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A Systematic Review of the Effectiveness of Supermarket-Based Interventions Involving Product, Promotion, or Place on the Healthiness of Consumer Purchases

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Abstract
Introduction The supermarket is increasingly recognised as a key environment to promote healthy eating. No previous reviews have focused specifically on the effectiveness of interventions that target the in-store supermarket environment for improving the healthiness of population food purchases.
Methods Systematic review of supermarket-based interventions related to nutrition. Interventions were included if they related to the type of products available for sale, promotion or consumer education and/or product placement. Interventions related to price and on-pack labelling were excluded. Outcomes included food purchasing, food consumption or body weight. Study quality was assessed using the Effective Public Health Practice Project quality assessment tool.
Results Of 50 included studies, the majority were conducted in the USA (74 %), with 33 % published in the last 3 years. Seventy percent of studies were rated as moderate ($n = 11$) or high ($n = 24$) quality. Positive effects were observed in 35 studies (70 %). Of the 15 studies that reported null or negative findings, most ($n = 12$) did not have a strong study design, large sample size or duration longer than 1 month.
Conclusions Most high-quality studies targeting the supermarket food environment reported improvements in the healthiness of consumer purchases in response to the intervention. Although it is difficult to identify specific intervention options that are likely to be most effective and sustainable in this setting, shelf labelling (particularly using nutrition summary scores) stands out as being particularly promising.

Keywords Supermarket · Intervention · Review · Obesity

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Introduction

Poor diets and obesity are among the leading contributors to the global burden of disease [1]. It is well recognised that the current state of food environments is a key driver of unhealthy diets [2]. Supermarkets represent a key setting for food purchases and enjoy market domination in many high-income countries [3–7]. The prominence of supermarkets is also increasing rapidly in low- and middle-income countries [8]. Recent studies have demonstrated that several aspects of the supermarket environment in a range of countries can be considered unhealthy [9••, 10]. Despite their crucial role in shaping population diets over the last 50 years [11], the supermarket food environment has not been a large focus of health promotion and obesity prevention efforts.

In considering the types of nutrition-related interventions that can be implemented in the supermarket setting, the 'Four 'P's of Marketing' (product, promotion, place and price) [12] represents a useful classification structure. In the context of healthy eating interventions, 'product' might include increasing the number of healthy options available; 'promotion' can be either non-interactive (e.g. shelf labels, signage, recipe cards) or interactive (e.g. taste testing, store tours, information sessions) interventions aimed at promoting healthier products

or educating consumers with respect to nutrition; 'place' may involve changing store layout or product positioning to promote healthier foods; while 'price' can include discounts, taxes, vouchers or subsidies.

A number of review articles over the past 10 years have evaluated the literature relating to interventions in the retail food environment designed to improve population nutrition [13–16]. Liberato et al., Escaron et al. and Glanz et al. all considered interventions related to each of the four P's, while van t'Riet only examined the provision of product health information, and only in studies using store sales data to evaluate the outcome. None of these focused exclusively on the supermarket, with interventions in small grocery, convenience and corner stores also included. For most consumers in high-income countries, supermarkets typically serve a very different purpose to small stores, with supermarkets providing the source of the majority of food eaten at home [3–7]. Accordingly, consumer behaviour and the influences on food purchases are likely to be different in the supermarket compared to other retail settings. Reviews that combine both supermarket and small-store interventions are less likely to identify those interventions that work best in the supermarket setting.

The potential population impact of changing the healthiness of the supermarket food environment is likely to be far greater than changes in smaller retail outlets. Moreover, scalability of successful interventions is likely to be much more feasible in the supermarket setting due to the relatively small number of retailers that dominate the supermarket sector. In high-income countries, it is common for a small number of companies to enjoy a large share of the retail food market [17]. This means that small changes in one or two major retailers have the potential to substantially change the diet of entire populations.

This study aimed to conduct a systematic review of the effectiveness of supermarket-based interventions involving product, promotion or place, on the healthiness of consumer purchases. While price is also a potentially important lever for influencing consumer behaviour, in light of recent reviews specifically focused on 'price'-related interventions in the retail setting [18, 19•], we did not include these in this review, but we incorporate the conclusions from earlier reviews in our discussion.

Methods

Data Sources

One author (EC) searched Medline Complete, PsychINFO, CINAHL Complete and Science Direct databases as well as Google Scholar during November and December 2015. Combinations of the following search terms were used: "Supermarket", "grocery", "food store", "intervention", "promot*", "program*", "in-store", "store-based", "marketing", "health*", "obesity", "retail" to search title and abstracts. A total of 3786 results were yielded. A Google search using the same search terms was also conducted in order to identify relevant grey literature on the topic. The search was restricted to articles published in English. No date limits were set. Articles were also found by forward-searching (searching for papers that cited relevant articles using Google Scholar) and identifying relevant papers included in previous reviews. Titles were read by one author (EC) and if deemed relevant to the review, the abstract was read also. Full text was downloaded if the study was likely to meet the inclusion criteria. See Fig. 1 for a flow chart of the study selection process.

Inclusion/Exclusion Criteria

One hundred and one full text articles were assessed against the inclusion and exclusion criteria, which are listed in Table 1. As per the aims of the review, studies were included if they reported on interventions related to product, promotion or place. Price interventions (such as taxation, subsidies and coupon incentives) were excluded, unless the study reported on the independent effect of other relevant in-store interventions. Mass media interventions were only included where they were part of a larger study that also included an in-store intervention. Interventions that related to on-pack product labelling (including front-of-pack labelling) were excluded as they were considered as operating at the product manufacturer, rather than retailer, level. Reviews of the effect of both price and on-pack labelling interventions are included in the discussion. Description of study designs was based on the categorization used in the Effective Public Health Practice Project (EPHPP) quality assessment tool [20].

Data Extraction

The full text of selected articles was assessed, and the following information was extracted from each article: study design, duration, year, participants/setting/country, details of intervention, main outcomes and study findings. Articles were grouped by intervention target as follows: (i) product: increasing stock levels or number of varieties of healthy foods, increasing quality of fresh food products; (ii) promotion: including shelf labels, signage such as posters and banners, store tours, cooking demonstrations, information sessions, taste testing, recipe cards, audio or video announcements, other informative tools such as games, podcasts and computer kiosks; and (iii) place: modifying store layouts to give more prominence to

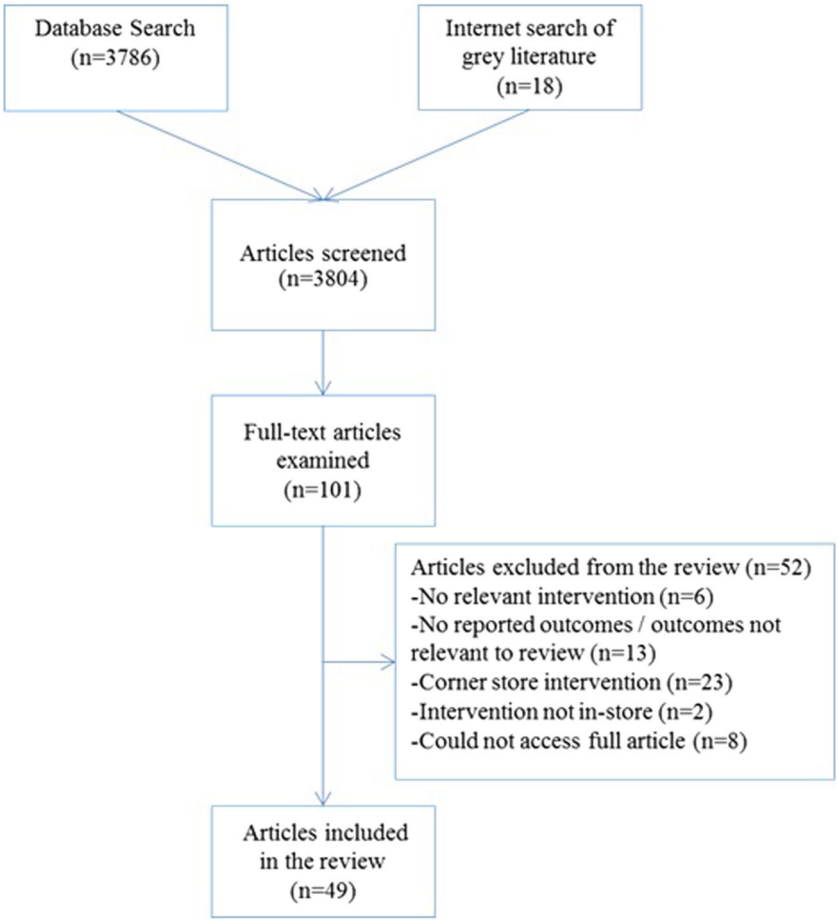

Fig. 1 Flow chart of study selection process

healthy foods or restrict prominence of unhealthy foods, e.g. changes to products displayed at ends-of-aisles and checkouts, increasing shelf space dedicated to healthy foods, decreasing shelf space dedicated to unhealthy foods. Interventions were also classified as either single component or multi-component, with multi-component studies potentially including more than one of product, promotion or place (and often more than one strategy within each category). Studies were also categorised by the level of customer interaction, with interactive interventions including components such as taste testing, interactive video systems and information sessions.

Quality Assessments

Quality assessment of 49 articles (representing 50 separate studies) was independently undertaken by two authors (AC and WN) based on the Quality Assessment Tool for Quantitative Studies, which was developed for the EPHPP [20]. A study quality rating of strong, moderate or weak was determined for each of six criteria: selection bias, design, confounders, blinding, data collection methods and drop-outs/withdrawals. Where studies assessed outcomes using both sales data and self-reported survey data, the quality assessment was based on the more objective sales data. For studies

Table 1 Inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Interventions	Changed the in-store environment to influence consumer nutrition/diet	Mass media interventions, 'price' interventions and front-and back-of-pack nutrition labelling interventions
Setting	Supermarkets, grocery stores and online stores	Corner stores, convenience stores and small food stores
Study design	Intervention studies (investigator led or natural experiment)	Observational studies
Outcomes	Store sales data, self-reported food purchase data, consumer food consumption and physical measures such as BMI	Where the only outcome measures were customer or staff knowledge/awareness/attitudes, customers' intended purchasing behaviours or process measures

with no control group, we still assessed potential confounders of the study, even though the question in the tool relates to differences between intervention and control groups prior to intervention. For studies with collection of data at one time point only, or which did not follow participants over time (for instance, measuring whole store sales data before and after the intervention), the drop-outs and withdrawal component of the assessment tool were rated as not applicable.

The ratings of each component were compared between the two authors, with 81 % inter-rater agreement (i.e. same rating for both assessors). Where discrepancies were observed, both assessors discussed the reasons for their decision and either both agreed on a final rating, or agreed to take an average between the two ratings. A final quality score was calculated for each study in two ways. In the first approach, using the method recommended by the EPHPP, studies were given an overall study rating of 'weak' if there were two or more weak ratings for individual components, 'moderate' if there was one weak rating or 'strong' if no components were rated as weak. In the second approach, scores (i.e. 1 = weak, 2 = moderate, 3 = strong) from each component were added together and divided by the number of components scored (multiplied by three). For example, if all components were scored, the final score would be (×/6*3)*100 %. If one component was not applicable, a final score would be calculated as (×/5*3)*100 %. A quality assessment summary table can be found in Appendix 1, with final quality scores for each study also included in the summary table (Appendix 2).

Results

Characteristics of Included Studies

From 3804 articles screened, 3679 were deemed ineligible based on title or abstract. The full text of the remaining 101 was required to fully assess eligibility. Of these, 52 were excluded from the review because of no eligible outcomes assessed ($n = 13$), no relevant intervention ($n = 6$), intervention conducted in small/corner stores ($n = 23$), intervention not conducted in-store ($n = 2$) or no access to full text article available (conference abstract only) ($n = 8$) (see Fig. 1).

Among the 49 included papers, the "Eat for Health" intervention was reported in three studies [21–23]. Conversely, two papers reported the results of two separate experiments [24, 25]. Therefore, the 49 papers represent a total of 50 separate studies. The majority of papers represent studies conducted in the USA (73 %), with other countries represented including the Netherlands (8 %), Australia (6 %), Canada (4 %), United Kingdom (4 %), Japan (2 %) and Norway (2 %). Almost half of all papers ($n = 24$, 49 %) were published last century, with one third published in the past 3 years ($n = 16$, 33 %). Relatively few papers reporting supermarket intervention studies were conducted between 2000 and 2013 ($n = 9$, 18 %). Seven of the included studies involved interventions tested during single shopping trips, with an additional six interventions being 2 weeks or less in duration. An additional 23 interventions (46 %) were between 1- and 6-month duration with the remaining 14 studies (28 %) having an intervention duration of 6 months to 3 years.

Study Types

The majority of studies were either randomised controlled trials (RCT) ($n = 11$, 22 %) or controlled trials ($n = 23$, 46 %). Eight studies used an interrupted time series design (16 %) [26–29, 30•, 31–33], while eight studies used either a cohort or cohort analytic design (16 %) [34–41]. The size of included studies is hard to evaluate, with some studies measuring intervention effects in individual customers (follow-up studies), and other studies examining effects across whole stores using collection of sales (scanner) data. Twelve studies (24 %) included <400 individual participants, with another nine studies (18 %) including >400 (and up to 535,000) participants. For studies that collected whole-store data, the number of stores varied, with 14 studies including only one or two stores, a further seven studies including between three and eight stores, and another eight studies including 14 or more stores (two studies included 168 stores). Twenty-four of the 50 studies (48 %) could be considered large (data from at least 400 participants, or whole-store data from at least three stores).

Thirty-three studies (66 %) were categorised as non-interactive (no direct customer interaction), while 14 studies included both interactive and non-interactive intervention components, and three studies involved only an interactive intervention. Looking at the broadest categorisation of the interventions, almost all studies (96 %) involved promotion as an intervention target, with two studies incorporating product and six incorporating place (note, some studies fell into more than one category). Most interventions focused heavily on increasing the consumption of healthy foods with very few interventions targeting a reduction in the promotion or availability of unhealthy foods. Thirty studies (60 %) were testing multiple intervention components (e.g. shelf tags, mass media, taste testing, flyers, posters or other signage and placement), with the majority of longer duration interventions (at least 2 months) being multi-component studies ($n = 23/29$, or 79 %). In contrast, only seven of the 21 single-component studies (33 %) had intervention periods lasting at least 2 months. Note that multiple components could be used in a single broad category—for instance, shelf tags, posters and flyers are all considered promotion. Only four studies included follow-up to ascertain the extent to which any intervention effects were maintained after the intervention ended [25, 32, 33, 42]. Body weight was not an outcome for any study, with

all studies reporting intervention effects on purchases of food. The majority of studies ($n = 30$, 60 %) used store sales data as the primary outcome measure.

Study Quality Assessment

The quality of included studies was summarised in two ways. Using the method recommended by the EPHPP, 24 studies (48 %) were rated as strong, 11 studies (22 %) rated as moderate and 15 studies (30 %) rated as weak (see Appendix 1). Using a summary percentage score tallied across each of the assessed components, the included studies ranged from 40 to 100 %, with an average score of 78 % (Appendices 1 and 2).

Characteristics of Successful Interventions

Overall, the majority (35/50 or 70 %) of studies reported positive intervention effects on the healthiness of consumer purchases in the intervention period [22, 24–33, 35–37, 39–49, 68, 69, 73–78, 80, 81]. Five of these studies were either controlled trials or RCTs, lasting at least 1 month and including objective outcome assessment (store sales data) and a large sample size (more than two stores). Successful interventions tested in these five high-quality studies include (1) a shelf label intervention, supported by posters and information booklets (sales of healthier milk, refried beans, cream cheese and peanut butter increased, but healthier mayonnaise and salad dressing decreased) [43]; (2) a multi-component healthy eating program including shelf labels, brochures, posters and a mass media campaign (estimated intervention effects ranging from 3.2 to 5.7 % for canned vegetables, dried beans and dried fruits) [22]; (3) a shelf label intervention identifying low-cholesterol and low-fat products, supported by information booklets (market share of tagged products increased in 8 of 16 product categories ($p < 0.05$) with a 12 % average increase) [44]; (4) a complex RCT testing the effect of display space, newspaper advertising, display location quality and price on 16 types of fruits and vegetables (shelf space increased sales for all categories of products—hard fruit 44 %, cooking vegetables 59 %, salad vegetables 28 % and soft fruit 49 %) [39]; and (5) a cluster RCT incorporating shelf tags, cross-promotion of products, taste tests and prominent placement (sales of 1 % milk, 2 of 3 types of frozen meals and water in checkout fridges increased (all $p < 0.05$), but no significant differences in sales of targeted cereals or in-aisle beverages) [45••]. As noted above, in several of these studies, positive effects were not observed in all categories tested [39, 44, 45••]. Two other large studies that did involve control groups could not be considered controlled trials because the intervention was not in the control of the investigators (and hence were categorised as cohort analytic designs) [36, 37]. Both investigated shelf-tag interventions and found significant intervention effects, with the study by Nikolova and Inman testing the addition of NuVal scores (summary scores based on food nutrient content) to existing shelf pricing tags. That study was conducted in 535,000 shoppers from 128 different stores, with control data from 8720 households (Nielsen panel data). The primary finding was that the addition of NuVal values to shelf tags did promote healthier food choices, although this effect weakened somewhat over time. The authors also reported that the nutrition scores made customers less sensitive to price and promotion.

Some other lower quality studies with positive intervention effects are also worth noting. These were either not controlled trials, were short term, had a small sample size or included self-reported outcome measures. Sutherland et al. and Cawley et al. both report on the implementation of the 'Guiding Stars' nutrition rating system in 168 stores from the Hannaford chain. Although interrupted time series designs (natural uncontrolled experiments), both studies reported significant impacts on food choices, with Sutherland et al. reporting a yearly increase in the purchase of products with a star rating between 2006 and 2008, and Cawley et al. reporting no change in sales of more nutritious food but a 8.3 % decrease in sales of less nutritious food between 2005 and 2007 [26, 28]. Thapa et al. also reported the positive effect of shelf labels ('shelf talkers') on sales of healthier products in the grain and pasta category (but not the other 11 categories) in one intervention supermarket, with the shelf labels accompanied by newspaper and TV advertisements, food demonstrations and healthy eating classes [46]. Payne et al. conducted two short-term trolley and floor signage interventions in single stores in Mexico, with both trials (which focused on social norms around fruit and vegetable purchasing) proving highly successful in encouraging greater consumption of fresh produce [24]. Finally, a UK study by Nakagawa et al. was the first (using a natural experimental design and combining outcome and exposure datasets) to report on the effect of end-of-aisle (end cap) displays on purchasing, with extremely large effects on purchasing (independent of discounts) observed: 52 % increase for carbonated drinks, 73 and 114 % for coffee and tea, respectively, and between 23 and 46 % for different types of alcohol [30•].

Given the multi-component nature of most interventions, it was not possible to evaluate the relative success of studies according to broad categorisation of product, promotion and place. In general, it was also difficult to identify specific intervention strategies that were particularly successful, partly because a large number of studies used many strategies, but also because there was wide variation in the quality, professionalism and scope of those interventions (quite apart from the heterogeneity in study quality). However, one intervention area that stood out as being particularly effective was shelf tags/talkers that identified healthier options. Seventeen studies incorporated some form of shelf labelling, with 14 of these having a positive outcome. Of these, the shelf label component was either the only intervention or the primary focus of the intervention for more than half ($n = 9$) of the studies. Several studies evaluated the placement of nutrition summary scores across the whole store (NuVal or Guiding Stars), with

each reporting positive findings [26, 28, 36, 47]. Cawley et al. and Sutherland et al. reported that the Guiding Stars were assigned to over 60,000 products [26, 28], while Sutherland noted that even products prepared in-store (e.g. meat and bakery items) carried this logo [26]. The NuVal database contains >90,000 scored products [36]. Of particular interest, studies using summary scores were among the only studies that could be said to have successfully impacted sales of both healthy and unhealthy foods (the others being small studies targeting priming of consumers prior to shopping and recommending 'switches' at point of purchase [48, 49]). Other shelf-tag interventions included those that highlighted only certain nutrients (e.g. fat, sodium, cholesterol) in a limited number of categories (e.g. milk, cream cheese, refried beans, peanut butter, mayonnaise, salad dressing in Teisl and Levy [43]). Multicomponent studies were no more likely to report positive findings than single-component studies in this review (both 70 %).

Characteristics of Studies with Null or Negative Findings

Fourteen studies reported no or minimal effect of the intervention on the healthiness of consumer purchases [23, 27, 34, 38, 50–55, 70–72, 79]. Eleven of these studies were controlled trials (four randomised [50–53]), and six of them involved numerous components and were part of large campaigns. No specific intervention type appeared to be more frequently represented among those that failed to change purchasing behaviour. Intervention types represented include nutrition-related flyers, demonstrations, videos, recipe cards, offering healthier product 'swaps' at point of purchase, posters and signage, shelf labels, placement (bananas only), podcasts, interactive video education, 'traffic–light' nutrition labelling (online) and a nutrition education 'bingo' game. The unsuccessful studies included three that could be considered a high-quality study design (controlled trial or RCT) with a large sample size and duration longer than 1 month. Among these, one study includes a nutrition signage intervention that added calorie content and key nutrient information (vitamins and minerals) to small signs (6 × 3.5 inches) for six produce items only (broccoli, cabbage, carrots, cauliflower, kiwi fruit and tomatoes) [53]. This intervention could therefore be considered minimal in scope, in comparison to the other interventions reviewed. Another unsuccessful intervention was the "Food for Health" project, which focused on 4-page brochures called "Eaters' Almanacs" in the dairy aisle, which were reinforced with shelf signs near targeted products, newspaper advertisements, radio spots, window signs, banners and posters all referencing the content of the Almanac. Although a more comprehensive intervention, it did require customers to engage fully in fairly complex and lengthy nutrition education messages. The authors acknowledge that this may have represented an 'unrealistic task' for consumers to translate into their product selection, even though customer knowledge and awareness of the program did increase [54]. Third, Sacks et al. reported no effect of a 10-week traffic–light nutrition labelling intervention in an Australian online supermarket [55]. The authors of that study contended that the absence of an intervention effect may have been related to the fact that the implementation was restricted to the retailer's 'own-brand' products, for which, at that time, product healthiness was likely to be less of a driver of consumer behaviour than in relation to branded products. The other 11 studies reporting no effect were either weaker study designs, had small sample sizes, self-reported purchase or consumption data, or minimal duration in comparison to other interventions reviewed.

Only one study reported a negative intervention effect, with Berning et al. reporting that labelling of microwave popcorn with low fat and low calorie shelf labels significantly decreased sales of healthier popcorn [42]. The likely explanation for this effect is that in the specific category of popcorn, customers are likely to equate low fat and low calorie popcorn with poor taste (less sugar and butter).

Other notable studies that had no effect on purchasing or consumption behaviour included (1) a large RCT in an online store prompting shoppers with healthier swaps at product selection and checkout [52], (2) a Dutch RCT that modified placement of bread to expose customers to healthier options first, (3) an uncontrolled experiment placing bananas at checkouts and in confectionery aisles [27] and (4) a large Dutch RCT that included posters, brochures, a self-help manual and shelf labels highlighting low-fat products in nine categories. The intervention effect in that study was assessed using self-reported fat consumption [50].

Discussion

This review found that the majority of high-quality studies targeting the supermarket food environment resulted in positive changes in the healthiness of consumer food purchases while the intervention was in place. The studies included a broad range of interventions of mixed quality, and the majority of studies included multiple intervention components targeting different aspects of the in-store environment. Accordingly, it is difficult to identify intervention options or characteristics that are likely to be most effective in this setting. Shelf labelling, however, is one likely exception, being included in a large number of studies, most of which reported positive findings. The extent to which intervention effects persist in the long term and strategies to enhance sustainability of effect are largely unstudied.

The presence of a supermarket in a community is often considered to have a highly beneficial impact on consumption of healthy food where few other options exist. In the USA, the introduction of supermarkets into 'food deserts' through the Healthy Food Financing Initiative has been a key policy for increasing access to nutritious food. Unfortunately, evaluations of new supermarkets are yet to show any substantial impact on

consumption of healthy foods or diet quality [56, 57]. This may be due to the fact that supermarkets do not only sell healthy food, but simultaneously strongly promote unhealthy 'discretionary' food [9••, 10]. Research also suggests that supermarkets in general represent a food and shopping culture dominated by overconsumption and inactivity [58–60]. In light of this, in-store interventions that target a reduction in the promotion of discretionary food are therefore likely to be critical for the promotion of healthy eating. This may be particularly important in disadvantaged areas [61]. Unfortunately, few of the interventions reviewed here specifically target a reduction in the consumption of discretionary food. This should be a high priority for future supermarket research.

Comparison with Previous Reviews

While this is the first review to exclusively focus on supermarkets, a number of previous reviews have focused on the potential of retail interventions to encourage healthy eating. The majority of papers reviewed here were not included in previous reviews, with all four including less than half of the papers reviewed here (Glanz et al. 2012 = 2 %; Liberato et al. 2014 = 27 %; Van t'Riet 2012 = 29 %; Escaron et al. 2014 = 41 %). This is partly because of the growing interest in supermarket-related research, with 16 of 49 reviewed papers published in the last 3 years. While this review did not include interventions related to price or on-pack nutrition labelling, these are critical elements to consider in relation to the supermarket environment. Several recent reviews [18, 19•, 62, 63] have investigated these aspects, finding that they are promising intervention areas to be considered in addition to the intervention options identified in this review. The two reviews of price interventions (in modelling and field experiments respectively) found that these were almost universally successful in encouraging healthy purchasing [18, 19•]. Two large RCTs testing the effect of price reductions for healthy foods have also recently been published. One New Zealand study found that price reduction led to increased purchasing of food in a range of healthier categories (fruits and vegetables in particular), but, importantly, that this did not result in any observable reductions in purchases of saturated fat, or other nutrients of public health concern [64]. The authors hypothesise that this differential may be due to variation in cross-elasticities of demand, or that the changes seen in fruit and vegetable purchases were not large enough to substantially effect overall macronutrient purchases. The second Australian trial found that price reductions were effective only for fruit (not vegetables, bottled water or diet beverages), and with no sustained effect post-intervention [65]. In considering price interventions, unintended compensatory purchasing can be a problematic side effect that needs to be carefully monitored. For example, when discounting healthy food, savings may be used to buy more 'less healthy' products, while increased purchase of discounted healthy food at one retailer may simply be a reflection of shifting purchasing locations rather than an overall increase in healthy food purchased [18].

Quality Assessment Method Used

The quality assessment method we have used here was specifically designed to measure the quality of quantitative studies in public health systematic reviews. It has been found to have greater inter-rater reliability than the Cochrane Collaboration Risk of Bias tool [66]; however, the agreement between these tools was only fair, indicating that they are measuring different aspects of study quality. It is clear that the quality assessment tool used will be more or less useful for different disciplines. In this review, the assessment of confounding was challenging, with many studies not conforming to a typical within-subject follow-up design but rather using whole store sales data as the outcome measure. While it is possible that shoppers in a given store may not be identical pre- and post-intervention (while in a typical follow-up study, the same customers would provide data at both time points), the amount of change is likely to be minimal, and it is clear that the objective measurement of sales data for a whole store is a hugely powerful, and cost-effective, method of assessing change in sales [64]. The use of shopper loyalty card databases linked to individual sales is likely to be an even more powerful research design, incorporating assessment at the level of the individual as well as data collected from checkout scanners.

It is also worth noting that the quality assessment tool does not specifically evaluate sample size, study duration or the quality of the intervention. Each of these are important considerations, which is why our result section focused heavily on these aspects of study quality. Almost none of the included studies that utilised signage or educational materials in their intervention provided examples of these. This information is likely to be critical to evaluate the results of studies, but also to incrementally improve on study quality. Signage interventions in particular are likely to be influenced significantly by the quality of the graphics used.

Implications for Future Research and Practice

Given the primacy of economic data to decision-making in the retail world, it is surprising and concerning that we were not able to identify a single study in this review that reported on the economic or financial effects of the intervention on the retailer. In addition, for many interventions, the outcome assessment only extended to sales of targeted products. The assessment of sales for whole product categories, and even the assessment of the overall effect of interventions on the healthiness of purchased foods across the whole store are also uncommon. The evaluations of summary nutrition labels, such as Guiding Stars and NuVal, stand out in this regard and are especially notable for their simultaneous impact on healthy and unhealthy foods. In order to

advocate for the uptake of retail interventions to retailers and legislators, this type of evidence and assessment of the cost-effectiveness of these interventions (which also appears to be absent from the literature, although was not a focus of this review) are likely to be critical.

While supermarket interventions are often multi-component in an effort to increase their impact, this frequently precludes an assessment of the independent effects of intervention components. Future studies assessing the isolated effects of intervention components are therefore likely to also be particularly important in order to make packaged interventions more efficient and cost-effective.

Many of the limitations of the included studies are a direct result of the limitations placed on researchers when conducting field experiments in collaboration with retailers. Sample size, study duration, intervention scope and even study design are not necessarily entirely in the researchers' control. Nevertheless, we have summarised some of the key features that define in-store supermarket studies with higher quality and better potential to impact population nutrition below. Although research not incorporating each of these elements can provide useful additions to the literature, it is research that aligns with these principles that is more likely to be implemented to scale and to make a public health impact.

- Sustainable, low-cost interventions that require little retailer input (for example, shelf labels/tags/talkers, placement and signage interventions)
- Assessment of outcomes using store sales data (preferably combined with shopper loyalty data)
- Interventions that impact a large number or even all product categories
- Multi-component studies built on establishment of the effectiveness of each component
- Study duration that allows assessment of the effect of the intervention over time
- Studies including stores from a single chain with uniform pricing (discounts) and promotion (e.g. catalogues/circulars)
- Assessment of the economic impact of the intervention on the retailer (i.e. profit effect)
- Publically funded collaborative research involving government, academia and retail to minimise conflicts of interest
- High-quality interventions implemented with high fidelity
- Strong research designs—either RCT or well-matched controlled trial

There is an enormous demand for studies incorporating these elements from retailers and communities who see the impact of obesity and want to know where to start in making changes to the food environment that has been at the heart of the obesity epidemic [2, 67].

Conclusions

This review provides a summary of published in-store supermarket interventions targeting healthy eating, acknowledging that a large number of interventions are conducted and evaluated by retailers but never published. As the first systematic review to specifically target supermarket interventions, it will provide a useful resource for both those wishing to conduct such studies, as well as communities who wish to work with retailers on nutrition promotion initiatives in their own context. From our results, it is clear that interventions targeting the in-store supermarket environment have considerable potential to change population diets, and social norms around what is a healthy diet. Shelf labelling using nutrition summary scores may be a particularly promising intervention target. Unfortunately, the size and quality of the literature base does not reflect the importance of supermarket environments to healthy eating and obesity prevention. Healthy eating initiatives are occurring in supermarkets all the time—evaluation of the impact of these using appropriate research designs will be critical to improve the literature in this area.

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Compliance with Ethics Guidelines

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- • Of importance
- •• Of major importance

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