that was manipulated was the only product available to participants, as opposed to there being other unmanipulated products available. It is plausible that the absence of any other products would increase the effect of the intervention, given less potential for its effect to be diluted.
- Summary risk of bias. Effect sizes for lower (versus higher) proximity were larger for studies at high risk of bias, versus both low risk of bias and those where there were some concerns.
- Socioeconomic context. Effect sizes for lower (versus higher) proximity were larger when deprivation status was low, than among studies with samples that were both high and low in deprivation.

At Stage 3, we examined intervention characteristics as covariates,

and the following single variable was significantly associated with the intervention effect.

- Absolute difference in proximity. Effect sizes for lower (versus higher) proximity were larger the farther away the product was placed relative to a comparator. Increasing distance resulting in an increased intervention effect is consistent with the theory underlying why the intervention might work.

At Stage 4, we examined participant characteristics as covariates, and found no variables to be associated with the intervention effect.

In summary, meta-regression analyses indicated that the intervention effect was greater under four conditions: the farther away the product was placed relative to a comparator; when only the targeted product(s) (as opposed to a wider range) was available; when participants were of low (versus both high and low) deprivation status; and when the study was at high risk of bias. The results of this analysis should be interpreted with caution because the numbers of data points available for each included explanatory variable only barely exceeded the prespecified minimum level for inclusion (i.e. available data from a minimum of 10 studies). Furthermore, the associations cannot be interpreted as causal, and some of the study characteristics were correlated with each other. For example, all of the studies assessed as at high risk/some concerns of bias were in low deprivation contexts (whilst all studies with samples that were both high and low in deprivation were at low risk of bias); and studies where there were other unmanipulated products available tended to be those in which the absolute difference in proximity was greater.

GRADE assessment applied to the analysis that excluded outliers indicated that the evidence for this outcome is of low certainty, meaning that current evidence provides some indication of the likely effect, but the likelihood that the actual effect will be substantially different is high. We reached this judgement through consideration of the following criteria. We downgraded the current evidence by one level (i.e. serious limitations) due to study limitations, as we judged the majority of study-level estimates of this effect to have significant concerns related to risk of bias. We did not downgrade the evidence for imprecision because even the lower CI value indicated a small-to-moderate intervention effect, and the number of participants (sample size) incorporated into this meta-analysis was substantial and exceeded the optimal information size. We did not downgrade the evidence for inconsistency (as although heterogeneity was substantial, effect sizes were in a consistent direction with reasonable overlap of CIs) or indirectness. We downgraded the evidence by one level for publication bias because formal assessment of the degree of asymmetry present in a funnel plot suggested its presence.

Our prespecified sensitivity analyses concerning imputed data meant the removal of data from [Painter 2002](#) and [Wansink 2006](#) from the primary analysis. This did not alter the results or interpretation, with point estimates and 95% CIs being similar to our primary meta-analysis (random-effects SMD  $-0.66$  (95% CI  $-0.94$  to  $-0.37$ ,  $P < 0.001$ ); fixed-effect SMD  $-0.46$  (95% CI  $-0.60$  to  $-0.32$ ,  $P < 0.001$ )). We excluded data from two studies from the primary analysis for this outcome due to the intervention effect being confounded as part of multicomponent interventions ([Cohen 2015](#); [Greene 2017](#)). In a prespecified sensitivity analysis, we reinstated these data, resulting in an analysis of 17 comparisons (2695 participants) identified from 14 food studies ([Cohen 2015](#); [Engell 1996](#) (S1); [Engell 1996](#) (S2); [Greene 2017](#); [Hunter 2018](#) (S1); [Hunter 2018](#) (S2); [Hunter 2019](#); [Langlet 2017](#); [Maas 2012](#) (S1); [Maas 2012](#) (S2); [Musher-Eizenman 2010](#); [Painter 2002](#); [Privitera 2014](#); [Wansink 2006](#)). This did not alter the result or interpretation, with point estimates and 95% CIs being similar to our primary meta-analysis (random-effects SMD  $-0.56$  (95% CI  $-0.79$  to  $-0.33$ ,  $P < 0.001$ ); fixed-effect SMD  $-0.44$  (95% CI  $-0.57$  to  $-0.31$ ,  $P < 0.001$ )).

## Secondary outcomes

Secondary outcomes, specified as selection and consumption outcomes relating to products not manipulated by the intervention, were rarely reported. This was principally because interventions manipulated all the available products, or because outcomes relating to non-manipulated products were not assessed. One availability study included secondary outcomes that met our criteria: [Pechey 2019](#) reported that the intervention resulted in significantly less total energy ( $-7.2\%$ ) being purchased, that is energy from all food categories, whether targeted by the intervention or not. Two proximity studies included pertinent secondary outcomes. [Cohen 2015](#) reported no effect of the intervention on selection and consumption of non-manipulated main meals, and [Kongsbak 2016](#) reported that the intervention resulted in less total energy being selected. Such limited reporting of these outcomes may be expected in laboratory studies featuring single or small numbers of products, but in this body of studies it was also rarely reported in field settings, which may also partly reflect the complexity of capturing and interpreting such data in complex real-world food environments. In sum, data on secondary outcomes were sparse and difficult to compare across studies due to differing study characteristics. There was, however, a small amount of evidence suggesting that compensatory behaviour - for example increased selection or consumption of non-manipulated products - did not occur. Furthermore, there was an absence of clear evidence suggesting that such compensatory behaviour did occur.



## ADDITIONAL SUMMARY OF FINDINGS *[Explanation]*

Lower versus higher proximity of food products for changing quantity of food selected or consumed					
<b>Patient or population:</b> Adults and children <b>Setting:</b> Field and laboratory settings <b>Intervention:</b> Lower proximity of food products (placed farther away) <b>Comparison:</b> Higher proximity of food products (placed nearer)					
Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	Number of participants (studies; comparisons)	Certainty of evidence (GRADE)
	Assumed risk: higher proximity of food products (placed nearer)	Corresponding risk: lower proximity of food products (placed farther away)			
Selection	Mean energy selected on an average snack occasion of 200 (±63) kcal <sup>1</sup>	Mean energy selected on an average snack occasion would be 41 kcal (20.5%) less with lower proximity (81 kcal fewer to 1 kcal fewer; 40.6% less to 0.3% less)	Mean selection in the lower proximity group was 0.65 standard deviations lower (1.29 lower to 0.01 lower)	41 (1 RCT; 1 comparison)	⊕○○○ VERY LOW <sup>234</sup>
Consumption	Mean energy intake on an average snack occasion of 200 (±63) kcal	Mean energy intake on an average snack occasion would be 38 kcal (18.9%) less with lower proximity (53 kcal fewer to 23 kcal fewer; 26.5% less to 11.3% less)	Mean consumption in the lower availability group was 0.60 standard deviations lower (0.84 lower to 0.36 lower)	1098 (12 RCTs; 15 comparisons)	⊕⊕○○ LOW <sup>25</sup>
The basis for the assumed risk is provided in Footnotes. <sup>6</sup> The corresponding risk (and its 95% confidence interval) is based on the assumed risk and the relative effect of the intervention (and its 95% CI). The relative effect is derived from the primary random-effects meta-analysis for the outcome <b>CI:</b> confidence interval; <b>kcal:</b> kilocalories; <b>RCT:</b> randomised controlled trial					

#### GRADE Working Group grades of evidence

**High certainty:** The current evidence provides a very good indication of the likely effect, and the likelihood that the actual effect will be substantially different is low.

**Moderate certainty:** The current evidence provides a good indication of the likely effect, and the likelihood that the actual effect of the treatment will not be substantially different is moderate.

**Low certainty:** The current evidence provides some indication of the likely effect, but the likelihood that the actual effect will be substantially different is high.

**Very low certainty:** The current evidence does not provide a reliable indication of the likely effect, and the likelihood that the actual effect will be substantially different is very high

<sup>1</sup>Assumes that all foods selected are consumed.

<sup>2</sup>Downgraded by one level for study limitations: study-level estimates of this effect were judged to have significant concerns related to risk of bias.

<sup>3</sup>Downgraded by one level for imprecision: the effect estimate derives from a single small study.

<sup>4</sup>Downgraded by one level for indirectness: all data derived from a study conducted in a laboratory setting, meaning it may be less directly informative to real-world implementation of the intervention.

<sup>5</sup>Downgraded by one level for publication bias: formal assessment of the degree of asymmetry present in a funnel plot suggested the presence of publication bias.

<sup>6</sup>Estimates of variance are based on data from a representative sample of UK adults, from the UK National Diet and Nutrition Survey Years 7-8 ([Public Health England 2018a](#)); see [Effects of interventions](#) for details.



## DISCUSSION

### Summary of main results

The evidence in this review suggests that people select less of a targeted range or category of food(s) when fewer options of that food are available. Because the direction of comparisons within the analysis is interchangeable, they likewise select more when more options are available. However, there was greater uncertainty about the effect of such availability interventions on consumption. A separate body of evidence suggests that people consume less food when products are placed farther away (and likewise more when placed nearer), with a less certain effect on selection. Consequently, these interventions have the potential to have beneficial or harmful effects on health, depending on the characteristics of the food(s) that they focus upon.

The summary effect sizes derived from meta-analyses were considerable, suggesting potential impacts of between 17% and 36% on energy selected and consumed on an average snack occasion. Although such estimates are necessarily tentative due to limitations of the underlying data and the assumptions inherent to generating and applying them, if sustained effects of such magnitude were realised and extended to foods consumed over each day, reductions in daily energy intake would have the potential to make meaningful contributions to addressing major risk factors for non-communicable disease. For example, 10-year weight gain between 1999 and 2009 among adults in England (i.e. 9 kg at the 90th percentile) has been estimated to be equivalent to extra energy intake of around 24 kcal per day over the same period (an amount equivalent to approximately 1.4% of average daily energy intake for UK adults) (Department of Health 2011). Any sustained reductions in daily energy intake exceeding this level are therefore likely to be effective in helping to prevent further weight gain in the population. Whilst these illustrations highlight the promise of these interventions, the sustainability of their effects has yet to be established, with the majority of studies in this review featuring short-term exposures to interventions, and because the certainty of the evidence varied and was assessed as low or very low for all outcomes, we can only have limited confidence in the effect estimates.

Importantly, the evidence base for this review was limited in quantity, often severely so, and was entirely absent for alcohol and tobacco products. Furthermore, evidence was sparse for secondary outcomes that could indicate the potential for unintended compensatory behaviour, although there was a small amount of evidence suggesting that this did not occur in response to the intervention and an absence of clear evidence suggesting that it did. Due to the lack of data, we were also unable to satisfactorily address the second objective of the review, concerning potential modifiers of the observed intervention effects (see [Overall completeness and applicability of evidence](#)).

### Overall completeness and applicability of evidence

The completeness and applicability of the evidence was limited as a result of several characteristics of the evidence base. The synthesised evidence was collected from 24 included studies, with only six reporting availability interventions. In only one primary analysis (the effect of proximity on consumption) did the sample size exceed the optimal information size. The sample sizes weaken confidence that these studies enable us to address the first objective of this review. An additional impact of the limited quantity of evidence is that this reduces the representativeness of the evidence base across a myriad of possible study, intervention, and participant contexts. This means that the extent to which the results of the review apply to other contexts is uncertain. For example, the majority of studies were conducted in the USA, with no studies in LMICs, and participants were typically characterised by low social and material deprivation. These factors limit assessment of social differentiation in effects relevant to health equity. For example, while we have no reason to expect that mechanisms by which exposure to these interventions may influence behaviour will differ substantively and systematically between people living in HICs and those living in LMICs, a range of socio-cultural, economic, and contextual differences between these groups could plausibly modify effects. Studies are needed that focus on these contexts.

A further limitation regarding completeness concerns the setting of studies. The majority of included studies were conducted in laboratory settings - which even when relatively naturalistic in their design cannot convincingly replicate uncontrolled, real-world settings - although this limitation does apply differentially to availability and proximity interventions. For availability interventions, while there was a very small number of studies, the majority were conducted in field settings (namely schools, a childcare facility, worksite cafeterias, and supermarkets) and intervention exposures were over prolonged time periods. Despite this, there were insufficient data to draw meaningful conclusions specific to any one type of field setting (e.g. schools or supermarkets), given that contextual characteristics and participant behaviours are likely to differ substantially between these settings. Only four proximity studies were conducted in field settings. Laboratory-based studies of proximity interventions, as is typical for such contexts, usually assessed one-off exposures or repeated exposures over relatively short time periods, with correspondingly short-term outcomes. They also usually exposed participants to a single, or small range of, snack food intended for immediate consumption, limiting the degree to which such effects can be generalised to complex real-world food environments.

The most notable gap in this evidence base, however, was the absence of any eligible studies investigating effects of these interventions on selection or consumption of either alcohol or tobacco products. This finding is consistent with the small proportion of studies on alcohol and tobacco compared with food products, which we found in a large scoping review of interventions within

physical micro-environments (Hollands 2013a; Hollands 2013b). This may be attributable to both a greater interest in, and more opportunities for, intervening on food products due to the broad range that are available, their ubiquity in multiple environments, and the necessity of their consumption. It may also reflect the proportion of research focused on reducing consumption of tobacco and alcohol, compared with food. Research on tobacco and alcohol has tended to consider treatments for the subgroup of the population addicted to those products, whereas studies in relation to food are more likely to take a whole-population approach. Furthermore, tobacco and alcohol are more highly regulated products in terms of where and how they can be sold, which may limit opportunities for research relative to food products.

Finally, due to the relatively small amount of available data, it was typically not possible to assess the impact of variations in characteristics between included studies on intervention effects. This meant that it was not possible to satisfactorily address the second objective of this review, namely to assess potential effect modifiers. It was only the effect of proximity on consumption that allowed meta-regression analyses - including only a small number of modifying variables - to be conducted. These analyses indicated that the intervention effect was greater: the farther away the product was placed relative to a comparator; when only the targeted product(s) (as opposed to a wider range) was available; when participants were of low (versus both high and low) deprivation status; and when the study was at high risk of bias. However, because the amount of data available only barely exceeded that which we set as the absolute minimum necessary, and due to their essentially observational nature, these findings should be given considerable caution. Before they can be meaningfully interpreted, they will require confirmation and replication in further research involving larger datasets, but ultimately may prove useful in evaluating, developing, and targeting interventions. Similarly, we were typically unable to examine whether potentially important associations were absent, in other words whether intervention effects were robust to variations in key intervention and participant characteristics. For example, while meta-regression analyses did not find that the proportion of female participants modified the intervention effect, which could add credence to the idea that altering environmental cues has the potential to impact behaviour across populations, we were unable to examine other key characteristics such as age or BMI.

## Quality of the evidence

At the level of individual studies, the large majority of studies were subject to significant concerns about risk of bias, reflecting serious concerns about study limitations, compounded by unclear and incomplete reporting of study methods. Commonly, this derived from concerns about bias arising from the randomisation process, but we could not identify any obvious reason to prevent the implementation of unbiased procedures for random sequence generation and allocation concealment or reporting thereof. At the

level of the evidence available for each outcome, we accounted for the significant concerns about risk of bias by downgrading each of these outcomes by one level within GRADE assessments. When also considering the full set of GRADE criteria for each outcome (detailed in [Effects of interventions](#)), we judged the evidence base to be of low certainty for the effect of availability on both selection and consumption ([Summary of findings for the main comparison](#)); low certainty for the effect of proximity on consumption; and very low certainty for the effect of proximity on selection ([Summary of findings 2](#)). In sum, this confers, at best, limited confidence in our estimated effects and necessitates due caution in their interpretation.

It is noted that Brian Wansink is an author on four of the studies included in the review (Greene 2017; Painter 2002; Wansink 2006; Wansink 2013a), two of which (Painter 2002; Wansink 2006) contributed data to our primary meta-analyses. This researcher has been subject to multiple retractions of his work due to academic misconduct (Munafò 2018). To date, none of the studies included in this review have been retracted, but should this occur, we will withdraw that study's data from updated meta-analyses conducted as part of a future update. Whilst these retractions introduce additional uncertainty regarding the veracity of other, unretracted studies he has authored, we chose not to report analyses that remove data from any studies authored by Wansink. This would assume that Wansink was principally responsible for the data reported in all studies for which he is an author - an unreasonable assumption without specific knowledge, and potentially unfair to co-authors. Relatedly, it could also set an unwelcome precedent for consistently excluding all data linked by co-authorship to an author who has had papers retracted due to academic misconduct. Finally, we note that for 12 of the studies, potential commercial conflicts of interest were unclear, thus preventing us from eliminating the possibility that the review results could be biased in some way by interests of the study authors.

## Potential biases in the review process

The potential for review author error and bias was reduced by involving at least two independent review authors in the selection of studies and the data extraction and study assessment processes. Whilst it remains possible that we failed to identify all relevant research for inclusion in the review, we used an extensive and highly sensitive search strategy involving a comprehensive range of databases and other sources, as well as backwards and forwards citation searches.

## Agreements and disagreements with other studies or reviews

We are not aware of other systematic reviews that focus specifically on these interventions across all settings and product types

and that also include a quantitative synthesis. [Bucher 2016](#) conducted a systematic review with substantial content overlap with the 'proximity studies' within the current review. Although that review did not meta-analyse the identified studies, the conclusions were consistent with those of the current review, namely that manipulating the order of food products or their proximity can influence food choice. A wide range of other reviews include, but are not limited to, one or both of the target interventions within a scope determined by specific settings or product types. For example, [Broers 2017](#) conducted a systematic review of a range of nudging interventions applied to fruit and vegetable choice, concluding that the largest effect was associated with interventions that altered the placement of products. [Grech 2015](#) reviewed evidence for nutrition interventions applied to vending machines, concluding that there was evidence that altering availability was an effective means of improving the nutritional quality of products purchased. Finally, [Cameron 2016](#) reviewed a broad range of evidence for supermarket-based interventions that included those changing product availability and placement, but the nature of the evidence meant that it was not possible to estimate effects of specific intervention strategies.

## AUTHORS' CONCLUSIONS

### Implications for practice

Given the complete absence of evidence for alcohol and tobacco products, the key implications of this review for public health policy and practice concern food products. Furthermore, we identified no evidence from low- and middle-income countries (LMICs), meaning that applicability to those contexts remains uncertain. Whilst, in practical terms, these interventions appear no less suitable for use in LMICs, due to, for example, their likely minimal (fixed and variable) costs, there is as yet insufficient evidence to judge their potential effectiveness or the feasibility of their implementation in such contexts.

This review suggests that policies and practices that alter the availability or proximity of food products could contribute to meaningful changes in the quantities of food that people select or consume, and could be used as part of a wider set of strategies to support healthier food consumption. With the exception of directly controlling availability and proximity, however, assessment of the effectiveness of possible intervention strategies that could achieve this was beyond the scope of this review. Furthermore, due to the limited quantity of current evidence and the low to very low certainty of this evidence, implications for practice are correspondingly tentative.

For interventions that alter availability, capitalising on these effects in a public health context could involve decreasing the absolute number of different options of a range or category of less-

healthy food, or decreasing the relative number (proportion) of less-healthy (to healthier) food options that are available within an environment. When the public health goal is to increase selection or consumption of healthier food(s), this could involve increasing the absolute number of different options of a range or category of healthier food, or increasing the relative number (proportion) of healthier (to less-healthy) options. In contrast to the proximity interventions, most of the small set of studies of availability were conducted in field settings, namely schools, a childcare facility, worksite cafeterias, and supermarkets, demonstrating that this is a strategy that is directly transferable to practice and can in theory be implemented in real-world settings. It therefore seems feasible that actions could be taken at a local level - by those who have direct responsibility for the characteristics of environments - whilst broader policy actions in at least some settings could ensure changes to availability. This could include mandating that the nutritional composition of certain ranges or categories of foods available within public-sector establishments like schools or hospitals meet specific nutritional criteria. For example, the Scottish Government and NHS Scotland have introduced the Healthcare Retail Standard (HRS) as a set of mandatory criteria for all retail outlets in all healthcare settings in Scotland, which include requiring at least 50% of products to be from a healthier range ([Scottish Government 2015](#)). In another example, as a result of pilot work, the availability of healthier options has been increased in vending machines in 105 National Health Service sites ([Public Health England 2018b](#)).

For interventions that alter proximity, capitalising on the observed effects could involve placing less-healthy food options in less immediately accessible positions relative to key environmental features (such as farther from entrances, checkouts, or walking or queueing routes), or placing healthier food options in more immediately accessible positions. In contrast to availability interventions, however, the evidence in this review derives principally from studies conducted in artificial laboratory settings. As such, while in principle such interventions would appear directly transferable to practice, their operationalisation and likely impact in real-world environments is less clear. Whilst it is challenging to identify practicable possibilities for intervention and to gauge the potential for higher-level policy actions that could impose subtle or context-specific changes to layouts of environments (such as changing the order of food presentation in cafeterias), actions could be initiated at the local level by those who have control of those environments. In addition, more comprehensive policy actions could encourage or mandate generalisable changes to environments, at least in certain contexts. For example, while checkout food policies in the UK are currently voluntary ([Ejlerskov 2018a](#)), the UK Government intends to consult on plans to ban through legislation the sale of unhealthy confectionery and snack foods at shop checkouts, end of aisles, and store entrances across the retail and out-of-home sectors. Such actions would result in these products being positioned in less accessible positions in shops ([Department](#)

of Health and Social Care 2018). While they are as yet not directly informed by true experimental evidence, observational data from natural experiments suggest that supermarket policies to reduce less-healthy food at checkouts impact upon purchasing of those foods, namely small packages of confectionery and potato crisps (Ejlertsen 2018b).

There remains considerable uncertainty about the effects of these interventions when implemented under free-living conditions, and their longer-term sustainability. Their effectiveness will be subject to all the challenges and complexities of achieving effective implementation at scale and sustained over time. One such complexity is that scaling up interventions of this kind, increasing their geographic coverage and scope, would involve introducing them into a complex food environment, populated by a multitude of available food and drink products other than those that are being manipulated. This would raise the potential for compensatory consumption or substitution effects (see [Implications for research](#)), which the evidence assembled in this review does not sufficiently elucidate.

### Implications for research

The key research implication of this review is that more high-quality studies of both availability and proximity interventions in field settings are needed. Studies of these kinds of environmental interventions are viable in real-world settings, as evidenced by existing examples, although feasibility studies attest to the fact that they are highly challenging to implement and conduct (Hollands 2018; Pechey 2019; Vermeer 2009). Future studies should demonstrate improved rigour in conduct and reporting including pre-registration of study protocols that are publicly available, and with fundamental concerns about risk of bias addressed where possible in line with common standards. Furthermore, in order to systematically develop an understanding of the effect of manipulating environmental cues, studies should, where possible, manipulate environmental cues in isolation in interventions that are designed to be unconfounded in terms of their potentially active components (Allan 2017). These new studies should include those focusing on alcohol and tobacco products, for which there was a complete absence that met the inclusion criteria for this review (see [Overall completeness and applicability of evidence](#)). These interventions are in principle transferable to these products given the range of both different alcohol and tobacco (and recognised alternative) products and of environments in which these are selected and consumed.

A further key implication of this review is that future studies should be designed to better assess and report the potential impact of these interventions on selection and consumption both over time - with extended durations of intervention exposure and outcome measurement - and for other products available within a given environment but not targeted by a given intervention. This would increase our understanding of potential compensatory or substitution be-

haviour, which could concern shifts in selection or consumption to other untargeted food products or categories. For example, a measured reduction in chocolate consumption, in response to an intervention targeting chocolate, could be accompanied by an unmeasured and undesirable equivalent increase in sugary drink consumption. Additionally, an intervention could alter the temporal patterning of behaviour as a result of compensation. For example, a measured reduction in chocolate consumption at midday could be accompanied by an unmeasured equivalent or greater increase in chocolate consumption later in the day. More detailed examination is therefore necessary to enable better estimation of an intervention's overall impact on energy consumption and related outcomes. Given that the current evidence base predominantly comprises laboratory studies that are limited to manipulating and assessing behaviour in relation to single or very limited ranges of snack foods intended for immediate consumption, it is unable to adequately address this issue. Relevant evidence from field studies remains sparse.

When implemented in real-world settings, these interventions are likely to be applied to highly complex ranges of manipulated and non-manipulated products. Although in this review we did break down the availability and proximity interventions into more granular subtypes, these categorisations remain relatively nebulous and may not be satisfactorily descriptive. It will also therefore be important for the research community to develop a more detailed conceptual understanding, and related means of characterisation and reporting of these interventions. Building on work delineating broad types of interventions in physical micro-environments using the TIPPME typology (Hollands 2017a), developments in this area attempt to map the complex parameters of these interventions and provide a conceptual framework for better characterising them (Pechey under review). In future, such developments may enable a more nuanced analysis and understanding of the intervention characteristics that principally determine effectiveness.

These implications for research are derived from reviewing the current evidence base, which derives exclusively from studies conducted in high-income countries (HICs). It is feasible that they may apply similarly to research in LMICs as for HICs, in that, for example, there is no inherent reason why the nature of interventions and study designs need differ when testing these interventions within LMICs. However, the lack of experience in conducting studies of this kind in LMICs allows for the possibility that research issues specific to such settings may emerge as the evidence accumulates.

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\* Indicates the major publication for the study

## CHARACTERISTICS OF STUDIES

### Characteristics of included studies *[ordered by study ID]*

Cohen 2015

Methods	<b>Study design:</b> Between-participants cluster-randomised controlled trial
Participants	<p><b>Setting:</b> Field setting</p> <p><b>Setting type:</b> School cafeteria</p> <p><b>Geographical region:</b> USA</p> <p><b>Number of enrolled participants:</b> 1587 (actively consented in groups of interest) (within 10 study sites)</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 1587 (100%)</p> <p><b>Study completers - mean age (SD):</b> 11.8 (not reported)</p> <p><b>Study completers - sex:</b> 55.4% female</p> <p><b>Specific social or cultural characteristics:</b> Low-income schoolchildren of elementary and middle school age</p> <p><b>Socioeconomic status context:</b> High deprivation</p> <p><b>Inclusion criteria:</b> None reported</p> <p><b>Exclusion criteria:</b> None reported</p>
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from start of queue line (order encountered along line (e.g. queue or aisle))</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Vegetables</p> <p><b>Duration of exposure to intervention:</b> &gt; 1 day</p> <p><b>Study arms:</b> Smart cafe intervention which included vegetables being offered at the start of the lunch line (along with: signage and images promoting fruits and vegetables prominently displayed, fruits placed in attractive containers, other fruit options placed next to the cash registers, white milk placed prominently in front of sugar-sweetened milk); control condition with vegetables being offered later in the lunch line</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> Vegetables offered at the start of the lunch line versus vegetables offered later in the lunch line</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> Yes (signage and images promoting fruits and vegetables prominently displayed, fruits placed in attractive containers, other fruit options placed next to the cash registers, white milk placed prominently in front of sugar-sweetened milk)</p>
Outcomes	<p><b>Outcomes reported in study:</b> Proportion of total participants selecting vegetables; proportion of total participants selecting an entrée; proportion of total participants selecting fruit; mean cups of vegetables consumed; mean cups of fruit consumed; proportion of entrée consumed; proportion of fruit consumed; proportion of vegetables consumed</p> <p><b>Selection outcome analysed:</b> Proportion of total participants selecting vegetables</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Longer term (&gt; 1 day)</p> <p><b>Consumption outcome analysed:</b> Mean cups of vegetables consumed (clear manipulation of proximity of vegetables)</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Longer term (&gt; 1 day)</p> <p><b>Secondary outcome:</b> Entrée selection; entrée consumption</p>

Funding source	Funded by grants from Arbella Insurance and the Nutritional Epidemiology of Cancer Education and Career Development Program. No conflicts of interest declared and it was stated that funders had no role in the study
Notes	Outcome data reported relate to only participants providing active consent. Data from participants within 2 additional study arms that had previously been randomised to a school chef intervention (ineligible, containing 4/14 schools within the larger study) 4 months prior to the randomisation assignment pertinent to the current analysis were not included

## Engell 1996 (S1)

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<b>Setting:</b> Laboratory setting <b>Setting type:</b> Naturalistic laboratory (dining room in research centre) <b>Geographical region:</b> USA <b>Number of enrolled participants:</b> 36 <b>Number (%) of enrolled participants completing the study and included in analysis:</b> 36 (100%) <b>Study completers - mean age (SD):</b> Not provided <b>Study completers - sex:</b> 0% female <b>Specific social or cultural characteristics:</b> Employees of US Army Natick Research Center <b>Socioeconomic status context:</b> Low deprivation <b>Inclusion criteria:</b> Male; employees of US Army Natick Research Center <b>Exclusion criteria:</b> None reported
Interventions	<b>Intervention type:</b> Proximity <b>Type of proximity intervention:</b> Proximity from positioned participant (table at which seated) (distance from set point) <b>Manipulated product type:</b> Food <b>Characteristics of manipulated products:</b> Water <b>Duration of exposure to intervention:</b> $\leq 1$ day <b>Study arms:</b> Water available within reach in pitcher on table; water available within immovable dispenser 610 cm (20 feet) from the table; water available within immovable dispenser 1220 cm (40 feet) from the table <b>Number of comparisons analysed:</b> 2 <b>Comparisons analysed:</b> Comparison 1: Water on table versus water 610 cm (20 feet) from table Comparison 2: Water on table versus water 1220 cm (40 feet) from table <b>Concurrent intervention components in factorial design:</b> No <b>Concurrent intervention components confounded with comparison of interest:</b> No
Outcomes	<b>Outcomes reported in study:</b> Water intake (g) <b>Selection outcome analysed:</b> N/A <b>Measurement of selection outcome:</b> N/A <b>Timing of selection outcome measurement:</b> N/A <b>Consumption outcome analysed:</b> Water intake (g) <b>Measurement of consumption outcome:</b> Objective <b>Timing of consumption outcome measurement:</b> Immediate ( $\leq 1$ day) <b>Secondary outcome:</b> N/A

Engell 1996 (S1) (Continued)

Funding source	Funding and conflicts of interest were not reported.
Notes	

Engell 1996 (S2)

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<b>Setting:</b> Laboratory setting <b>Setting type:</b> Naturalistic laboratory (dining room in research centre) <b>Geographical region:</b> USA <b>Number of enrolled participants:</b> 60 <b>Number (%) of enrolled participants completing the study and included in analysis:</b> 60 (100%) <b>Study completers - mean age (SD):</b> Not provided <b>Study completers - sex:</b> 0% female <b>Specific social or cultural characteristics:</b> Employees of US Army Natick Research Center <b>Socioeconomic status context:</b> Low deprivation <b>Inclusion criteria:</b> Male; employees of US Army Natick Research Center <b>Exclusion criteria:</b> None reported
Interventions	<b>Intervention type:</b> Proximity <b>Type of proximity intervention:</b> Proximity from positioned participant (table at which seated) (distance from set point) <b>Manipulated product type:</b> Food <b>Characteristics of manipulated products:</b> Water <b>Duration of exposure to intervention:</b> $\leq 1$ day <b>Study arms:</b> Water available within reach on table; water available 610 cm (20 feet) from table. (In 2 x 3 factorial design with social manipulation: no confederate; confederate drinking small amount; confederate drinking large amount) <b>Number of comparisons analysed:</b> 1 <b>Comparisons analysed:</b> Water on table versus water 610 cm (20 feet) from table <b>Concurrent intervention components in factorial design:</b> Yes (social manipulation: no confederate; confederate drinking small amount; confederate drinking large amount) <b>Concurrent intervention components confounded with comparison of interest:</b> No
Outcomes	<b>Outcomes reported in study:</b> Water intake (g) <b>Selection outcome analysed:</b> N/A <b>Measurement of selection outcome:</b> N/A <b>Timing of selection outcome measurement:</b> N/A <b>Consumption outcome analysed:</b> Water intake (g) <b>Measurement of consumption outcome:</b> Objective <b>Timing of consumption outcome measurement:</b> Immediate ( $\leq 1$ day) <b>Secondary outcome:</b> N/A
Funding source	Funding and conflicts of interest were not reported.
Notes	



Methods	<b>Study design:</b> Between-participants cluster-randomised controlled trial
Participants	<b>Setting:</b> Field setting <b>Setting type:</b> Teachers lounges in schools <b>Geographical region:</b> USA <b>Number of enrolled participants:</b> N/A (10 vending machines) <b>Number (%) of enrolled participants completing the study and included in analysis:</b> N/A (100% of vending machines) <b>Study completers - mean age (SD):</b> N/A <b>Study completers - sex:</b> N/A <b>Specific social or cultural characteristics:</b> School teachers lounges <b>Socioeconomic status context:</b> Low deprivation <b>Inclusion criteria:</b> Ability of vending machines to electronically track sales on site <b>Exclusion criteria:</b> None reported
Interventions	<b>Intervention type:</b> Availability <b>Type of availability intervention:</b> Relative number (proportion) of less-healthy (to healthier) options: higher and lower availability of high-fat (relative to low-fat) items in vending machines <b>Manipulated product type:</b> Food <b>Characteristics of manipulated products:</b> High-fat snack food (containing over 5 g of fat) or gum products, being replaced by low-fat products <b>Duration of exposure to intervention:</b> > 1 day <b>Study arms:</b> No changes made, vending machines with 33 snack food and gum items including 5 low-fat items (< 5 g of fat); reductions in available high-fat items due to including 3 additional low-fat items, plus labels highlighting prices of low-fat items; reductions in available high-fat items due to including 3 additional low-fat items, plus labels, plus large motivational signs <b>Number of comparisons analysed:</b> 1 <b>Comparisons analysed:</b> Higher availability of high-fat items, vending machines with 33 snack food and gum items including 5 low-fat items (< 5 g of fat) versus lower availability of high-fat items, vending machines with 33 snack food and gum items including 8 low-fat items (< 5 g of fat) (combining 2 study conditions) <b>Concurrent intervention components in factorial design:</b> No <b>Concurrent intervention components confounded with comparison of interest:</b> Yes (labels (1 condition) and labels plus signs (1 condition))
Outcomes	<b>Outcomes reported in study:</b> Total items sold; number of a range of low-fat items sold; number of high-fat items sold; total dollar sales for low-fat items <b>Selection outcome analysed:</b> Mean number of high-fat ('Other') items sold in intervention weeks <b>Measurement of selection outcome:</b> Objective <b>Timing of selection outcome measurement:</b> Longer term (> 1 day) <b>Consumption outcome analysed:</b> No <b>Measurement of consumption outcome:</b> N/A <b>Timing of consumption outcome measurement:</b> N/A <b>Secondary outcome:</b> N/A
Funding source	United States Department of Agriculture/Agricultural Research Service (USDA/ARS) and National Cancer Institute. The authors did not report on conflicts of interest
Notes	The vending machines were in different schools, but there was no mention of school size, number of teachers who purchased products, etc., and data were reported at site-level. Outcome data (standard deviations) requested from

the authors (11/2017) was not received

## Foster 2014

Methods	<b>Study design:</b> Between-participants cluster-randomised controlled trial
Participants	<p><b>Setting:</b> Field setting</p> <p><b>Setting type:</b> Supermarkets</p> <p><b>Geographical region:</b> USA</p> <p><b>Number of enrolled participants:</b> N/A (8 supermarkets)</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> N/A (100% of supermarkets)</p> <p><b>Study completers - mean age (SD):</b> N/A</p> <p><b>Study completers - sex:</b> N/A</p> <p><b>Specific social or cultural characteristics:</b> High-minority, low-income shoppers</p> <p><b>Socioeconomic status context:</b> High deprivation</p> <p><b>Inclusion criteria:</b> Eligible supermarkets had to be located in a low-to-moderate income census tract, located in an area of below-average supermarket density, or located in an area having a supermarket customer base with &gt; 50% living in a low-income census tract</p> <p><b>Exclusion criteria:</b> None reported</p>
Interventions	<p><b>Intervention type:</b> Availability</p> <p><b>Type of availability intervention:</b> Relative number (proportion) of less-healthy (to healthier) options: higher and lower availability (in checkout refrigerators) of full-calorie beverages (vs reduced-calories beverages)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Full-calorie beverages in checkout refrigerators. In context of wide range of other products in shops (including other manipulated categories such as milk and frozen meals)</p> <p><b>Duration of exposure to intervention:</b> &gt; 1 day</p> <p><b>Study arms:</b> Targeted products were 1) milk, 2) ready-to-eat cereal, 3) beverages (split into in-aisle beverages and checkout cooler beverages for the intervention), and 4) single-serving frozen meals. The intervention consisted of 4 major marketing strategies used across all categories, with placement as the dominant strategy and promotion as the secondary strategy. Strategies included 1) multiple facings: increased the number of facings of the recommended products; 2) prime placement: placed recommended products at eye/arm level and in the middle of the category aisle and reordered types of milk so that 2% milk was located on the left-hand side of the dairy case followed by 1%, skim, and then whole milk; 3) signage: placed call-out signs with the recommended product's name and price, and shelf runners below recommended products; and 4) secondary placement: mimicked shelf strategies (1 and 2) in all secondary placements (end caps, dead space stacks, etc.). In addition, other strategies were used as appropriate to the category, including 5) cross promotion (cereal and beverages only): displayed recommended products in 2 product categories together, through dead space stacks and end caps (e.g. cereal and bananas, soda and water); and 6) taste-testing (milk only): offered free samples of recommended products to increase shoppers' exposure to healthier options. Control supermarkets received no intervention</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> More facings (shelf space) for full-calorie beverages (vs reduced-calorie beverages) in checkout refrigerators versus fewer facings (less shelf space) for full-calorie beverages (vs reduced-calorie beverages) in checkout refrigerators</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> Yes (prime placement of zero-calorie options, placing water on the top shelf of refrigerator and diet beverages on middle 2 shelves)</p>

Outcomes	<p><b>Outcomes reported in study:</b> Weekly sales data for each product category (milk; cereal; frozen meals; in-aisle beverages; checkout cooler beverages)</p> <p><b>Selection outcome analysed:</b> Weekly sales data for full-calorie/regular checkout cooler beverages</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Longer term (&gt; 1 day)</p> <p><b>Consumption outcome analysed:</b> No</p> <p><b>Measurement of consumption outcome:</b> N/A</p> <p><b>Timing of consumption outcome measurement:</b> N/A</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	Supported by grants from the Robert Wood Johnson Foundation and the United States Department of Agriculture. The authors reported that there were no conflicts of interest
Notes	Checkout cooler beverages were selected as outcome of interest as targeted by the least confounded availability intervention with the fewest concurrent intervention components. Full-calorie beverages (vs low-calorie and water) within that wider category selected as primary outcome due to relative importance of reducing consumption of high-energy products versus increasing consumption of low-energy products

## Greene 2017

Methods	<b>Study design:</b> Between-participants cluster-randomised controlled trial
Participants	<p><b>Setting:</b> Field setting</p> <p><b>Setting type:</b> School cafeteria</p> <p><b>Geographical region:</b> USA</p> <p><b>Number of enrolled participants:</b> 10 study sites (randomised into a fruit intervention (n = 4), vegetable intervention (n = 3), or control group (n = 3))</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 7 sites with 2108 children in grades 5 to 8 (70%) (this paper only presented results for 2 out of 3 conditions: fruit intervention (n = 4) versus control (n = 3))</p> <p><b>Study completers - mean age (SD):</b> Not reported</p> <p><b>Study completers - sex:</b> Not reported</p> <p><b>Specific social or cultural characteristics:</b> Students from urban and rural middle schools</p> <p><b>Socioeconomic status context:</b> Both high and low deprivation</p> <p><b>Inclusion criteria:</b> Middle schools (grades 5 to 8) from upstate New York</p> <p><b>Exclusion criteria:</b> None reported</p>
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from start of line</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Fruit</p> <p><b>Duration of exposure to intervention:</b> <math>\geq 1</math> day</p> <p><b>Study arms:</b> Fruit is placed first in the line of foods offered; control with no changes (presumed to be later in line)</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> Fruit is placed first in the line of foods offered versus control with no changes (the schools were offered Smarter Lunchrooms training postintervention)</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> Yes (further changes to enhance</p>

Greene 2017 (Continued)

	convenience, visibility, and attractiveness were: at least 2 varieties of fruit were offered; fruit was offered in at least 2 separate locations; cut fruits were displayed in small, attractive cups; whole fruits were displayed in a large, attractive fruit bowl at eye level; fruits were labelled with creative names; creative fruit names were displayed on monthly and daily menus; "fruit factoids" were displayed on dry-erase boards at eye level)
Outcomes	<p><b>Outcomes reported in study:</b> Fruit, vegetable, and milk selection and consumption based on plate waste data; mean number of items selected and consumed; proportion of lunch trays that contained any type of fruit</p> <p><b>Selection outcome analysed:</b> Mean number of fruit items selected</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Consumption outcome analysed:</b> Mean number of fruit items consumed</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Secondary outcome:</b> Vegetable and milk selection and consumption</p>
Funding source	Supported by Agriculture and Food Research Initiative Grant no. 2012-68001-19604 from the US Department of Agriculture National Institute of Food and Agriculture, Childhood Obesity Prevention: Integrated Research, Education, and Extension to Prevent Childhood Obesity-A2101
Notes	Although this study also randomised 3 of the 10 schools to a vegetable intervention, outcome data for these 3 schools were not reported in this publication - only fruit intervention results were reported. Publication of the remaining data will be monitored in future updates. Secondary outcomes of vegetable and milk selection and consumption reported in this paper were secondary observations in relation to the intervention focused on promoting fruit. Reports that ensuring availability of at least 2 choices of fruit was already being met in most schools, so while proximity was manipulated, availability was seemingly not altered

Hunter 2018 (S1)

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<p><b>Setting:</b> Laboratory setting</p> <p><b>Setting type:</b> Laboratory (multipurpose room in community setting)</p> <p><b>Geographical region:</b> UK</p> <p><b>Number of enrolled participants:</b> 159</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 100%</p> <p><b>Study completers - mean age (SD):</b> 38.4 (15.2)</p> <p><b>Study completers - sex:</b> 63.5% female</p> <p><b>Specific social or cultural characteristics:</b> General public sample</p> <p><b>Socioeconomic status context:</b> Both high and low deprivation</p> <p><b>Inclusion criteria:</b> 18 years or over</p> <p><b>Exclusion criteria:</b> Food allergies or intolerance</p>
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from positioned participant (chair at which seated) (distance from set point)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Chocolate M&amp;Ms</p> <p><b>Duration of exposure to intervention:</b> <math>\leq 1</math> day</p>

**Hunter 2018 (S1)** (Continued)

	<p><b>Study arms:</b> 1000 g of chocolate M&amp;Ms in a transparent 1-litre bowl placed 20 cm from seated participants' right armrest; 1000 g of chocolate M&amp;Ms in a transparent 1-litre bowl placed 70 cm from seated participants' right armrest</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> M&amp;Ms placed at 20 cm from participant versus M&amp;Ms placed at 70 cm from participant</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> No</p>
Outcomes	<p><b>Outcomes reported in study:</b> Proportion of total participants consuming any M&amp;Ms (specified as primary outcome); mean amount of snacks consumed (grams)</p> <p><b>Selection outcome analysed:</b> N/A</p> <p><b>Measurement of selection outcome:</b> N/A</p> <p><b>Timing of selection outcome measurement:</b> N/A</p> <p><b>Consumption outcome analysed:</b> Proportion of total participants consuming any M&amp;Ms</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	UK Medical Research Council and Raymond and Beverly Sackler Foundation. The authors reported that there were no conflicts of interest
Notes	

**Hunter 2018 (S2)**

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<p><b>Setting:</b> Laboratory setting</p> <p><b>Setting type:</b> Laboratory (multipurpose room in community setting)</p> <p><b>Geographical region:</b> UK</p> <p><b>Number of enrolled participants:</b> 246</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 100%</p> <p><b>Study completers - mean age (SD):</b> 36.2 (13)</p> <p><b>Study completers - sex:</b> 56.5% female</p> <p><b>Specific social or cultural characteristics:</b> General public sample</p> <p><b>Socioeconomic status context:</b> Both high and low deprivation</p> <p><b>Inclusion criteria:</b> 18 years or over</p> <p><b>Exclusion criteria:</b> Food allergies or intolerance</p>
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from positioned participant (chair at which seated) (distance from set point)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Chocolate M&amp;Ms</p> <p><b>Duration of exposure to intervention:</b> <math>\leq 1</math> day</p> <p><b>Study arms:</b> 1000 g of chocolate M&amp;Ms in a transparent 1-litre bowl placed 20 cm from seated participants' right armrest; 1000 g of chocolate M&amp;Ms in a transparent 1-litre bowl placed 70 cm from seated participants' right armrest. (In factorial 2 x 2 design with manipulation of cognitive load: cognitive load earlier in session; cognitive</p>

## Hunter 2018 (S2) (Continued)

	load later in session) <b>Number of comparisons analysed:</b> 1 <b>Comparisons analysed:</b> M&Ms placed at 20 cm from participant versus M&Ms placed at 70 cm from participant <b>Concurrent intervention components in factorial design:</b> Yes (cognitive load earlier in session; cognitive load later in session) <b>Concurrent intervention components confounded with comparison of interest:</b> No
Outcomes	<b>Outcomes reported in study:</b> Proportion of total participants consuming any M&Ms (specified as primary outcome); mean amount of snacks consumed (grams) <b>Selection outcome analysed:</b> N/A <b>Measurement of selection outcome:</b> N/A <b>Timing of selection outcome measurement:</b> N/A <b>Consumption outcome analysed:</b> Proportion of total participants consuming any M&Ms <b>Measurement of consumption outcome:</b> Objective <b>Timing of consumption outcome measurement:</b> Immediate ( $\leq 1$ day) <b>Secondary outcome:</b> N/A
Funding source	UK Medical Research Council and Raymond and Beverly Sackler Foundation. The authors reported that there were no conflicts of interest
Notes	

## Hunter 2019

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<b>Setting:</b> Laboratory setting <b>Setting type:</b> Laboratory (multipurpose room in community setting) <b>Geographical region:</b> UK <b>Number of enrolled participants:</b> 249 <b>Number (%) of enrolled participants completing the study and included in analysis:</b> 99.6% <b>Study completers - mean age (SD):</b> 35.7 (12.4) <b>Study completers - sex:</b> 49.4% female <b>Specific social or cultural characteristics:</b> General public sample <b>Socioeconomic status context:</b> Both high and low deprivation <b>Inclusion criteria:</b> 18 years or over <b>Exclusion criteria:</b> Food allergies or intolerance
Interventions	<b>Intervention type:</b> Proximity <b>Type of proximity intervention:</b> Proximity from positioned participant (chair at which seated) (distance from set point) <b>Manipulated product type:</b> Food <b>Characteristics of manipulated products:</b> Chocolate M&Ms <b>Duration of exposure to intervention:</b> $\leq 1$ day <b>Study arms:</b> 1000 g of chocolate M&Ms in a transparent 1-litre bowl placed 20 cm from seated participants' right armrest; 1000 g of chocolate M&Ms in a transparent 1-litre bowl placed 70 cm from seated participants' right armrest. (In factorial 2 x 2 design with manipulation of proximity of bowl of raisins: bowl of raisins placed at 20 cm; bowl of raisins placed at 70 cm) <b>Number of comparisons analysed:</b> 1



	<p><b>Comparisons analysed:</b> M&amp;Ms placed at 20 cm from participant versus M&amp;Ms placed at 70 cm from participant</p> <p><b>Concurrent intervention components in factorial design:</b> Yes (bowl of raisins placed at 20 cm; bowl of raisins placed at 70 cm)</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> No</p>
Outcomes	<p><b>Outcomes reported in study:</b> Proportion of total participants consuming any M&amp;Ms (specified as primary outcome); mean amount of M&amp;Ms consumed (grams); proportion of total participants consuming any raisins; mean amount of M&amp;Ms consumed (grams)</p> <p><b>Selection outcome analysed:</b> N/A</p> <p><b>Measurement of selection outcome:</b> N/A</p> <p><b>Timing of selection outcome measurement:</b> N/A</p> <p><b>Consumption outcome analysed:</b> Proportion of total participants consuming any M&amp;Ms</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	UK Medical Research Council and Raymond and Beverly Sackler Foundation. The authors reported that there were no conflicts of interest
Notes	

## Kocken 2012

Methods	<b>Study design:</b> Between-participants cluster-randomised controlled trial
Participants	<p><b>Setting:</b> Field setting</p> <p><b>Setting type:</b> School setting, vending machines</p> <p><b>Geographical region:</b> The Netherlands</p> <p><b>Number of enrolled participants:</b> N/A (40 schools)</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> N/A (intervention = 13 schools, control = 15 schools) (70%)</p> <p><b>Study completers - mean age (SD):</b> N/A</p> <p><b>Study completers - sex:</b> N/A</p> <p><b>Specific social or cultural characteristics:</b> Schoolchildren</p> <p><b>Socioeconomic status context:</b> High deprivation</p> <p><b>Inclusion criteria:</b> None reported</p> <p><b>Exclusion criteria:</b> None reported</p>
Interventions	<p><b>Intervention type:</b> Availability</p> <p><b>Type of availability intervention:</b> Relative number (proportion) of less-healthy (to healthier) options: higher and lower availability of unfavourable extra foods (<math>&gt; 170</math> kcal) (relative to lower-calorie options) in vending machines</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Unfavourable extra foods (i.e. products with empty calories that deliver only energy and no important vitamins or minerals) (<math>&gt; 170</math> kcal), replaced by <math>&lt; 100</math> kcal (favourable) and moderately unfavourable (100 to 170 kcal) foods. In context of also replacing unfavourable beverages with favourable beverages</p> <p><b>Duration of exposure to intervention:</b> <math>&gt; 1</math> day</p> <p><b>Study arms:</b> Unfavourable, high-energy foods (<math>&gt; 170</math> kcal) in vending machines were replaced by <math>&lt; 100</math> kcal (favourable) and moderately unfavourable (100 to 170 kcal) foods, with categorisation based on Netherlands Nutrition Centre recommendations. Intervention had to result in at least 75% of products being offered required to</p>

**Kocken 2012** (Continued)

	<p>be favourable or moderately favourable. As long as the 75% criterion was met, foods were not necessarily replaced by the same type of product. Control schools kept the original products</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> More unfavourable, high-energy extra food options available in vending machines versus fewer unfavourable, high-energy extra food options available in vending machines</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> No</p>
Outcomes	<p><b>Outcomes reported in study:</b> Mean proportions (%) of products sold per product group and category. Mean sales volumes per food category averaged for number of students per school</p> <p><b>Selection outcome analysed:</b> Mean proportion (%) of unfavourable “extra” products (&gt; 170 kcal) sold</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Longer term (&gt; 1 day)</p> <p><b>Consumption outcome analysed:</b> N/A</p> <p><b>Measurement of consumption outcome:</b> N/A</p> <p><b>Timing of consumption outcome measurement:</b> N/A</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	The Netherlands Organisation for Health Research and Development. The authors did not report on conflicts of interest
Notes	This study was conducted in 3 phases, and only data from Phase I were used in this review (reduced availability of higher-calorie products). In Phase II, labels were introduced, and in Phase III, prices were reduced. Purchase of extra products was selected as outcome measure as these were the least-nutritious categorisation of foods “that deliver only energy and no important vitamins or minerals” and relative importance of reducing consumption of high-energy products versus increasing consumption of low-energy products

**Kongsbak 2016**

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<p><b>Setting:</b> Laboratory setting</p> <p><b>Setting type:</b> Naturalistic laboratory (buffet installation within laboratory)</p> <p><b>Geographical region:</b> Denmark</p> <p><b>Number of enrolled participants:</b> 65</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 100%</p> <p><b>Study completers - mean age (SD):</b> 24.1 (0.5)</p> <p><b>Study completers - sex:</b> 100% male</p> <p><b>Specific social or cultural characteristics:</b> Male university students</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Male university students aged between 18 and 29</p> <p><b>Exclusion criteria:</b> None reported</p>
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from start of buffet line (order encountered along line (e.g. queue or aisle))</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Mixed salad (comprising spinach, cauliflower, carrot, white cabbage,</p>

**Kongsbak 2016** (Continued)

	<p>peas, apples, green beans, and parsley components) (in context of manipulation of other items in buffet order: pasta, bread, meatballs)</p> <p><b>Duration of exposure to intervention:</b> <math>\leq 1</math> day</p> <p><b>Study arms:</b> Mixed salad placed at beginning of buffet queue line (with components in individual bowls); mixed salad placed later in buffet queue line (with components mixed in a single bowl)</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> Mixed salad placed at start of buffet line, meaning accessed first versus mixed salad placed later in buffet line, meaning accessed after other foods</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> Yes (salad components placed in individual bowls when mixed salad placed at start of buffet queue line, whilst salad components mixed in a single bowl when mixed salad placed at end of buffet queue line)</p>
Outcomes	<p><b>Outcomes reported in study:</b> Self-served salad (fruit and vegetables); self-served pasta; self-served meatballs; self-served bread; total grams of all food served; total energy (kJ) of all food served</p> <p><b>Selection outcome analysed:</b> Self-served salad (fruit and vegetables)</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Consumption outcome analysed:</b> N/A</p> <p><b>Measurement of consumption outcome:</b> N/A</p> <p><b>Timing of consumption outcome measurement:</b> N/A</p> <p><b>Secondary outcome:</b> Total food (grams) selected; total energy (kJ) selected</p>
Funding source	Funding and conflicts of interest were not reported.
Notes	

**Langlet 2017**

Methods	<b>Study design:</b> Between-participants cluster-randomised controlled trial
Participants	<p><b>Setting:</b> Laboratory setting</p> <p><b>Setting type:</b> A room set up with tables and chairs (workstations) in a high school</p> <p><b>Geographical region:</b> Sweden</p> <p><b>Number of enrolled participants:</b> 41 (2 classes)</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 41 (100%)</p> <p><b>Study completers - mean age (SD):</b> 16.8 years (0.3) in the proximal group and 16.6 (0.4) in the distal group</p> <p><b>Study completers - sex:</b> 54% female</p> <p><b>Specific social or cultural characteristics:</b> High school students between 15 and 17 years old who were attending a natural science class</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Participants were recruited from 2 first-year natural science classes of a high school situated in central Stockholm (as part of a bigger trial organised in the school through the EU project SPLENDID, with the same student sample participating in behaviourally monitored lunch sessions earlier during the test days). Participation was non-discriminative, since every student was allowed to participate irrespective of their background, BMI, or sex</p> <p><b>Exclusion criteria:</b> None reported</p>

Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from positioned participant</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Snack foods of grapes, chocolate, and crackers</p> <p><b>Duration of exposure to intervention:</b> <math>\leq 1</math> day</p> <p><b>Study arms:</b> Proximal arm, where food was situated at arm's length from participants, and a distal arm, where food was situated at least 6 m away from participants</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> Snack foods placed closer to participants versus snack foods placed farther away from participants</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> No</p>
Outcomes	<p><b>Outcomes reported in study:</b> Mean energy intake of each food type per participant, and the total energy intake per participant (for all snacks) (kcal); mean number of servings per individual across food types; mean energy content of each serving across food types (kcal)</p> <p><b>Selection outcome analysed:</b> Mean energy selected per individual (for all snacks) (kcal) (not directly reported in full but received from authors)</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Consumption outcome analysed:</b> Mean energy intake per participant (for all snacks) (kcal)</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Immediate (<math>&lt; 1</math> day)</p> <p><b>Secondary outcome:</b> Mean energy content of each serving across food types (kcal); temporal analysis of servings</p>
Funding source	<p>Internationella Engelska Gymnasiet SoÈdermalm (Internationella Engelska Skolan) and Division of Applied Neuroendocrinology (Department of Neurobiology, Care Sciences and Society, Karolinska Institutet) received funding from the European Community's Information and Communication Technology Programme under Grant Agreement No. 610746, 01/10/2013±30/09/</p>
Notes	<p>Selection outcome of mean energy selected per individual (for all snacks) (kcal) was not directly reported in full but was received from authors (26 November 2018) (as well as available in datasets posted on website of journal hosting publication although not in required form)</p>

Maas 2012 (S1)

Methods	<p><b>Study design:</b> Between-participants randomised controlled trial</p>
Participants	<p><b>Setting:</b> Laboratory setting</p> <p><b>Setting type:</b> Laboratory</p> <p><b>Geographical region:</b> The Netherlands</p> <p><b>Number of enrolled participants:</b> 80</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 77 (96.3%)</p> <p><b>Study completers - mean age (SD):</b> 22.3 (3.7)</p> <p><b>Study completers - sex:</b> 100% female</p> <p><b>Specific social or cultural characteristics:</b> Female students</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Female students; age 17 to 38 years; BMI between 18 and 30 kg/m<sup>2</sup></p>

**Maas 2012 (S1)** (Continued)

	<b>Exclusion criteria:</b> Food allergies; current eating pathology
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from positioned participant (chair at which seated) (distance from set point)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Chocolate M&amp;Ms</p> <p><b>Duration of exposure to intervention:</b> <math>\leq 1</math> day</p> <p><b>Study arms:</b> 1000 g of chocolate M&amp;Ms in a transparent bowl placed 20 cm from seated participants' right armrest; 1000 g of chocolate M&amp;Ms in a transparent bowl placed 70 cm from seated participants' right armrest; 1000 g of chocolate M&amp;Ms placed 140 cm from seated participants' right armrest</p> <p><b>Number of comparisons analysed:</b> 2</p> <p><b>Comparisons analysed:</b></p> <p>Comparison 1: M&amp;Ms placed 20 cm from participant versus M&amp;Ms placed 70 cm from participant</p> <p>Comparison 2: M&amp;Ms placed 20 cm from participant versus M&amp;Ms placed 140 cm from participant</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> No</p>
Outcomes	<p><b>Outcomes reported in study:</b> Likelihood of snack consumption; amount of snacks consumed</p> <p><b>Selection outcome analysed:</b> N/A</p> <p><b>Measurement of selection outcome:</b> N/A</p> <p><b>Timing of selection outcome measurement:</b> N/A</p> <p><b>Consumption outcome analysed:</b> Amount of snacks consumed</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	Funding and conflicts of interest were not reported.
Notes	Amount of snacks consumed was the selected outcome of interest because the amount consumed is more relevant to health outcomes than whether any were consumed

**Maas 2012 (S2)**

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<p><b>Setting:</b> Laboratory setting</p> <p><b>Setting type:</b> Laboratory</p> <p><b>Geographical region:</b> The Netherlands</p> <p><b>Number of enrolled participants:</b> 58</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 54 (93.1%)</p> <p><b>Study completers - mean age (SD):</b> 21.3 (2.6)</p> <p><b>Study completers - sex:</b> 100% female</p> <p><b>Specific social or cultural characteristics:</b> Female students</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Female students; age 17 to 29 years; BMI between 18 and 30 kg/m<sup>2</sup></p> <p><b>Exclusion criteria:</b> Food allergies; current eating pathology</p>

Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from positioned participant (chair at which seated) (distance from set point)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Chocolate M&amp;Ms</p> <p><b>Duration of exposure to intervention:</b> <math>\leq 1</math> day</p> <p><b>Study arms:</b> 1000 g of chocolate M&amp;Ms in a transparent bowl placed 20 cm from seated participants' right armrest; 1000 g of chocolate M&amp;Ms in a transparent bowl placed 70 cm from seated participants' right armrest; 1000 g of chocolate M&amp;Ms placed 140 cm from seated participants' right armrest</p> <p><b>Number of comparisons analysed:</b> 2</p> <p><b>Comparisons analysed:</b></p> <p>Comparison 1: M&amp;Ms placed 20 cm from participant versus M&amp;Ms placed 70 cm from participant</p> <p>Comparison 2: M&amp;Ms placed 20 cm from participant versus M&amp;Ms placed 140 cm from participant</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> N/A</p>
Outcomes	<p><b>Outcomes reported in study:</b> Likelihood of snack consumption; amount of snacks consumed</p> <p><b>Selection outcome analysed:</b> N/A</p> <p><b>Measurement of selection outcome:</b> N/A</p> <p><b>Timing of selection outcome measurement:</b> N/A</p> <p><b>Consumption outcome analysed:</b> Amount of snacks consumed</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	Funding and conflicts of interest were not reported.
Notes	Amount of snacks consumed was the selected outcome of interest because the amount consumed is more relevant to health outcomes than whether any were consumed

#### Musher-Eizenman 2010

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<p><b>Setting:</b> Laboratory setting</p> <p><b>Setting type:</b> Naturalistic laboratory (dining room set up in a school gymnasium)</p> <p><b>Geographical region:</b> USA</p> <p><b>Number of enrolled participants:</b> 31</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 27 (87.1%)</p> <p><b>Study completers - mean age (SD):</b> 6.3 (2.3)</p> <p><b>Study completers - sex:</b> 42% female</p> <p><b>Specific social or cultural characteristics:</b> Preschool and school-age children at a local childcare centre</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Children agreeing to take part in the snack time activity, agreeing to answer questions from the researchers, and agreeing to be weighed and measured</p> <p><b>Exclusion criteria:</b> None reported</p>

Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from positioned participant (table at which seated) (distance from set point)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Animal crackers (cookies) (in context of also manipulating carrot slices on subsequent testing session)</p> <p><b>Duration of exposure to intervention:</b> <math>\leq 1</math> day</p> <p><b>Study arms:</b> Seated at Table 1 (nearest to snack bowl); Seated at Table 2; Seated at Table 3; Seated at Table 4; Seated at Table 5 (farthest from snack bowl)</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b></p> <p>Comparison 1: Participants seated at Tables 1 and 2 (i.e. serving bowl of animal crackers placed nearest (28 cm) to table (participant seated at Table 1) plus serving bowl of animal crackers placed approximately 250 cm to table (participant seated at Table 2)); participants seated at Tables 3, 4, and 5 (i.e. serving bowl of animal crackers placed approximately 500 cm to table (participant seated at Table 3) plus serving bowl of animal crackers placed approximately 750 cm to table (participant seated at Table 4) plus serving bowl of animal crackers placed approximately 1000 cm to table (participant seated at Table 5))</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> N/A</p>
Outcomes	<p><b>Outcomes reported in study:</b> Mean number of animal crackers consumed; mean number of carrot slices consumed</p> <p><b>Selection outcome analysed:</b> N/A</p> <p><b>Measurement of selection outcome:</b> N/A</p> <p><b>Timing of selection outcome measurement:</b> N/A</p> <p><b>Consumption outcome analysed:</b> Mean number of animal crackers consumed</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	Funding and conflicts of interest were not reported.
Notes	Attempted to contact authors April 2017 and November 2017 to confirm outcome data and if participants re-randomised on each of the 2 testing days, but no response received. Cannot assume re-randomisation, so treated as single study

## Painter 2002

Methods	<b>Study design:</b> Within-participants cross-over randomised controlled trial
Participants	<p><b>Setting:</b> Field setting</p> <p><b>Setting type:</b> Workplace office in university setting</p> <p><b>Geographical region:</b> USA</p> <p><b>Number of enrolled participants:</b> 16</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 16 (100%)</p> <p><b>Study completers - mean age (SD):</b> Not reported (median = 43 years)</p> <p><b>Study completers - sex:</b> 62.5% female</p> <p><b>Specific social or cultural characteristics:</b> Office workers at university workplace office</p> <p><b>Socioeconomic status context:</b> Low deprivation</p>



**Painter 2002** (Continued)

	<b>Inclusion criteria:</b> Office workers at a university workplace office <b>Exclusion criteria:</b> None reported
Interventions	<b>Intervention type:</b> Proximity <b>Type of proximity intervention:</b> Proximity from positioned participant (desk at which seated) (distance from set point) <b>Manipulated product type:</b> Food <b>Characteristics of manipulated products:</b> Chocolate (candy chocolate “kisses” in a container) <b>Duration of exposure to intervention:</b> > 1 day <b>Study arms:</b> Chocolate placed on top of the desk (near and visible); chocolate placed in desk drawer (near but not visible); chocolate placed on distal shelf (200 cm (2 m) away) (far and visible) <b>Number of comparisons analysed:</b> 1 <b>Comparisons analysed:</b> Chocolate placed on top of the desk (near and visible) versus chocolate placed on distal shelf (200 cm (2 m) away) (far and visible) <b>Concurrent intervention components in factorial design:</b> No <b>Concurrent intervention components confounded with comparison of interest:</b> N/A
Outcomes	<b>Outcomes reported in study:</b> Mean number of chocolates consumed per day <b>Selection outcome analysed:</b> N/A <b>Measurement of selection outcome:</b> N/A <b>Timing of selection outcome measurement:</b> N/A <b>Consumption outcome analysed:</b> Mean number of chocolates consumed per day <b>Measurement of consumption outcome:</b> Objective <b>Timing of consumption outcome measurement:</b> Longer term (> 1 day) <b>Secondary outcome:</b> N/A
Funding source	Funding and conflicts of interest were not reported.
Notes	The corresponding author confirmed that assignment was randomised (16 March 2016). Outcome data (standard deviations) requested from the authors in November 2017 were not received. The study arm in which chocolates were placed in desk drawer (so as to not be visible) was excluded from our analyses as it confounds the effect of proximity and is not relevant to the current review

**Pechey 2019**

Methods	<b>Study design:</b> Stepped-wedge cluster-randomised controlled trial
Participants	<b>Setting:</b> Field setting <b>Setting type:</b> Workplace cafeterias <b>Geographical region:</b> UK <b>Number of enrolled participants:</b> Not reported (there were potentially 5200 employees targeted from 6 study sites) <b>Number (%) of enrolled participants completing the study and included in analysis:</b> 6 sites (100%) <b>Study completers - mean age (SD):</b> Not reported <b>Study completers - sex:</b> Not reported <b>Specific social or cultural characteristics:</b> Employees at the study sites included: those with higher and intermediate managerial, administrative, and professional occupations; those with supervisory, clerical, and junior managerial, administrative, and professional occupations; and those with semi-skilled and unskilled manual occupations

	<p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Sites were included if they: (a) were based in England, (b) had approximately 350 or more employees, and (c) could provide at least weekly sales data on individual items and the energy (kcal) content of items sold</p> <p><b>Exclusion criteria:</b> None reported</p>
Interventions	<p><b>Intervention type:</b> Availability</p> <p><b>Type of availability intervention:</b> Relative number (proportion) of less-healthy (to healthier) options: Higher and lower availability of less-healthy (i.e. higher-energy) cooked meal, snack, cold drink, and sandwich options (relative to healthier (i.e. lower-energy) options)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Less-healthy foods replaced by healthier cooked meals, sandwiches, and snacks: healthier cooked meals (excluding breakfast) were defined as having under 300 kcal for a meal component or under 500 kcal for a complete meal; healthier sandwiches (or equivalents, e.g. wraps, panini, baguettes, bagels) were defined as those under 350 kcal; healthier savoury snacks were: under 120 kcal per pack; sweet snacks: under 150 kcal per pack; and cold drinks: under 50 kcal per pack (e.g. zero or light varieties)</p> <p><b>Duration of exposure to intervention:</b> <math>\geq 1</math> day</p> <p><b>Study arms:</b> No changes made in cafeterias; cafeterias with reductions in less-healthy food and increased healthy foods (without changing the absolute number of food items offered)</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> Baseline data/no change in food items offered in cafeterias (higher availability of less-healthy food) versus lower availability of less-healthy food and increased availability of healthy cooked meals, sandwiches, and snacks</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> No</p>
Outcomes	<p><b>Outcomes reported in study:</b> Total energy (kcal) purchased per day from intervention categories; total energy (kcal) purchased per day from all categories; total revenue (GBP) per day from all categories</p> <p><b>Selection outcome analysed:</b> Total energy (kcal) purchased per day from intervention categories</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Longer term (<math>&gt; 1</math> day)</p> <p><b>Consumption outcome analysed:</b> N/A</p> <p><b>Measurement of consumption outcome:</b> N/A</p> <p><b>Timing of consumption outcome measurement:</b> N/A</p> <p><b>Secondary outcome:</b> Total energy (kcal) purchased per day from all categories; total revenue (GBP) per day from all categories</p>
Funding source	<p>Funded by the National Institute for Health Research Policy Research Programme (Policy Research Unit in Behaviour and Health (PR-UN-0409-10109) and IGD (Institute of Grocery Distribution) (RG83425)). The authors stated that there were no conflicts of interest</p>
Notes	<p>Trial registration record at <a href="https://clinicaltrials.gov/ct2/show/nct03252158">clinicaltrials.gov/ct2/show/nct03252158</a>. Cluster-randomised trial, but data were aggregate/cluster level. During the intervention period, sites were asked to position replacements in the same location, and with as close as possible to the same number of packs as the removed product, and to restock these as usual. Replacement products were priced at their recommended retail price or using the catering providers' normal pricing guidance. Statistical data necessary to input SMD and 95% CIs were provided by study authors in November 2018</p>

## Privitera 2012 (S1)

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<b>Setting:</b> Laboratory setting <b>Setting type:</b> Naturalistic laboratory (kitchen space) <b>Geographical region:</b> USA <b>Number of enrolled participants:</b> 48 <b>Number (%) of enrolled participants completing the study:</b> No information <b>Study completers - mean age (SD):</b> 19.9 (1.1) <b>Study completers - sex:</b> Not reported <b>Specific social or cultural characteristics:</b> University students <b>Socioeconomic status context:</b> Low deprivation <b>Inclusion criteria:</b> None reported - recruitment via classroom visits <b>Exclusion criteria:</b> Participants who had eaten in the 2 hours prior to start of the study were excluded
Interventions	<b>Intervention type:</b> Proximity <b>Type of proximity intervention:</b> Proximity from participant (kitchen table at which seated) (distance from set point) <b>Manipulated product type:</b> Food <b>Characteristics of manipulated products:</b> Sweet red apple slices <b>Duration of exposure to intervention:</b> $\leq 1$ day <b>Study arms:</b> On table, clear bowl; on counter, clear bowl; on table, opaque bowl; on counter, opaque bowl <b>Number of comparisons analysed:</b> 1 <b>Comparisons analysed:</b> Apple slices in bowl on table (within arm's reach) versus bowl on counter (200 cm away) <b>Concurrent intervention components in factorial design:</b> Yes (opacity of bowl container was manipulated to alter food visibility) <b>Concurrent intervention components confounded with comparison of interest:</b> No
Outcomes	<b>Outcomes reported in study:</b> Number of items consumed <b>Selection outcome analysed:</b> N/A <b>Measurement of selection outcome:</b> N/A <b>Timing of selection outcome measurement:</b> N/A <b>Consumption outcome analysed:</b> Number of items consumed <b>Measurement of consumption outcome:</b> Objective <b>Timing of consumption outcome measurement:</b> Immediate ( $\leq 1$ day) <b>Secondary outcome:</b> N/A
Funding source	The authors stated that they received no financial support and that there were no conflicts of interest
Notes	

## Privitera 2012 (S2)

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<b>Setting:</b> Laboratory setting <b>Setting type:</b> Naturalistic laboratory (kitchen space) <b>Geographical region:</b> USA <b>Number of enrolled participants:</b> 48 <b>Number (%) of enrolled participants completing the study:</b> No information

**Privitera 2012 (S2)** (Continued)

	<b>Study completers - mean age (SD):</b> 20.1 (1.6) <b>Study completers - sex:</b> Not reported <b>Specific social or cultural characteristics:</b> University students <b>Socioeconomic status context:</b> Low deprivation <b>Inclusion criteria:</b> None reported - recruitment via classroom visits <b>Exclusion criteria:</b> Participants who had eaten in the 2 hours prior to start of the study were excluded
Interventions	<b>Intervention type:</b> Proximity <b>Type of proximity intervention:</b> Proximity from participant (kitchen table at which seated) (distance from set point) <b>Manipulated product type:</b> Food <b>Characteristics of manipulated products:</b> Baby-cut carrots <b>Duration of exposure to intervention:</b> ≤ 1 day <b>Study arms:</b> On table, clear bowl; on counter, clear bowl; on table, opaque bowl; on counter, opaque bowl <b>Number of comparisons analysed:</b> 1 <b>Comparisons analysed:</b> Baby-cut carrots in bowl on table (within arm's reach) versus bowl on counter (200 cm away) <b>Concurrent intervention components in factorial design:</b> Yes (opacity of bowl container was manipulated to alter food visibility) <b>Concurrent intervention components confounded with comparison of interest:</b> No
Outcomes	<b>Outcomes reported in study:</b> Number of items consumed <b>Selection outcome analysed:</b> N/A <b>Measurement of selection outcome:</b> N/A <b>Timing of selection outcome measurement:</b> N/A <b>Consumption outcome analysed:</b> Number of items consumed <b>Measurement of consumption outcome:</b> Objective <b>Timing of consumption outcome measurement:</b> Immediate (≤ 1 day) <b>Secondary outcome:</b> N/A
Funding source	The authors stated that they received no financial support and that there were no conflicts of interest
Notes	

**Privitera 2014**

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<b>Setting:</b> Laboratory setting <b>Setting type:</b> Naturalistic laboratory (kitchen space) <b>Geographical region:</b> USA <b>Number of enrolled participants:</b> 60 <b>Number (%) of enrolled participants completing the study:</b> 56 (93.3%) <b>Study completers - mean age (SD):</b> 19.4 (0.9) <b>Study completers - sex:</b> 53.6% female <b>Specific social or cultural characteristics:</b> University students <b>Socioeconomic status context:</b> Low deprivation <b>Inclusion criteria:</b> None reported - recruitment via classroom visits

	<b>Exclusion criteria:</b> Participants who had eaten in the 2 hours prior to start of the study were excluded
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from participant (kitchen table at which seated) (distance from set point)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Butter popcorn (high-calorie food (158 calories and 734 kJ per serving) in context of also a proximity manipulation of lower-calorie food, apple slices (0 calories and energy density is 304 kJ per serving))</p> <p><b>Duration of exposure to intervention:</b> <math>\leq 1</math> day</p> <p><b>Study arms:</b> Apple near (30 cm), popcorn far (200 cm); popcorn near, apple far; both near</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> Popcorn near (apple near) versus popcorn far (apple near)</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> No (location of a secondary non-target food was changed, but selected comparisons of interest for review unaffected)</p>
Outcomes	<p><b>Outcomes reported in study:</b> Popcorn consumption; apple consumption</p> <p><b>Selection outcome analysed:</b> N/A</p> <p><b>Measurement of selection outcome:</b> N/A</p> <p><b>Timing of selection outcome measurement:</b> N/A</p> <p><b>Consumption outcome analysed:</b> Popcorn consumption (g)</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	Funding and conflicts of interest were not reported.
Notes	

## Roe 2013

Methods	<b>Study design:</b> Within-participants cross-over cluster-randomised controlled trial
Participants	<p><b>Setting:</b> Field setting</p> <p><b>Setting type:</b> Childcare facility</p> <p><b>Geographical region:</b> USA</p> <p><b>Number of enrolled participants:</b> 61 (4 classrooms)</p> <p><b>Number (%) of enrolled participants completing the study:</b> 61 (100%)</p> <p><b>Study completers - mean age (SD):</b> 4.4 (0.5)</p> <p><b>Study completers - sex:</b> 52.5% female</p> <p><b>Specific social or cultural characteristics:</b> Schoolchildren</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Not stated, children aged 3 to 5 years</p> <p><b>Exclusion criteria:</b> Not stated, children who were allergic to any of the foods served were not included</p>
Interventions	<p><b>Intervention type:</b> Availability</p> <p><b>Type of availability intervention:</b> Absolute number of different options available: higher and lower availability</p>

**Roe 2013** (Continued)

	<p>of fruits and vegetables (children offered 3 varieties of fruit or vegetable or a single type of fruit or vegetable)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Fruit (apple, peach, pineapple) and vegetable (cucumber, sweet potato, tomato) snacks. All children were also provided with a small piece of pita bread (16 g; 43 kcal) and 250 mL of water</p> <p><b>Duration of exposure to intervention:</b> &gt; 1 day</p> <p><b>Study arms:</b> Children were offered 3 varieties of fruit or vegetables from a bowl; children were offered a single type of fruit or vegetable from a bowl</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> 3 types of fruit or vegetable versus 1 type of fruit or vegetable</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> N/A</p>
Outcomes	<p><b>Outcomes reported in study:</b> Mean number of fruit and vegetable pieces selected; mean number of fruit and vegetable pieces eaten</p> <p><b>Selection outcome analysed:</b> Mean number of fruit and vegetable pieces selected</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Longer term (&gt; 1 day)</p> <p><b>Consumption outcome analysed:</b> Mean number of fruit and vegetable pieces eaten</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Longer term (&gt; 1 day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	Study was supported by a National Institutes of Health grant. No conflicts of interest were reported
Notes	

**Stubbs 2001**

Methods	<b>Study design:</b> Within-participants cross-over randomised controlled trial
Participants	<p><b>Setting:</b> Laboratory setting</p> <p><b>Setting type:</b> Laboratory (Human Nutrition Unit, where participants had their own fridge, freezer, and microwave)</p> <p><b>Geographical region:</b> UK</p> <p><b>Number of enrolled participants:</b> 12</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 12 (100%)</p> <p><b>Study completers - mean age (SD):</b> 33.4 (7.2)</p> <p><b>Study completers - sex:</b> 100% male</p> <p><b>Specific social or cultural characteristics:</b> Men only</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Not stated, healthy, non-smoking men</p> <p><b>Exclusion criteria:</b> Not stated, men who were following a specialised diet or exercise regimen</p>
Interventions	<p><b>Intervention type:</b> Availability</p> <p><b>Type of availability intervention:</b> Absolute number of different options available: higher and lower variety of foods (number of foods provided on a daily menu)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Breakfast, lunch, dinner meals, and snacks</p> <p><b>Duration of exposure to intervention:</b> &gt; 1 day</p>

**Stubbs 2001** (Continued)

	<p><b>Study arms:</b> Participants were studied for three 9-day periods. From days 3 to 9, participants were given ad libitum access to a 3-day rotating menu of either low-, medium-, or high-variety foods. Study arms were: low variety, with 5 items available; medium variety, with 10 items available; high variety, with 15 items available</p> <p><b>Number of comparisons analysed:</b> 2</p> <p><b>Comparisons analysed:</b></p> <p>Comparison 1: high-variety arm (for meals, participants had 3 menu options) versus medium-variety arm (for meals, participants had 2 menu options). Each food item had a similar macronutrient composition</p> <p>Comparison 2: medium-variety arm (for meals, participants had 2 menu options) versus low-variety arm (for meals, participants had 1 menu option). Each food item had a similar macronutrient composition</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> N/A</p>
Outcomes	<p><b>Outcomes reported in study:</b> Average daily food, energy, and macronutrient intakes (weight, energy, protein, fat, carbohydrate)</p> <p><b>Selection outcome analysed:</b> N/A</p> <p><b>Measurement of selection outcome:</b> N/A</p> <p><b>Timing of selection outcome measurement:</b> N/A</p> <p><b>Consumption outcome analysed:</b> Energy intake (MJ)</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Long term (&gt; 1 day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	The work was supported by the Scottish Office. No conflicts of interest were reported
Notes	Outcome data (standard deviations) requested from the authors in November 2017 were not received

**Wansink 2006**

Methods	<b>Study design:</b> Within-participants cross-over randomised controlled trial
Participants	<p><b>Setting:</b> Field setting</p> <p><b>Setting type:</b> Workplace offices in university setting</p> <p><b>Geographical region:</b> USA</p> <p><b>Number of enrolled participants:</b> 40</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 40 (100%)</p> <p><b>Study completers - mean age (SD):</b> 42.2 (11.3)</p> <p><b>Study completers - sex:</b> 100% female</p> <p><b>Specific social or cultural characteristics:</b> Office workers at university workplace</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Female office workers in a university setting; typically consume 3 or more pieces of candy each week</p> <p><b>Exclusion criteria:</b> Those who eat less than 3 pieces of candy a week</p>
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from positioned participant (desk at which seated) (distance from set point)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Chocolate (candy chocolate "kisses")</p>



Wansink 2006 (Continued)

	<p><b>Duration of exposure to intervention:</b> &gt; 1 day</p> <p><b>Study arms:</b> Chocolate placed in covered clear bowl on top of desk; chocolate placed in covered opaque bowl on top of desk; chocolate placed in covered clear bowl 200 cm (2 m) away from desk at similar level; chocolate placed in covered opaque bowl 200 cm (2 m) away from desk at similar level</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> Chocolate placed in bowl on top of desk versus chocolate placed in bowl 200 cm (2 m) away from desk at similar level</p> <p><b>Concurrent intervention components in factorial design:</b> Yes (clear or opaque bowl)</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> No</p>
Outcomes	<p><b>Outcomes reported in study:</b> Mean number of chocolates consumed per day</p> <p><b>Selection outcome analysed:</b> N/A</p> <p><b>Measurement of selection outcome:</b> N/A</p> <p><b>Timing of selection outcome measurement:</b> N/A</p> <p><b>Consumption outcome analysed:</b> Mean number of chocolates consumed per day</p> <p><b>Measurement of consumption outcome:</b> Objective</p> <p><b>Timing of consumption outcome measurement:</b> Longer term (&gt; 1 day)</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	Funding and conflicts of interest were not reported.
Notes	Author confirmed that assignment was randomised (16 March 2016). Outcome data (standard deviations) requested from the authors in November 2017 were not received

Wansink 2013a

Methods	<b>Study design:</b> Between-participants randomised controlled trial
Participants	<p><b>Setting:</b> Field setting</p> <p><b>Setting type:</b> Breakfast buffet at work conference</p> <p><b>Geographical region:</b> USA</p> <p><b>Number of enrolled participants:</b> 124</p> <p><b>Number (%) of enrolled participants completing the study and included in analysis:</b> 124 (100%)</p> <p><b>Study completers - mean age (SD):</b> Not reported</p> <p><b>Study completers - sex:</b> Not reported</p> <p><b>Specific social or cultural characteristics:</b> Human Resource managers attending a conference on behaviour change and health</p> <p><b>Socioeconomic status context:</b> Low deprivation</p> <p><b>Inclusion criteria:</b> Human Resource managers attending a conference on behaviour change and health</p> <p><b>Exclusion criteria:</b> None reported</p>
Interventions	<p><b>Intervention type:</b> Proximity</p> <p><b>Type of proximity intervention:</b> Proximity from start of queue line (start or end of a buffet line)</p> <p><b>Manipulated product type:</b> Food</p> <p><b>Characteristics of manipulated products:</b> Cheesy eggs (in context of also proximity manipulation of other items in buffet order: fried potatoes, bacon, cinnamon rolls, low-fat granola, low-fat yoghurt, fruit)</p> <p><b>Duration of exposure to intervention:</b> ≤ 1 day</p>

	<p><b>Study arms:</b> Least-healthy food (cheesy eggs) placed first in buffet line, amongst set of foods placed in order of less healthy to healthier; least-healthy food (cheesy eggs) placed last in buffet line, amongst set of foods placed in order of healthier to less healthy</p> <p><b>Number of comparisons analysed:</b> 1</p> <p><b>Comparisons analysed:</b> Least-healthy food (cheesy eggs) placed first in buffet line, amongst set of foods placed in order of less healthy to healthier versus least-healthy food (cheesy eggs) placed last in buffet line, amongst set of foods placed in order of healthier to less healthy</p> <p><b>Concurrent intervention components in factorial design:</b> No</p> <p><b>Concurrent intervention components confounded with comparison of interest:</b> N/A</p>
Outcomes	<p><b>Outcomes reported in study:</b> Proportion of participants selecting least-healthy food (cheesy eggs); proportion of participants selecting fried potatoes; proportion of participants selecting bacon; proportion of participants selecting cinnamon rolls; proportion of participants selecting low-fat granola; proportion of participants selecting low-fat yoghurt; proportion of participants selecting fruit</p> <p><b>Selection outcome analysed:</b> Proportion of participants selecting least-healthy food (cheesy eggs)</p> <p><b>Measurement of selection outcome:</b> Objective</p> <p><b>Timing of selection outcome measurement:</b> Immediate (<math>\leq 1</math> day)</p> <p><b>Consumption outcome analysed:</b> N/A</p> <p><b>Measurement of consumption outcome:</b> N/A</p> <p><b>Timing of consumption outcome measurement:</b> N/A</p> <p><b>Secondary outcome:</b> N/A</p>
Funding source	The authors stated that no support or funding was received, and that there were no conflicts of interest
Notes	Data were modelled, and the raw data based on observations were not obtainable from the authors (contacted November 2017). This study was therefore excluded from the analysis

BMI: body mass index

kcal: kilocalories

N/A: not applicable

SD: standard deviation

### Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
<a href="#">Alinia 2011</a>	Study design ineligible
<a href="#">Altintozglou 2015</a>	No measurement of selection or consumption
<a href="#">Anderson 2005</a>	No eligible intervention
<a href="#">Angelopoulos 2009</a>	No eligible intervention

(Continued)

<a href="#">Ayala 2013</a>	No eligible intervention
<a href="#">Ayala 2015</a>	No eligible intervention
<a href="#">Backman 2011</a>	No eligible intervention
<a href="#">Bartholomew 2006</a>	Study design ineligible
<a href="#">Beets 2014</a>	No measurement of selection or consumption
<a href="#">Bere 2006</a>	No eligible intervention
<a href="#">Bergamaschi 2016</a>	No eligible intervention
<a href="#">Bonsergent 2013</a>	No eligible intervention
<a href="#">Bonvecchio-Arenas 2010</a>	No eligible intervention
<a href="#">Bucher 2011</a>	No eligible intervention
<a href="#">Bucher 2014</a>	No eligible intervention
<a href="#">Burns 2015</a>	No eligible intervention
<a href="#">Butler 1996</a>	No measurement of selection or consumption
<a href="#">Caldwell 2009</a>	No eligible intervention
<a href="#">Carroll 2018</a>	No measurement of selection or consumption
<a href="#">Chandon 2002</a>	Study design ineligible
<a href="#">Cohen 2014</a>	No eligible intervention
<a href="#">Coleman 2012</a>	No eligible intervention
<a href="#">Dayan 2011</a>	No eligible intervention
<a href="#">De Wild 2015</a>	No eligible intervention
<a href="#">Divert 2015</a>	Study design ineligible
<a href="#">Dominguez 2013</a>	No eligible intervention
<a href="#">Elsbernd 2016</a>	No eligible intervention

(Continued)

Epstein 2009	No measurement of selection or consumption
Epstein 2013	No eligible intervention
Epstein 2015	No eligible intervention
Eriksen 2003	No eligible intervention
Fisher 1999	No eligible intervention
French 2004	No eligible intervention
French 2005a	No eligible intervention
French 2005b	No eligible intervention
French 2010a	No eligible intervention
French 2010b	No eligible intervention
Giles 2012	No eligible intervention
Gillis 2009	No eligible intervention
Gittelsohn 2013	No eligible intervention
Hanks 2012	Study design ineligible
Harnack 2012	No eligible intervention
Haws 2013	No eligible intervention
Hoerr 1993	Study design ineligible
Kahn 2004	No eligible intervention
Keller 2015	No measurement of selection or consumption
Kim 2012	Study design ineligible
Kimathi 2009	Study design ineligible
Kingsland 2011	No eligible intervention
Kocken 2015	No eligible intervention

(Continued)

Kovalskys 2010	No eligible intervention
Kroese 2016	Study design ineligible
Lachat 2009	No eligible intervention
Leak 2014	No eligible intervention
Lee 2014	Study design ineligible
Lee-Kwan 2013	Study design ineligible
Linde 2012	No eligible intervention
Loughridge 2005	Study design ineligible
Lytle 2006	No eligible intervention
Marcus 2009	No eligible intervention
Martinez-Donate 2015	No eligible intervention
Meengs 2012	No eligible intervention
Mennella 2008	No measurement of selection or consumption
Meyers 1980	Study design ineligible
Moore 2008	No eligible intervention
Muckelbauer 2009	No eligible intervention
Muckelbauer 2009b	No eligible intervention
Norton 2006	No measurement of selection or consumption
Novotny 2011	No eligible intervention
O'Connell 2012	No eligible intervention
Parker 2001	No eligible intervention
Patel 2011	No eligible intervention
Perez-Morales 2011	No eligible intervention

(Continued)

<a href="#">Perry 2004</a>	No eligible intervention
<a href="#">Rausch 2013</a>	No eligible intervention
<a href="#">Raynor 2006</a>	No eligible intervention
<a href="#">Raynor 2012a</a>	No eligible intervention
<a href="#">Raynor 2012b</a>	No eligible intervention
<a href="#">Raynor 2012c</a>	No eligible intervention
<a href="#">Redden 2015</a>	Study design ineligible
<a href="#">Romero 2016</a>	No eligible intervention
<a href="#">Rozin 2011</a>	Study design ineligible
<a href="#">Sallis 2003</a>	No eligible intervention
<a href="#">Scherr 2013</a>	No eligible intervention
<a href="#">Scherr 2014</a>	No eligible intervention
<a href="#">Schwartz 2009</a>	Study design ineligible
<a href="#">Shin 2015</a>	No eligible intervention
<a href="#">Sigurdsson 2011</a>	Study design ineligible
<a href="#">Song 2008</a>	Study design ineligible
<a href="#">Stea 2009</a>	Study design ineligible
<a href="#">Steenhuis 2004</a>	No eligible intervention
<a href="#">Steeves 2015</a>	No eligible intervention
<a href="#">Steyn 2015</a>	No eligible intervention
<a href="#">Te Velde 2008</a>	No eligible intervention
<a href="#">Temple 2008</a>	No eligible intervention
<a href="#">Thorndike 2016</a>	No eligible intervention

(Continued)

<a href="#">Thorndike 2017</a>	No eligible intervention
<a href="#">Toft 2017</a>	Study design ineligible
<a href="#">Uglen 2013</a>	Study design ineligible
<a href="#">Uglen 2014</a>	Study design ineligible
<a href="#">van Herpen 2014</a>	No eligible intervention
<a href="#">van Kleef 2012</a>	Study design ineligible
<a href="#">Van Lippevelde 2012</a>	No eligible intervention
<a href="#">Visscher 2010</a>	Study design ineligible
<a href="#">Wansink 2011</a>	Not an empirical study
<a href="#">Wansink 2013b</a>	No measurement of selection or consumption
<a href="#">Wijnhoven 2015</a>	No eligible intervention
<a href="#">Wilbur 1981</a>	Study design ineligible
<a href="#">Wilcox 2009</a>	No eligible intervention
<a href="#">Wilson 2017</a>	Study design ineligible
<a href="#">Wolfenden 2015</a>	No eligible intervention
<a href="#">Wordell 2012</a>	Study design ineligible
<a href="#">Zeinstra 2010</a>	No eligible intervention

## Characteristics of studies awaiting assessment *[ordered by study ID]*

### [Hua 2017](#)

Methods	2 x 2 x 2 factorial randomised controlled trial
Participants	Students, staff, and employees on a university campus
Interventions	All co-located snack and beverage vending machines (n = 56, 28 snack and 28 beverage) were randomised into 1 of 8 conditions (from a 2x2x2 factorial design): higher availability of healthier products (or not) and/or 25% price reduction for healthier items (or not) and/or promotional signs on machines (or not)



**Hua 2017** (Continued)

Outcomes	The main outcome measures were changes in units sold and revenue
Notes	Identified in updated searches in July 2018. Authors contacted 5th October 2018 for additional information as to eligibility and whether necessary data were collected but no response received

**Watanabe 2016**

Methods	Students were randomly divided into 2 groups for a buffet lunch in 2 separate rooms. In 1 room, 16 kinds of foods were ordered, from vegetable foods to protein foods (vegetable-first group), whilst the dishes were in reverse order in the other room (protein-first group)
Participants	61 students
Interventions	Foods ordered from vegetable foods to protein foods (vegetable-first group) versus dishes in reverse order in other room (protein-first group)
Outcomes	Number of consumed foods was compared between the 2 groups.
Notes	Authors contacted for full study report.

**Characteristics of ongoing studies** [ordered by study ID]**Knowles 2017**

Trial name or title	Investigating the proximity effect in a competitive food environment
Methods	Detailed in registration on Open Science Framework ( <a href="https://osf.io/fgm4s/">osf.io/fgm4s/</a> )
Participants	
Interventions	
Outcomes	
Starting date	
Contact information	Daniel Knowles < <a href="mailto:Daniel.Knowles@bcu.ac.uk">Daniel.Knowles@bcu.ac.uk</a> >
Notes	

### Knowles 2018a

Trial name or title	Exploring the role of effort within the proximity effect
Methods	Detailed in registration on Open Science Framework ( <a href="https://osf.io/eqt92/">osf.io/eqt92/</a> )
Participants	
Interventions	
Outcomes	
Starting date	
Contact information	Daniel Knowles < <a href="mailto:Daniel.Knowles@bcu.ac.uk">Daniel.Knowles@bcu.ac.uk</a> >
Notes	

### Knowles 2018b

Trial name or title	Exploring the role of visual salience within the proximity effect
Methods	Detailed in registration on Open Science Framework ( <a href="https://osf.io/5gx9y/">osf.io/5gx9y/</a> )
Participants	
Interventions	
Outcomes	
Starting date	
Contact information	Daniel Knowles < <a href="mailto:Daniel.Knowles@bcu.ac.uk">Daniel.Knowles@bcu.ac.uk</a> >
Notes	

### Knowles 2018c

Trial name or title	Does the proximity effect occur through non-conscious processes?
Methods	Detailed in registration on Open Science Framework ( <a href="https://osf.io/zn256/">osf.io/zn256/</a> )
Participants	
Interventions	
Outcomes	
Starting date	

Contact information	Daniel Knowles <Daniel.Knowles@bcu.ac.uk>
Notes	

## ADDITIONAL TABLES

Table 1. 'Risk of bias' assessments

Study	Bias arising from the randomisation process	Bias arising from the timing of identification and recruitment of individual participants in relation to timing of randomisation (CRCT only)	Bias due to deviations from intended interventions	Bias due to missing outcome data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall risk of bias (selection)	Overall risk of bias (consumption)
<i>Availability studies</i>								
Fiske 2004	Some concerns	Low risk	Low risk	Low risk	Low risk	Low risk	Some concerns	N/A
Foster 2014	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	N/A
Kocken 2012	Some concerns	Low risk	Low risk	Low risk	Low risk	Low risk	Some concerns	N/A
Pechey 2019	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	Some concerns	N/A
Roe 2013	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	Some concerns	Some concerns
Stubbs 2001	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Some concerns
<i>Proximity studies</i>								
Cohen 2015	Some concerns	Low risk	Low risk	Low risk	Low risk	Low risk	Some concerns	Some concerns

**Table 1. 'Risk of bias' assessments** (Continued)

Engell 1996 (S1)	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Some concerns
Engell 1996 (S2)	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Some concerns
Greene 2017	Some concerns	Low risk	Low risk	Low risk	Low risk	Low risk	Some concerns	Some concerns
Hunter 2018 (S1)	Low risk	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Low risk
Hunter 2018 (S2)	Low risk	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Low risk
Hunter 2019	Low risk	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Low risk
Kongsbak 2016	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	Some concerns	N/A
Langlet 2017	Some concerns	Low risk	Low risk	Low risk	Low risk	Low risk	Some concerns	Some concerns
Maas 2012 (S1)	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Some concerns
Maas 2012 (S2)	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Some concerns
Musher-Eizenman 2010	Some concerns	N/A	Low risk	Some concerns	Low risk	Low risk	N/A	High risk
Painter 2002	Some concerns	N/A	Some concerns	Low risk	Low risk	Low risk	N/A	Some concerns
Privitera 2012 (S1)	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Some concerns
Privitera 2012 (S2)	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Some concerns
Privitera 2014	Some concerns	N/A	Low risk	Low risk	Low risk	Low risk	N/A	Some concerns
Wansink 2006	Some concerns	N/A	Some concerns	Low risk	Low risk	Low risk	N/A	Some concerns

**Table 1. 'Risk of bias' assessments** (Continued)

Wansink 2013a	High risk	N/A	Low risk	Low risk	Low risk	Low risk	High risk	N/A
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CRCT: cluster-randomised controlled trials

Justifications for assessments are available at the following (<http://dx.doi.org/10.6084/m9.figshare.9159824>)

## APPENDICES

### Appendix I. Search strategies, search dates and yields

**MEDLINE (OvidSP - including MEDLINE In-Process), 1946 to February week 3 2016**

**Original search executed: 1st March 2016, records retrieved = 75026**

**Updated search executed: 23rd July 2018, records retrieved = 14185**

1. \*Beverages/
2. \*Alcohol Drinking/
3. (drink\$ or drunk\$ or alcohol\$ or beverage\$1 or beer\$1 or lager\$1 or wine\$1 or cider\$1 or alcopop\$1 or alco-pop\$1 or spirit or spirits or liquor\$1 or liqueur\$1 or liqueur\$1 or whisky or whiskey or whiskies or whiskeys or schnapps or brandy or brandies or gin or gins or rum or rums or tequila\$1 or vodka\$1 or cocktail\$1).ti,ab.
4. \*Tobacco/
5. \*Smoking/
6. (cigar\$ or smok\$ or tobacco\$ or e-cig\$).ti,ab.
7. \*Diet/
8. \*Food/
9. \*Food Intake/
10. \*Food Habits/
11. \*Food Preferences/
12. \*Eating/
13. \*Drinking/
14. \*Food Dispensers, Automatic/
15. (nutri\$ or calori\$ or food\$ or eat or eats or eaten or eating or ate or low-fat or meal\$ or dessert\$1 or snack\$ or drink\$ or beverage\$1).ti,ab.
16. ((increase\$1 or increasing or add\$1 or added or adding or addition\$1 or additional or introduce\$1 or introduction\$1 or introducing or extend\$ or reduc\$ or decrease\$1 or decreasing or remov\$ or restrict\$ or limit\$ or proxim\$ or distal or distanc\$ or position\$ or reposition\$ or visib\$ or accessib\$ or close or closer or closest or near or nearer or nearest or adjacent or far or farther or farthest or farthestmost or further or furthest or furthermost) adj3 (amount\$1 or volume\$1 or quantity or quantities or availab\$ or range\$ or assortment\$1 or arrangement\$1 or array\$ or display\$ or choice\$1 or option\$ or item\$1 or effort or convenien\$ or salien\$ or product\$1 or packag\$ or portion\$ or serving\$ or glass or glasses or bottle\$ or dish\$2 or bowl\$1 or plate\$1 or box or boxes or boxed or bag or bags or bagged or packet\$ or carton\$1 or vending\$)).ti,ab.
17. ((increase\$1 or increasing or add\$1 or added or adding or addition\$1 or additional or introduce\$1 or introduction\$1 or introducing or extend\$ or reduc\$ or decrease\$1 or decreasing or remov\$ or restrict\$ or limit\$ or proxim\$ or distal or distanc\$ or position\$ or reposition\$ or visib\$ or accessib\$ or close or closer or closest or near or nearer or nearest or adjacent or far or farther or farthest or farthestmost or further or furthest or furthermost) adj3 (food\$ or fruit\$ or vegetable\$ or FV or FFV or F&V or low-fat or meal\$ or dessert\$1 or snack\$ or drink\$ or beverage\$1 or alcohol\$ or cigar\$ or tobacco or e-cig\$)).ti,ab.
18. or/1-3
19. or/4-6

20. or/7-15
21. 16 and 18
22. 16 and 19
23. 16 and 20
24. or/17,21-23
25. exp animals/ not humans/
26. (rat or rats or mouse or mice or murine or rodent or rodents or hamster or hamsters or pig or pigs or porcine or rabbit or rabbits or animal or animals or dog or dogs or cat or cats or cow or cows or bovine or sheep or ovine or monkey or monkeys).ti,ab.
27. or/25-26
28. 24 not 27
29. (editorial or case reports or in vitro).pt.
30. 28 not 29

**Embase (OvidSP), 1980 to Week 9 2016**

**Original search executed: 1st March 2016, records retrieved = 68184**

**Updated search executed: 23rd July 2018, records retrieved = 4688**

1. \*Beverage/
2. \*Alcohol Consumption/
3. (drink\$ or drunk\$ or alcohol\$ or beverage\$1 or beer\$1 or lager\$1 or wine\$1 or cider\$1 or alcopop\$1 or alco-pop\$1 or spirit or spirits or liquor\$1 or liqueur\$1 or liqueur\$1 or whisky or whiskey or whiskies or whiskeys or schnapps or brandy or brandies or gin or gins or rum or rums or tequila\$1 or vodka\$1 or cocktail\$1).ti,ab.
4. \*Tobacco/
5. \*Smoking/
6. (cigar\$ or smok\$ or tobacco\$ or e-cig\$).ti,ab.
7. \*Diet/
8. \*Food/
9. \*Food Intake/
10. \*Food Habits/
11. \*Food Preferences/
12. \*Eating/
13. \*Drinking/
14. \*Food Dispensers, Automatic/
15. (nutri\$ or calori\$ or food\$ or eat or eats or eaten or eating or ate or low-fat or meal\$ or dessert\$1 or snack\$ or drink\$ or beverage\$1).ti,ab.
16. ((increase\$1 or increasing or add\$1 or added or adding or addition\$1 or additional or introduce\$1 or introduction\$1 or introducing or extend\$ or reduc\$ or decrease\$1 or decreasing or remov\$ or restrict\$ or limit\$ or proxim\$ or distal or distanc\$ or position\$ or reposition\$ or visib\$ or accessib\$ or close or closer or closest or near or nearer or nearest or adjacent or far or farther or farthest or farthestmost or further or furthest or furthestmost) adj3 (amount\$1 or volume\$1 or quantity or quantities or availab\$ or range\$ or assortment\$1 or arrangement\$1 or array\$ or display\$ or choice\$1 or option\$ or item\$1 or effort or convenien\$ or salien\$ or product\$1 or packag\$ or portion\$ or serving\$ or glass or glasses or bottle\$ or dish\$2 or bowl\$1 or plate\$1 or box or boxes or boxed or bag or bags or bagged or packet\$ or carton\$1 or vending\$)).ti,ab.
17. ((increase\$1 or increasing or add\$1 or added or adding or addition\$1 or additional or introduce\$1 or introduction\$1 or introducing or extend\$ or reduc\$ or decrease\$1 or decreasing or remov\$ or restrict\$ or limit\$ or proxim\$ or distal or distanc\$ or position\$ or reposition\$ or visib\$ or accessib\$ or close or closer or closest or near or nearer or nearest or adjacent or far or farther or farthest or farthestmost or further or furthest or furthestmost) adj3 (food\$ or fruit\$ or vegetable\$ or FV or FFV or F&V or low-fat or meal\$ or dessert\$1 or snack\$ or drink\$ or beverage\$1 or alcohol\$ or cigar\$ or tobacco or e-cig\$)).ti,ab.
18. or/1-3
19. or/4-6
20. or/7-15
21. 16 and 18
22. 16 and 19
23. 16 and 20
24. or/17,21-23
25. exp animals/ not humans/

26. (rat or rats or mouse or mice or murine or rodent or rodents or hamster or hamsters or pig or pigs or porcine or rabbit or rabbits or animal or animals or dog or dogs or cat or cats or cow or cows or bovine or sheep or ovine or monkey or monkeys).ti,ab.
27. or/25-26
28. 24 not 27
29. (editorial or case reports or in vitro).pt.
30. 28 not 29

**PsycINFO (OvidSP) 1806 to February Week 4 2016**

**Original search executed: 1st March 2016, records retrieved = 23813**

**Updated search executed (in EBSCOhost): 23rd July 2018, records retrieved = 8267**

1. \*Alcoholic Beverage/
2. \*Beverages (Nonalcoholic)/
3. \*Alcohol Drinking Patterns/
4. (drink\$ or drunk\$ or alcohol\$ or beverage\$1 or beer\$1 or lager\$1 or wine\$1 or cider\$1 or alcopop\$1 or alco-pop\$1 or spirit or spirits or liquor\$1 or liqueur\$1 or liqueur\$1 or whisky or whiskey or whiskies or whiskeys or schnapps or brandy or brandies or gin or gins or rum or rums or tequila\$1 or vodka\$1 or cocktail\$1).ti,ab.
5. \*Tobacco Smoking/
6. (cigar\$ or smok\$ or tobacco\$ or e-cig\$).ti,ab.
7. \*Diets/
8. \*Food/
9. \*Food Intake/
10. \*Food Preferences/
11. \*Eating Behavior/
12. \*Drinking Behavior/
13. (nutri\$ or calori\$ or food\$ or eat or eats or eaten or eating or ate or low-fat or meal\$ or dessert\$1 or snack\$ or drink\$ or beverage\$1).ti,ab.
14. ((increase\$1 or increasing or add\$1 or added or adding or addition\$1 or additional or introduce\$1 or introduction\$1 or introducing or extend\$ or reduc\$ or decrease\$1 or decreasing or remov\$ or restrict\$ or limit\$ or proxim\$ or distal or distanc\$ or position\$ or reposition\$ or visib\$ or accessib\$ or close or closer or closest or near or nearer or nearest or adjacent or far or farther or farthest or farthestmost or further or furthest or furthestmost) adj3 (amount\$1 or volume\$1 or quantity or quantities or availab\$ or range\$ or assortment\$1 or arrangement\$1 or array\$ or display\$ or choice\$1 or option\$ or item\$1 or effort or convenien\$ or salien\$ or product\$1 or packag\$ or portion\$ or serving\$ or glass or glasses or bottle\$ or dish\$2 or bowl\$1 or plate\$1 or box or boxes or boxed or bag or bags or bagged or packet\$ or carton\$1 or vending\$)).ti,ab.
15. ((increase\$1 or increasing or add\$1 or added or adding or addition\$1 or additional or introduce\$1 or introduction\$1 or introducing or extend\$ or reduc\$ or decrease\$1 or decreasing or remov\$ or restrict\$ or limit\$ or proxim\$ or distal or distanc\$ or position\$ or reposition\$ or visib\$ or accessib\$ or close or closer or closest or near or nearer or nearest or adjacent or far or farther or farthest or farthestmost or further or furthest or furthestmost) adj3 (food\$ or fruit\$ or vegetable\$ or FV or FFV or F&V or low-fat or meal\$ or dessert\$1 or snack\$ or drink\$ or beverage\$1 or alcohol\$ or cigar\$ or tobacco or e-cig\$)).ti,ab.
16. or/1-4
17. or/5-6
18. or/7-13
19. 14 and 16
20. 14 and 17
21. 14 and 18
22. or/15,19-21
23. limit 22 to human

**Cochrane Central Register of Controlled Trials (CENTRAL), 1992 to 3rd March 2016 (Issue 2 of 12, 2016)**

**Original search executed: 3rd March 2016, records retrieved = 15300**

**Updated search executed: 23rd July 2018, records retrieved = 4620**

((drink\* OR drunk\* OR alcohol\* OR beverage\* OR beer\* OR lager\* OR wine\* OR cider\* OR alcopop\* OR alco-pop\* OR spirit OR spirits OR liquor\* OR liqueur\* OR liqueur\* OR whisky OR whiskey OR whiskies OR whiskeys OR schnapps OR brandy OR brandies OR gin OR gins OR rum OR rums OR tequila\* OR vodka\* OR cocktail\* OR cigar\* OR smok\* OR tobacco\* OR e-cig\* OR nutri\* OR calori\* OR food\* OR eat OR eats OR eaten OR eating OR ate OR low-fat OR meal\* OR dessert\* OR snack\*) AND ((increase\* OR increasing OR add OR adds OR added OR adding OR addition OR additions OR additional OR introduce\* OR introduction\*



OR introducing OR extend\* OR reduc\* OR decrease\* OR decreasing OR remov\* OR restrict\* OR limit\* OR proxim\* OR distal OR distanc\* OR position\* OR reposition\* OR visib\* OR accessib\* OR close OR closer OR closest OR nearer OR nearest OR adjacent OR far OR farther OR farthest OR farthestmost OR further OR furthest OR furthestmost) NEAR/6 (amount OR amounts OR volume\* OR quantity OR quantities OR availab\* OR range\* OR assortment\* OR arrangement\* OR array\* OR display\* OR choice\* OR option\* OR item OR items OR effort\* OR convenien\* OR salien\* OR product OR products OR package\* OR portion\* OR serving\* OR glass OR glasses OR bottle\* OR dish OR dishes OR bowl OR bowls OR plate OR plates OR plated OR box OR boxes OR boxed OR bag OR bags OR bagged OR packet\* OR carton\* OR vending\*))

OR

((increase\* OR increasing OR add OR adds OR added OR adding OR addition OR additions OR additional OR introduce\* OR introduction\* OR introducing OR extend\* OR reduc\* OR decrease\* OR decreasing OR remov\* OR restrict\* OR limit\* OR proxim\* OR distal OR distanc\* OR position\* OR reposition\* OR visib\* OR accessib\* OR close OR closer OR closest OR nearer OR nearest OR adjacent OR far OR farther OR farthest OR farthestmost OR further OR furthest OR furthestmost) NEAR/6 (food\* OR fruit\* OR vegetable\* OR FV OR FFV OR F&V OR low-fat OR meal\* OR dessert\* OR snack\* OR drink\* OR beverage\* OR alcohol\* OR cigar\* OR tobacco OR e-cig\*))

NOT

(rat or rats or mouse or mice or murine or rodent or rodents or hamster or hamsters or pig or pigs or porcine or rabbit or rabbits or animal or animals or dog or dogs or cat or cats or cow or cows or bovine or sheep or ovine or monkey or monkeys)

#### **Applied Social Sciences Index and Abstracts (ProQuest) 1987 to 2nd March 2016**

**Original search executed: 2nd March 2016, records retrieved = 762**

**Updated search executed: 24th July 2018, records retrieved = 4398**

((drink\* OR drunk\* OR alcohol\* OR beverage[\*1] OR beer[\*1] OR lager[\*1] OR wine[\*1] OR cider[\*1] OR alcopop[\*1] OR alcopop[\*1] OR spirit OR spirits OR liquor[\*1] OR liqueur[\*1] OR liqueur[\*1] OR whisky OR whiskey OR whiskies OR whiskeys OR schnapps OR brandy OR brandies OR gin OR gins OR rum OR rums OR tequila[\*1] OR vodka[\*1] OR cocktail[\*1] OR cigar\* OR smok\* OR tobacco\* OR e-cig\* OR nutri\* OR kalori\* OR food\* OR eat OR eats OR eaten OR eating OR ate OR low-fat OR meal\* OR dessert[\*1] OR snack\*) AND ((increase[\*1] OR increasing OR add[\*1] OR added OR adding OR addition[\*1] OR additional OR introduce[\*1] OR introduction[\*1] OR introducing OR extend\* OR reduc\* OR decrease[\*1] OR decreasing OR remov\* OR restrict\* OR limit\* OR proxim\* OR distal OR distanc\* OR position\* OR reposition\* OR visib\* OR accessib\* OR close OR closer OR closest OR nearer OR nearest OR adjacent OR far OR farther OR farthest OR farthestmost OR further OR furthest OR furthestmost) NEAR/6 (amount[\*1] OR volume[\*1] OR quantity OR quantities OR availab\* OR range\* OR assortment[\*1] OR arrangement[\*1] OR array\* OR display\* OR choice[\*1] OR option\* OR item[\*1] OR effort\* OR convenien\* OR salien\* OR product[\*1] OR package\* OR portion\* OR serving\* OR glass OR glasses OR bottle\* OR dish OR dishes OR bowl[\*1] OR plate[\*1] OR box OR boxes OR boxed OR bag OR bags OR bagged OR packet\* OR carton[\*1] OR vending\*)) OR ((increase[\*1] OR increasing OR add[\*1] OR added OR adding OR addition[\*1] OR additional OR introduce[\*1] OR introduction[\*1] OR introducing OR extend\* OR reduc\* OR decrease[\*1] OR decreasing OR remov\* OR restrict\* OR limit\* OR proxim\* OR distal OR distanc\* OR position\* OR reposition\* OR visib\* OR accessib\* OR close OR closer OR closest OR nearer OR nearest OR adjacent OR far OR farther OR farthest OR farthestmost OR further OR furthest OR furthestmost) NEAR/6 (food\* OR fruit\* OR vegetable\* OR FV OR FFV OR F&V OR item[\*1] OR product[\*1] OR package\* OR portion\* OR serving\* OR glass OR glasses OR bottle\* OR dish OR dishes OR bowl[\*1] OR plate[\*1] OR box OR boxes OR boxed OR bag OR bags OR bagged OR packet\* OR carton[\*1] OR vending\*)) NOT (rat or rats or mouse or mice or murine or rodent or rodents or hamster or hamsters or pig or pigs or porcine or rabbit or rabbits or animal or animals or dog or dogs or cat or cats or cow or cows or bovine or sheep or ovine or monkey or monkeys)

#### **Science Citation Index Expanded (Web of Science) (1900 to 2nd March 2016) + Social Sciences Citation Index (Web of Science) (1956 to 2nd March 2016) + Conference Proceedings Citation Index - Science (Web of Science) (1990 to 2nd March 2016) + Conference Proceedings Citation Index - Social Science & Humanities (Web of Science) (1990 to 2nd March 2016)**

**Original search executed: 2nd March 2016, records retrieved = 50164**

**Updated search executed: 24th July 2018, records retrieved = 8922**

# 1

TS=(drink\* OR drunk\* OR alcohol\* OR beverage[\*1] OR beer[\*1] OR lager[\*1] OR wine[\*1] OR cider[\*1] OR alcopop[\*1] OR alcopop[\*1] OR spirit OR spirits OR liquor[\*1] OR liqueur[\*1] OR liqueur[\*1] OR whisky OR whiskey OR whiskies OR whiskeys OR schnapps OR brandy OR brandies OR gin OR gins OR rum OR rums OR tequila[\*1] OR vodka[\*1] OR cocktail[\*1] OR cigar\* OR smok\* OR tobacco\* OR e-cig\* OR nutri\* OR kalori\* OR food\* OR eat OR eats OR eaten OR eating OR ate OR low-fat OR meal\* OR dessert[\*1] OR snack\* OR fruit\* OR vegetable\* OR FV OR FFV OR F&V OR item[\*1] OR product[\*1] OR package\* OR portion\* OR serving\* OR glass OR glasses OR bottle\* OR dish OR dishes OR bowl[\*1] OR plate[\*1] OR box OR boxes OR boxed OR bag OR bags OR bagged OR packet\* OR carton[\*1] OR vending\*)

Indexes=SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH Timespan=All years

# 2

TS=(proxim\* OR distal OR distanc\* OR position\* OR reposition\* OR visib\* OR accessib\* OR availab\* OR range\* OR assortment[\*1] OR arrangement[\*1] OR array\* OR display\* OR choice[\*1] OR option\* OR effort OR convenien\* OR salien\*)

Indexes=SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH Timespan=All years

# 3

#2 AND #1

Indexes=SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH Timespan=All years

# 4

TS=(rat or rats or mouse or mice or murine or rodent or rodents or hamster or hamsters or pig or pigs or porcine or rabbit or rabbits or animal or animals or dog or dogs or cat or cats or cow or cows or bovine or sheep or ovine or monkey or monkeys)

Indexes=SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH Timespan=All years

#5

#3 NOT #4

Indexes=SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH Timespan=All years

#6

#3 NOT #4

**Refined by:** [excluding] **WEB OF SCIENCE CATEGORIES:** ( MATERIALS SCIENCE MULTIDISCIPLINARY OR WATER RESOURCES OR MECHANICS OR ENGINEERING ELECTRICAL ELECTRONIC OR OCEANOGRAPHY OR CELL BIOLOGY OR ENVIRONMENTAL SCIENCES OR COMPUTER SCIENCE INFORMATION SYSTEMS OR ELECTROCHEMISTRY OR FOOD SCIENCE TECHNOLOGY OR ENERGY FUELS OR NUCLEAR SCIENCE TECHNOLOGY OR CHEMISTRY PHYSICAL OR AGRICULTURE MULTIDISCIPLINARY OR FORESTRY OR PLANT SCIENCES OR MATERIALS SCIENCE CERAMICS OR BIOPHYSICS OR ECOLOGY OR ZOOLOGY OR CLINICAL NEUROLOGY OR PHYSICS APPLIED OR SOIL SCIENCE OR BIOCHEMISTRY MOLECULAR BIOLOGY OR ENGINEERING MECHANICAL OR BIOLOGY OR CHEMISTRY ANALYTICAL OR GENETICS HEREDITY OR CHEMISTRY INORGANIC NUCLEAR OR COMPUTER SCIENCE THEORY METHODS OR COMPUTER SCIENCE SOFTWARE ENGINEERING OR CHEMISTRY MULTIDISCIPLINARY OR THERMODYNAMICS OR ENGINEERING BIOMEDICAL OR OPTICS OR PHYSICS ATOMIC MOLECULAR CHEMICAL OR MATERIALS SCIENCE COATINGS FILMS OR ENGINEERING MANUFACTURING OR MARINE FRESHWATER BIOLOGY OR BIODIVERSITY CONSERVATION OR BIOTECHNOLOGY APPLIED MICROBIOLOGY OR COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS OR CARDIAC CARDIOVASCULAR SYSTEMS OR POLYMER SCIENCE OR PHYSICS MULTIDISCIPLINARY OR DENTISTRY ORAL SURGERY MEDICINE OR PHYSICS CONDENSED MATTER OR ONCOLOGY OR IMMUNOLOGY OR AGRONOMY OR METALLURGY METALLURGICAL ENGINEERING OR EVOLUTIONARY BIOLOGY OR ENGINEERING CHEMICAL OR FISHERIES OR IMAGING SCIENCE PHOTOGRAPHIC TECHNOLOGY OR TELECOMMUNICATIONS OR TOXICOLOGY OR CHEMISTRY APPLIED OR ENTOMOLOGY OR RESPIRATORY SYSTEM OR PHARMACOLOGY PHARMACY OR COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE OR AGRICULTURE DAIRY ANIMAL SCIENCE OR HORTICULTURE OR ENDOCRINOLOGY METABOLISM OR ENGINEERING MULTIDISCIPLINARY OR GEOSCIENCES MULTIDISCIPLINARY OR GEOCHEMISTRY GEOPHYSICS OR CHEMISTRY ORGANIC OR ASTRONOMY ASTROPHYSICS OR AGRICULTURAL ENGINEERING OR AUTOMATION CONTROL SYSTEMS OR INSTRUMENTS INSTRUMENTATION OR RADIOLOGY NUCLEAR MEDICINE MEDICAL IMAGING OR PHYSICS PARTICLES FIELDS OR COMPUTER SCIENCE HARDWARE ARCHITECTURE OR CHEMISTRY MEDICINAL OR NANOSCIENCE NANOTECHNOLOGY OR SPECTROSCOPY OR MICROBIOLOGY OR ENGINEERING CIVIL OR ENGINEERING ENVIRONMENTAL OR METEOROLOGY ATMOSPHERIC SCIENCES OR PERIPHERAL VASCULAR DISEASE OR SURGERY OR GASTROENTEROLOGY HEPATOLOGY OR LIMNOLOGY OR BIOCHEMICAL RESEARCH METHODS OR GERIATRICS GERONTOLOGY OR SOCIAL WORK OR REHABILITATION OR ENGINEERING INDUSTRIAL OR MATERIALS SCIENCE COMPOSITES OR ANESTHESIOLOGY OR VIROLOGY OR FAMILY STUDIES OR STATISTICS PROBABILITY OR AUDIOLOGY SPEECH LANGUAGE PATHOLOGY OR PEDIATRICS OR MATHEMATICS APPLIED OR COMMUNICATION OR SOCIOLOGY OR POLITICAL SCIENCE OR ORNITHOLOGY OR ORTHOPEDICS OR AGRICULTURAL ECONOMICS POLICY OR DEVELOPMENTAL BIOLOGY OR SPORT SCIENCES OR CRITICAL CARE MEDICINE OR EDUCATION SCIENTIFIC DISCIPLINES OR ACOUSTICS OR PARASITOLOGY OR MEDICAL INFORMATICS OR UROLOGY NEPHROLOGY OR ENGINEERING AEROSPACE OR INFORMATION SCIENCE LIBRARY SCIENCE OR OBSTETRICS GYNECOLOGY OR OPERATIONS RESEARCH MANAGEMENT SCIENCE OR LAW OR PATHOLOGY OR ANATOMY MORPHOLOGY OR MEDICINE LEGAL OR PRIMARY HEALTH CARE OR EDUCATION EDUCATIONAL RESEARCH OR PLANNING DEVELOPMENT OR MATHEMATICS OR MEDICAL LABORATORY TECHNOLOGY OR MATERIALS SCIENCE PA-

PER WOOD OR DERMATOLOGY OR PHYSICS NUCLEAR OR PHYSICS FLUIDS PLASMAS OR ANTHROPOLOGY OR WOMEN S STUDIES OR MANAGEMENT OR GEOGRAPHY OR MATHEMATICAL COMPUTATIONAL BIOLOGY OR OPHTHALMOLOGY OR MATHEMATICS INTERDISCIPLINARY APPLICATIONS OR PHYSICS MATHEMATICAL OR TROPICAL MEDICINE OR SOCIAL SCIENCES MATHEMATICAL METHODS OR NURSING OR HEMATOLOGY OR SOCIAL ISSUES OR BUSINESS OR CRYSTALLOGRAPHY OR BUSINESS FINANCE OR VETERINARY SCIENCES OR REPRODUCTIVE BIOLOGY OR PSYCHOLOGY DEVELOPMENTAL OR TRANSPORTATION OR MINERALOGY OR PALEONTOLOGY OR OTORHINOLARYNGOLOGY OR GERONTOLOGY OR INFECTIOUS DISEASES OR EMERGENCY MEDICINE OR LINGUISTICS OR MYCOLOGY OR CRIMINOLOGY PENOLOGY OR RHEUMATOLOGY OR INTERNATIONAL RELATIONS OR GEOLOGY OR PUBLIC ADMINISTRATION OR GEOGRAPHY PHYSICAL OR ROBOTICS OR ARCHITECTURE OR DEMOGRAPHY OR ANDROLOGY OR HISTORY PHILOSOPHY OF SCIENCE OR HISTORY OR AREA STUDIES OR HEALTH CARE SCIENCES SERVICES OR URBAN STUDIES OR HEALTH POLICY SERVICES OR PSYCHOLOGY EDUCATIONAL OR ALLERGY OR PSYCHOLOGY MATHEMATICAL OR MINING MINERAL PROCESSING OR TRANSPORTATION SCIENCE TECHNOLOGY OR COMPUTER SCIENCE CYBERNETICS OR CONSTRUCTION BUILDING TECHNOLOGY OR ETHICS OR INDUSTRIAL RELATIONS LABOR OR ENGINEERING GEOLOGICAL OR MEDICAL ETHICS OR PSYCHOLOGY PSYCHOANALYSIS OR MATERIALS SCIENCE TEXTILES OR ETHNIC STUDIES OR REMOTE SENSING OR ENGINEERING PETROLEUM OR INTEGRATIVE COMPLEMENTARY MEDICINE OR HISTORY OF SOCIAL SCIENCES OR MATERIALS SCIENCE CHARACTERIZATION TESTING OR PHILOSOPHY OR MATERIALS SCIENCE BIOMATERIALS OR ENGINEERING MARINE OR MICROSCOPY OR HUMANITIES MULTIDISCIPLINARY OR PSYCHIATRY OR NEUROIMAGING OR LITERARY THEORY CRITICISM OR LITERATURE OR ART OR LITERATURE GERMAN DUTCH SCANDINAVIAN OR RELIGION OR POETRY OR EDUCATION SPECIAL OR MEDIEVAL RENAISSANCE STUDIES OR CELL TISSUE ENGINEERING OR LITERATURE AMERICAN OR FILM RADIO TELEVISION OR CULTURAL STUDIES OR CLASSICS OR ENGINEERING OCEAN OR ASIAN STUDIES OR LANGUAGE LINGUISTICS OR THEATER OR ARCHAEOLOGY OR LITERATURE SLAVIC OR MUSIC OR LITERATURE ROMANCE OR TRANSPLANTATION OR DANCE)

*Indexes=SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH Timespan=All years*

These exclusions mean that the search is focused on the following:

Searching in PUBLIC ENVIRONMENTAL OCCUPATIONAL HEALTH (12,220) MEDICINE RESEARCH EXPERIMENTAL (1,224) SOCIAL SCIENCES INTERDISCIPLINARY (606) NUTRITION DIETETICS (10,318) PSYCHOLOGY (1,163) PSYCHOLOGY SOCIAL (546) MULTIDISCIPLINARY SCIENCES (9,815) BEHAVIORAL SCIENCES (1,132) PSYCHOLOGY BIOLOGICAL (410) MEDICINE GENERAL INTERNAL (7,521) PSYCHOLOGY EXPERIMENTAL (791) ENVIRONMENTAL STUDIES (310) SUBSTANCE ABUSE (5,107) ECONOMICS (774) HOSPITALITY LEISURE SPORT TOURISM (162) PSYCHOLOGY CLINICAL (2,392) SOCIAL SCIENCES BIOMEDICAL (663) PSYCHOLOGY APPLIED (117) PSYCHOLOGY MULTIDISCIPLINARY (1,389) PHYSIOLOGY (658) ERGONOMICS (38)

**Trials Register of Promoting Health Interventions (EPPI Centre) (2004 to 4th March 2016)**

**Original search executed: 4th March 2016, records retrieved = 747**

**Updated search executed: 27th July 2018, records retrieved = 19**

110 Focus of the report: alcohol OR healthy eating OR tobacco

111 Type(s) of intervention: environmental modification

112 110 AND 111

113 Freetext (item record) "proximity"

114 Freetext (item record) "proximal"

115 Freetext (item record) "distal"

116 Freetext (item record) "distanc\*"

117 Freetext (item record) "position\*"

118 Freetext (item record) "reposition\*"

119 Freetext (item record) "visib\*"

120 Freetext (item record) "accessib\*"

121 Freetext (item record) "effort\*"

122 Freetext (item record) "convenien\*"

123 Freetext (item record) "salien\*"

124 Freetext (item record) "availab\*"

125 Freetext (item record) "range\*"

126 Freetext (item record) "assortment\*"

127 Freetext (item record) "arrangement\*"
 128 Freetext (item record) "array\*"
 129 Freetext (item record) "display\*"
 130 Freetext (item record) "choice\*"
 131 Freetext (item record) "option\*"
 132 113 OR 114 OR 115 OR 116 OR 117 OR 118 OR 119 OR 120 OR 121 OR 122 OR 123 OR 124 OR 125 OR 126 OR 127  
 OR 128 OR 129 OR 130 OR 131
 133 Freetext (item record) "drink\*"
 134 Freetext (item record) "drunk\*"
 135 Freetext (item record) "alcohol\*"
 136 Freetext (item record) "beverage\*"
 137 Freetext (item record) "beer\*"
 138 Freetext (item record) "lager\*"
 139 Freetext (item record) "wine\*"
 140 Freetext (item record) "cider\*"
 141 Freetext (item record) "alcopop\*"
 142 Freetext (item record) "alco-pop\*"
 143 Freetext (item record) "spirit"
 144 Freetext (item record) "spirits"
 145 Freetext (item record) "liquor\*"
 146 Freetext (item record) "liqueur\*"
 147 Freetext (item record) "liqueur\*"
 148 Freetext (item record) "whisk\*"
 149 Freetext (item record) "schnapps"
 150 Freetext (item record) "brandy"
 151 Freetext (item record) "brandies"
 152 Freetext (item record) "gin"
 153 Freetext (item record) "gins"
 154 Freetext (item record) "rum"
 155 Freetext (item record) "rums"
 156 Freetext (item record) "tequila\*"
 157 Freetext (item record) "vodka\*"
 158 Freetext (item record) "cocktail\*"
 159 Freetext (item record) "cigar\*"
 160 Freetext (item record) "smoke"
 161 Freetext (item record) "smokes"
 162 Freetext (item record) "smoking"
 163 Freetext (item record) "smoker"
 164 Freetext (item record) "smokers"
 165 Freetext (item record) "smoked"
 166 Freetext (item record) "tobacco\*"
 167 Freetext (item record) "nutri\*"
 168 Freetext (item record) "calori\*"
 169 Freetext (item record) "food\*"
 170 Freetext (item record) "eat"
 171 Freetext (item record) "eats"
 172 Freetext (item record) "eaten"
 173 Freetext (item record) "eating"
 174 Freetext (item record) "ate"
 175 Freetext (item record) "low-fat"
 176 Freetext (item record) "meal\*"
 177 Freetext (item record) "dessert\*"
 178 Freetext (item record) "snack\*"

179 Freetext (item record) "fruit\*"  
 180 Freetext (item record) "vegetable\*"  
 181 Freetext (item record) "FV"  
 182 Freetext (item record) "FFV"  
 183 Freetext (item record) "F&V"  
 184 133 OR 134 OR 135 OR 136 OR 137 OR 138 OR 139 OR 140 OR 141 OR 142 OR 143 OR 144 OR 145 OR 146 OR 147  
 OR 148 OR 149 OR 150 OR 151 OR 152 OR 153 OR 154 OR 155 OR 156 OR 157 OR 158 OR 159 OR 160 OR 161 OR 162  
 OR 163 OR 164 OR 165 OR 166 OR 167 OR 168 OR 169 OR 170 OR 171 OR 172 OR 173 OR 174 OR 175 OR 176 OR 177  
 OR 178 OR 179 OR 180 OR 181 OR 182 OR 183  
 185 132 AND 184  
 186 112 OR 185

## Appendix 2. Details of the semi-automated screening workflow

The semi-automated screening workflow proceeded in four phases: i) Initial sample; ii) Active learning; iii) Topic modelling; iv) Active learning (final phase). A separate methods paper is being developed that will describe these processes in greater detail.

### Initial sample

Firstly, we screened a random sample of title-abstract records to establish an initial estimate of the baseline inclusion rate ([Shemilt 2014](#)), to both inform prospective monitoring of the performance of the semi-automated screening workflow and to supply an unbiased initial sample of records for machine learning (see 'Active learning', below).

### Active learning

Secondly, we deployed active learning with the aim of identifying records of potentially eligible studies as rapidly as possible. In this phase, title-abstract records were prioritised for manual screening using active learning, whereby the machine iteratively 'learns' to distinguish between relevant and irrelevant records in conjunction with manual user input ([Miwa 2014](#)). We previously deployed this method in two large-scale systematic scoping reviews of interventions to change health behaviour ([Shemilt 2013](#); [Hollands 2013a](#); [Shemilt 2014](#)). Active learning was initially trained using small samples of provisionally included and excluded records drawn from a reference set of 24 records of potentially eligible studies identified by a published scoping review on physical micro-environment interventions ([Hollands 2013a](#)), and in the random sample of citations screened in the first phase (Initial sample). In order to deploy active learning, a stopping criterion is needed that prespecifies when this phase will be truncated. We set the stopping criterion in terms of the maximum marginal resource the review team was willing to 'pay' in order to identify one additional title-abstract record of a potentially eligible study. We prospectively monitored and recorded screening time-on-task and stopped the active learning phase of the semi-automated workflow when the review authors had completed 15 hours of duplicate screening (i.e. 30 hours time-on-task in total for two review authors) without identifying any further records of potentially eligible studies. In practice, this equated to a figure of 1700 title-abstract records. At this point, we also screened a second random sample of records to establish a second estimate of the baseline inclusion rate ([Shemilt 2014](#)). In this active learning phase of the workflow, we alternated between title-abstract and full-text screening stages after each set of 2400 title-abstract records had been manually screened. This was intended to promote more accurate initial title-abstract screening decisions, and to enable retrospective modelling of the impact of using full-text screening decisions in training data for active learning.

### Topic modelling

Active learning was expected to have identified the large majority of title-abstract records of potentially eligible studies that were present in the full set retrieved by electronic searches before the above stopping criterion for that phase was enacted. However, given that active learning iteratively prioritises further title-abstract records for screening based on the researchers' preceding eligibility decisions about records that were also prioritised by active learning (i.e. the algorithm progressively finds 'more of the same'), we introduced an entirely different, novel method into the semi-automated workflow, in order to provide a check and balance on the use of active learning alone. In this third phase of title-abstract screening, records were allocated for duplicate manual screening based on topic modelling using Latent Dirichlet Allocation (LDA) ([Pedregosa 2011](#)). Topic modelling essentially clusters title-abstract records according to the combinations of terms they contain and returns a set of 'topic terms' for each cluster (hereafter, a 'topic').

Topic modelling was used to generate 50 topics underlying the full set of title-abstracts retrieved by electronic searches (or included amongst the reference set), and concurrently to generate a series of 'membership scores' for each unscreened record, by topic. The membership score is based on the computed probability that a record is described by the topic (i.e. a higher membership score reflects a higher probability of membership of the topic) and is  $> 0$  for all records in all topics. Each unscreened title-abstract record was then allocated to the single topic that corresponded with its highest membership score. Results of a preliminary simulation study, conducted to simulate this phase of the workflow in a screening dataset curated from another Cochrane Review (Hollands 2015), indicated that the large majority of generated topics contained no unscreened records of potentially eligible studies (i.e. most topics are irrelevant), and also that the review authors were able to discriminate accurately between topics that contained the most and fewest records of potentially eligible studies when blinded to this information. Two review authors therefore examined each topic, blinded to the number of records allocated to each, and placed the 50 topics in rank order based on their inter-subjective judgement of the likelihood that each set of terms describes a set of records that includes eligible studies. A second ranking of the 50 topics was also generated based on the number of potentially eligible title-abstract records each topic contained amongst records already screened up to the end of the active learning phase (i.e. a data-generated ranking). We then computed a composite ranking by adding together the review authors' ranking and the data-generated ranking, once the latter had been multiplied by 0.5. This procedure assigns double weight to the review authors' judgements in the composite ranking, promoting those topics that the review authors rank higher but that contain a relatively low number of potentially eligible title-abstract records amongst those already screened (and, conversely, demoting those topics that the authors rank lower but that contain a relatively low number of potentially eligible title-abstract records amongst those already screened). At the end of the active learning phase, the 'remaining screening budget' (i.e. the 'overall screening budget' minus the number of records already screened) was calculated and allocated between topics, by drawing a random sample of unscreened title-abstract records from each topic (i.e. the sum of the sizes of the 50 random samples equalled the remaining screening budget). The sizes of random samples drawn from topics were scaled to approximate a beta distribution ( $\alpha = 0.3$ ,  $\beta = 3.0$ ) across rank-ordered topics (highest to lowest), in order to reflect our prior belief (informed by results of the simulation study) about the likely distribution of any further potentially eligible title-abstract records across rank-ordered topics. Sampled records were then allocated for duplicate manual screening in topic rank order, from highest to lowest ranked. This procedure ensured that records assigned to a higher-ranked topic were more likely to be allocated for screening, relative to those assigned to a lower-ranked topic. We continued the topic modelling phase of title-abstract screening until either all records allocated using the above procedure had been screened, or the early stopping criterion was enacted, which was the case. This stopping rule was based on prospective monitoring of time-on-task, and required that we truncated this phase of the semi-automated screening workflow when review authors had completed 15 hours of duplicate screening (i.e. 30 hours time-on-task in total for two review authors) without identifying any further records of potentially eligible studies. As previously, the stopping criterion was set at 1700 title-abstract records.

### Active learning (final phase)

Because the topic modelling phase may detect additional title-abstract records that alter any subsequent prioritisation of records by active learning, we conducted a final phase of screening using the active learning method outlined above, truncated according to the same stopping criterion (15 hours of duplicate screening, that being 1700 records screened). Including this further phase gave additional confidence that, within available resources, all relevant title-abstract records had been identified.

### Use of semi-automated screening workflow for review updates

Following the original searches conducted in March 2016, the searches were subsequently updated in July 2018. A simplified version of the workflow described above was then applied to the updated searches. This involved an active learning process that was able to learn from the coding decisions made in the initial screening process, with a model being constructed based on the large number of include and exclude decisions from the initial title-abstract screening (in which 27,116 records were screened). This model was then applied to the updated searches to rank title-abstract records by their likely relevance. The ranked records were then screened in descending order of highest-lowest likely relevance until the same stopping rule as was previously employed was met (i.e. 1700 title-abstract records without identifying a potentially eligible record, based on time-on-task estimates). A topic modelling process was not used for screening the updated searches, because in the initial screening all of the included studies were identified as a result of the active learning phase, and therefore topic modelling had provided no additional value.

## Appendix 3. Meta-regression analyses

### Procedure

Univariate meta-regression analyses were conducted on the following covariates for stages 2, 3, and 4.

Stage 2:

1. Study design (categorical)
2. Study setting (categorical)
3. Product healthiness (categorical)
4. Duration of exposure to invention (categorical)
5. Socioeconomic status (categorical)
6. Product-outcome relationship (categorical)
7. Timing of outcome measurement (categorical)
8. Risk of bias summary (categorical)

Stage 3:

1. Absolute difference in proximity (continuous)

Stage 4:

1. Percentage of female participants (continuous)

We had intended that covariates within each stage would be combined as a multivariate analysis to identify the set of covariates that best explained the statistical heterogeneity observed during meta-analysis. A final meta-regression model would therefore be formulated that included covariates from all three stages.

The following procedure was to be used to select and incorporate covariates into the multivariate model.

1. Covariates identified as potentially important predictors of the outcome in stages 2, 3, and 4 ranked in order of  $R^2$  values.
2. A stepwise procedure used to add a covariate to the top-ranked covariate to a multivariable meta-regression model.
3. A covariate is retained in the multivariable model should a significant effect be observed for the covariate, the  $R^2$  value does not decrease and no collinearity/multicollinearity is detected with other covariates in the multivariable meta-regression model.

In practice, only univariate meta-regression analyses could be satisfactorily conducted. Multivariate analyses were not possible due to a lack of data and given that there were not variables identified that modified the intervention effect within each stage of the analysis.

Results of the univariate meta-regression analyses were as follows, with variables displaying significant associations in bold.

### Stage 2:

Covariate	Estimate (95% CI)	P	R <sup>2</sup> (%)
Study design (0 = Between-participants 1 = Within-participants)	0.254 (−0.452, 0.961)	0.481	0.00
Study setting (0 = Field 1 = Laboratory)	−0.254 (−0.961, 0.452)	0.481	0.00
Product healthiness (0 = Less healthy 1 = Healthier 2 = Mixed)	(Healthier) −0.468 (−1.164, 0.229)	0.739	0.00
	(Mixed) −0.170 (−0.166, 0.827)	0.188	0.00
Duration of exposure (0 = 1 day or less 1 = More than 1 day)	0.254 (−0.452, 0.961)	0.481	0.00

(Continued)

<b>Socioeconomic context</b> (0 = High and low deprivation 1 = Low deprivation)	−0.442 (−0.835, −0.050)	0.027	57.06
<b>Product-outcome relationship</b> (0 = Other products available 1 = No other products)	−0.795 (−1.168, −0.422)	< 0.001	100.00
Timing of outcome measurement (0 = Immediate 1 = Longer term)	0.254 (−0.452, 0.961)	0.481	0.00
<b>Risk of bias summary</b> (0 = High risk 1 = Low risk 2 = Some concerns)	(Low) 1.774 (0.803, 2.746) (Some) 1.448 (0.471, 2.425)	< 0.001 0.0037	100.00

Stage 3:

Covariate	Estimate (95% CI)	P	R <sup>2</sup>
<b>Absolute difference in proximity</b>	−0.0011 (−0.0017, −0.0005)	< 0.001	100.00

Stage 4:

Covariate	Estimate (95% CI)	P	R <sup>2</sup>
Percentage of female participants	0.0068 (−0.0004, 0.0140)	0.063	6.13

## WHAT'S NEW



Date	Event	Description
4 September 2019	New citation required but conclusions have not changed	Changed to open access. No other changes made to the text of the review

## CONTRIBUTIONS OF AUTHORS

Draft the protocol: all authors

Develop a search strategy: GJH, IS

Search for trials: GJH, PC, IS

Obtain copies of trials: GJH, PC, IS

Select studies for inclusion: GJH, PC, IS, DO

Extract data from studies: GJH, PC, SEK

Enter data into Review Manager 5: GJH, PC, SEK

Carry out the analysis: SA, JPTH

Interpret the analysis: all authors

Draft the final review: all authors

## DECLARATIONS OF INTEREST

Gareth Hollands declares no financial or other conflicts of interest.

Patrice Carter declares no financial or other conflicts of interest.

Sumayya Anwer declares no financial or other conflicts of interest.

Sarah King declares no financial or other conflicts of interest.

Susan Jebb declares no financial or other conflicts of interest.

David Ogilvie declares no financial or other conflicts of interest.

Ian Shemilt declares no financial or other conflicts of interest.

Julian Higgins declares no financial or other conflicts of interest.

Theresa Marteau declares no financial or other conflicts of interest.

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- University of Bristol, UK.  
Computer provision
- University College London, UK.  
Computer provision

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Funding for the protocol

## DIFFERENCES BETWEEN PROTOCOL AND REVIEW

1. Methods - Types of studies: We excluded randomised studies that had only a single participating site with site-level data in the intervention and/or the comparator group because this would result in the treatment effect being completely confounded with the site characteristics.

## NOTES

This Review contains articles on which Brian Wansink ( John Dyson Professor of Marketing at Cornell University) was an author, who is known to have committed academic misconduct ( <https://www.bmj.com/content/363/bmj.k4309>). Seventeen of his articles have been retracted as of 9<sup>th</sup> August 2019 ( <http://retractiondatabase.org/RetractionSearch.aspx?auth%3dWansink>). None of the 17 retracted articles authored by Wansink have been included in this Cochrane Review. The results and conclusions of the review are therefore not affected. However, four articles on which Wansink is an author, and which have not been retracted, were included in this review, and two of these four articles contributed data to the primary meta-analyses. These retractions introduce additional uncertainty regarding the veracity of other studies Wansink has authored, including those contributing to this review. Should any study included in this review be retracted, we will withdraw that study's data from updated meta-analyses conducted as part of future updates of this Cochrane review.