Received: 5 July 2022 | Revised: 6 February 2023 | Accepted: 4 March 2023

DOI: 10.1111/obr.13565

REVIEW

OBESITY Reviews WILEY

Healthier diets for all? A systematic review and meta-analysis examining socioeconomic equity of the effect of increasing availability of healthier foods on food choice and energy intake

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Funding information
H2020 European Research Council, Grant/Award Number: PIDS, 803194

Summary

Widespread availability of unhealthy food and drink products may contribute to socioeconomic patterning in obesity. Therefore, increasing the availability of healthier foods may be one approach to reducing obesity without widening existing inequalities. This systematic review and meta-analysis examined the impact of increasing the availability of healthier food and drink on consumer behavior among individuals with higher and lower socioeconomic position (SEP). Eligible studies were required to use experimental designs to compare conditions of higher vs lower availability of healthier vs less healthy options on food choice-related outcomes and measure SEP. Thirteen eligible studies were included. Odds of choosing a healthy item were higher when availability was increased for higher (OR = 5.0, 95% CI: 3.3, 7.7) and lower (OR = 4.9, CI: 3.0, 8.0) SEP. Increased availability of healthier foods was also associated with a decrease in energy content of selections for higher (−131 kcal; CI: −76, −187) and lower (−109 kcal; CI: −73, −147) SEP. There was no SEP moderation. Increasing the relative availability of healthier foods may be an equitable and effective approach to improve population-level diet and address obesity, though more research is required testing this in real-world environments.

KEYWORDS
consumer behavior, food environment, SES, socioeconomic position

1 | BACKGROUND

The modern day food environment is thought to play a critical role in contributing to population level excess energy intake and obesity.[1] Such environments include a widespread availability of foods high in energy and low in nutritional value (e.g. fast foods), coupled with more limited access to healthier more nutritious foods lower in energy (e.g. fresh produce). More socioeconomically deprived communities have increased access and availability of the types of outlets that sell foods higher in energy (e.g.[2,3]), and access to these types of outlets has been associated with a higher prevalence of overweight and obesity (for a review see[4]). In line with this, nutritional quality of diet is also socioeconomically patterned, with lower socioeconomic position (SEP) associated with less nutritious dietary patterns.[4–6]

How then to address socioeconomic inequalities in obesity and promote healthier diets for all? If reduced access to healthier foods contributes to SEP patterning of obesity, then increasing availability of healthier foods may be one part of the solution.[7] However, it

Abbreviations: BMI, body mass index; SEP, socioeconomic position.

is important to estimate the likely impact that increasing healthy food availability would have on individuals of both lower and higher SEP, especially given potential SEP differences in diet and food preference. Increasing availability of healthier food options is thought to increase healthier food choice by making it more likely that preferred food options available are healthier.[8] Yet, because lower SEP is associated with a reduced preference for healthier foods in the diet (e.g.[9]), increasing the availability of healthier foods may be less likely to change dietary choice of lower compared to higher SEP groups. Although there has been limited testing of this possibility, in a recent laboratory study, Pechey and colleagues[10] found some inconclusive evidence that increasing the availability of healthier foods had a smaller impact on food choice in lower vs. higher SEP participants. Conversely, Marty, Jones, & Robinson[11] found that increasing the availability of healthier food products (characterized by being lower in energy content) had a similar sized effect on food choice in participants of lower higher and lower SEP.

Although a 2019 review on the impact of availability interventions on food and drink selection found that increasing availability of specific food and drinks increased their selection and consumption by 17–35%,[12] the review did not explicitly examine healthier and less healthy products and critically did not examine whether the effect of availability interventions differed depending on participants' SEP. Furthermore, since Hollands and colleagues conducted their review searches (2018), a number of studies have been published that directly compared the effectiveness of availability interventions between participants of higher and lower SEP (e.g.[10,11,13,14]).

The aim of the current review was thus to examine evidence on whether there are SEP differences in the effects of increasing the availability of healthier foods/drinks on the likelihood of choosing healthier foods/drinks and amount of energy selected.

2 | METHODS

The PRISMA guidelines for reporting on systematic reviews were followed when conducting and reporting this review. Full details on the method and analysis plan can be found in the pre-registered study protocol on the Open Science Framework (DOI: 10.17605/OSF.IO/BUQ9X), and on PROSPERO (CRD42021270060).

2.1 | Study selection

We included experimental studies that altered the availability of healthier vs. less healthy foods and drinks (hereafter defined as foods) in any setting where individuals would be instructed to, or voluntarily, consume these products, or make choices about products to consume. This included laboratory settings, online settings involving hypothetical or real choices, and real-world settings (e.g. restaurants, supermarkets, schools, etc.). To be eligible, studies were required to have also reported measurement of SEP. To define healthier (vs less healthy) foods and drinks we followed the definitions used in the included studies, which included food/drinks lower (vs higher) in energy (e.g.[15]) and energy density (e.g.[16]), as well as drinks that were non-alcoholic (vs alcoholic) (e.g.[17]).

2.1.1 | Participants

Studies on human participants were eligible (adults aged 18 and above or children aged under 18). To be eligible, it was required that studies reported measuring SEP at the participant (e.g. education level, household income, subjective social status [SSS]) or area (e.g. Index of Multiple Deprivation) level.

2.1.2 | Intervention vs comparator

Studies were required to involve at least two conditions. We defined intervention conditions as those with a higher availability (operationalized as proportion [%] or total number available) of healthier foods vs less healthy foods, as compared to the comparator condition, which had a lower availability (operationalized as proportion [%] or total number available) of healthier foods vs less healthy foods. For example, a comparator condition might have an equal proportion healthier (EPH) and less healthy (e.g. 50:50), and the intervention condition might have a higher proportion healthier (HPH) than less healthy (e.g. 60:40). Alternatively, a comparator condition could have a lower proportion healthier (LPH) than less healthy (e.g. 40:60), and the intervention condition might have had equal proportion healthier (EPH) and less healthy (e.g. 50:50) or higher proportion healthier (HPH) than less healthy (e.g. 60:40). Finally, a comparator condition might have had equal proportion healthier (EPH) and less healthy (e.g. 50:50), while an intervention condition might have also had equal proportion healthier (EPH) and less healthy (e.g. 50:50), but with the intervention condition having an increased *number* of healthier (and less healthy) foods. This would constitute an absolute increase in availability of healthier foods, with no proportional or relative change (see[18] for a conceptual overview of absolute and relative availability interventions).

2.1.3 | Defining healthier and less healthy foods

We defined "healthier" and "less healthy" products according to the definition used in each individual study, though the validity of each definition was checked. For example, based on Public Health England recommendations for daily energy intake, we consider that energy content of meals defined as "healthier" would typically not exceed 600 kcal, with snacks not exceeding 200 kcal.[19] Examples of "healthier" foods typically lower in energy were low energy meals or snacks (such as dried fruit) and non-alcoholic beverages (as opposed to alcoholic beverages). Examples of "less healthy" foods typically higher in energy were higher energy meals or snacks (such as chocolate bars), and alcoholic beverages.

2.1.4 | Outcomes

To be eligible, studies were required to measure consumer behaviors such as hypothetical or real food choice (which could be coded as % choosing the "healthier" food; primary outcome), total energy selected (kcal), total energy consumed (kcal), or amount purchased (£) (as a proxy for amount eaten); all secondary outcomes.

2.1.5 | Study design

Between-subjects (i.e. participants are randomized to a higher or lower availability condition) and within-subjects (i.e. participants complete both/all conditions) designs were eligible for inclusion. Studies in which the unit of randomization was an outlet or location in a real-world setting (e.g. restaurant, school, or supermarket randomized to a condition which had higher availability of healthier foods, or to a condition which had lower availability of healthier foods), and studies in these settings using pre-post designs (e.g. before and after implementing an availability intervention) were also eligible. Crossed designs (e.g. which also manipulated another experimental factor such as energy labeling) were eligible, though analyses were conducted only between availability comparisons. Interventions which were confounded by another intervention (e.g. a study which also introduced menu labeling or nutrition education at the same time as increasing the availability of healthier meals) were not eligible.

2.2 | Article identification strategy

In 2019 there was a large Cochrane review of healthier food and drink availability studies, so we first identified potentially eligible articles by searching the reference list and list of excluded studies from this review.[12] We next ran an updated search for papers published since the searches were carried out by Hollands and colleagues (i.e. 23 July 2018–16 June 2021). Three databases were searched for relevant keywords: PsycINFO, SCOPUS, and MEDLINE (see Supplementary Information for full set of terms used). We also used a snowballing approach to identify further articles for screening, including forward citation tracking for all eligible articles and the 2019 review, as well as searching the reference lists of all eligible articles. We also contacted authors of eligible articles to enquire as to whether they had published any additional relevant papers, and searched the OSF preprint archive for unpublished and gray literature. One author screened potential articles from the 2019 review and completed title/abstract screening. A second author checked 20% of title/abstracts conducted by the first author to assess consistency (no eligible articles were missed by the first author) and conducted the grey literature searches (e.g. unpublished work, preprints, forward citation tracking). Both authors conducted full-text screening for all potentially eligible articles independently, and any inconsistencies were resolved through discussion. An updated search was conducted on 11 May 2022 (databases and OSF preprint archive), which identified no additional papers.

2.3 | Data extraction

Two authors independently extracted data, and any discrepancies were resolved through discussion. We extracted information about participants sampled (e.g. demographics and type of sampling used), study characteristics (e.g. study type and setting, details about study design, SEP measure, and categorization). When studies reported categorizing participants as "higher" and "lower" in SEP, the categorization used in the paper was retained. For example, lower SEP was most often defined as up to A level (US equivalent: Advanced Placement [AP] examinations) and higher SEP as higher education (US equivalent: above high school) (e.g.[11,14,17]). Other studies categorized lower SEP as GCSE/equivalent or below (US equivalent: US High school diploma or below) (e.g.[10,20]), and higher SEP as degree level and above[10] or A level and above (US equivalent: AP examinations).[20] When SEP was collected but not categorized as "higher" and "lower" (e.g. data was collected as part of baseline demographic information but not analyzed), for the primary indicator (education), to be consistent with the majority of included studies, lower SEP was defined as up to A level and higher SEP was defined as higher education. If studies reported more than two SEP groups, we planned to extract and analyze data for the two most extreme groups (i.e., highest vs. lowest SEP grouping). We extracted outcome data on food choice (% choosing the healthier food), kcal content of items selected, and energy intake (kcal), obtained separately for lower and higher SEP to enable comparisons. In instances in which studies manipulated availability across different contexts (e.g. participants chose from multiple menus),[13] we extracted outcome data averaged across the different context (e.g. mean % of healthy choices, mean kcal content of items selected) and used this in analyses. We also extracted details about the availability intervention (e.g. definition of healthier foods, magnitude of intervention in lower vs higher availability conditions). For full information about data extracted from each study, see Table S1.

2.4 | Missing information

If required data was not reported separately for lower and higher SEP in the article or associated online repositories, but the paper indicated that SEP was measured (e.g. as part of demographic baseline information), the data was requested from the authors via email. As education was the most commonly used indicator of SEP, if results were not reported by SEP, we prioritized requesting results by education level (if available).

2.5 | Quality assessment: risk of bias

We developed a risk of bias measure informed by existing risk of bias tools and study methodology guidelines (e.g.[21,22]), as existing tools did not directly address all important indicators of bias. Studies were classified as being at higher risk of bias if they did not report pre-registration, if they reported conflicts of interest (COI) or did not provide a

statement on COIs, if they did not report data quality checks for online studies (e.g. attention or consistency checks), or if they did not describe attempts to address demand characteristics (e.g. use of cover story or measurement of participant awareness of study aims). They were also classified as being higher risk of bias if they used a small sample (i.e. N < 12 for within-subjects, or N < 20 per group for between-subjects), if random allocation to condition (between-subjects) or order (within-subjects) was not used, or if any key method information was missing (e.g. little to no information on how foods were selected or – if appropriate - categorized as healthier/less healthy).

2.6 | Statistical analysis

Pre-registered analyses are available online (DOI: 10.17605/OSF.IO/BUQ9X). Meta-analyses were conducted using the "metafor" package in R. Multi-level, random-effects models with a restricted maximum likelihood estimator were used, which were required as each study provided multiple effect sizes to analyses.

2.6.1 | Primary analyses

The primary analysis was a meta-analysis to examine the effect of increasing the availability of healthier foods (higher vs lower availability) on the % choosing the healthier food as the primary outcome, and including SEP (higher vs lower) as a sub-group factor to examine whether effects of availability on food choice differed by SEP group. For binary outcome (choice of healthier foods vs unhealthy foods) we computed the log odds ratio for analyses. If the effect was from a within-participants design, this was the marginal log-odds ratio.

2.6.2 | Publication bias and outliers

We examined asymmetry of the effect sizes, inspecting funnel plots for potential publication bias. We conducted an Egger's test of asymmetry and Trim and Fill procedure.[23,24] We examined the effect of removing outliers and potential influential cases in the primary analysis. See online supplementary materials for full details.

2.6.3 | Secondary analyses

For the secondary analyses, we used the mean difference ("MD") effect size, with SEP (higher vs lower) as a sub-group factor to examine whether the effect of increasing the availability of healthier foods (higher vs lower availability) on kcal selected differed by SEP group. For all analyses we removed,[16] as this study required participants to choose multiple food products as part of a shopping task, inflating any mean differences in kcals selected. All effect sizes were calculated using the "escalc" function in the metafor package. Heterogeneity was assessed using the I^2 statistic, with >50% indicative of moderate and >75% indicative of substantial heterogeneity.

2.6.4 | Risk of bias scores

For primary and secondary analyses, we ran subgroup analyses to examine whether findings differed when removing studies which i) did not use random allocation or counterbalancing to condition, ii) did not address demand characteristics, iii) had a small sample size (e.g. n < 20 per condition), iv) did not report pre-registration or conflicts of interest, or finally v) did not report using data quality measures (for online studies).

2.6.5 | Study-level modifiers

We conducted meta-regressions to examine whether size of the intervention influenced the effect of availability on % choosing a healthier food (primary) and total kcal selected (secondary), with a subgroup analysis by SEP (higher, lower). To quantify the size of the intervention for primary analyses involving food choice, we coded the difference in the conditions by dividing % healthier in the higher availability condition by the % healthier in the lower availability condition. That is, if the higher availability of healthier food condition had 50% healthier, and the lower availability of healthier food condition had 25% healthier, the size of the difference would be 50/25 = 2. To quantify the size of the intervention for secondary analyses involving total kcal selected, we calculated the difference in mean kcal content of all available food products in the higher availability vs. lower availability conditions.

3 | RESULTS

3.1 | Study characteristics

Thirteen studies identified from ten articles were eligible (see Figure 1). In all studies SEP was operationalized as education level. The majority of studies defined higher SEP as degree/equivalent and higher, except three studies which defined it as A levels or above, see Table 1. The majority of studies (10/13) recruited samples from the United Kingdom, two studies (2/13) recruited samples from the United States, and one study (1/13) recruited samples from Germany and Poland. Studies tended to use community (3/13) and online panel (10/13) samples. The proportion of samples that was lower SEP ranged from 19% to 75%. Of the six studies reporting mean sample BMI, all were above the normal range (18.5–24.9; mean BMI ranged from 26.5 to 30.7). Most studies (9/13) used between-subjects designs (availability intervention manipulated between participants), while the remainder (4/13) used within-subjects designs (availability intervention manipulated within participants). One study examined drink choices, while all others (12/13) examined food choices. There were

four studies manipulating availability for snacks, six for meals, one for supermarket groceries, and one for both snacks and meals. Most studies involved hypothetical choices (10/13) except three which involved snack or meal choices for consumption. All studies included a higher availability condition with a higher proportion of healthier foods than the lower availability condition (13/13). One study also included a higher availability condition with a higher number of healthier (and less healthy) foods as compared to the lower availability condition, with no change in the proportion (%) of healthy foods (1/13).

We were able to extract or obtain data on choice (% choosing the healthier food) from all studies except one (12/13), kcal selected from seven studies (7/13), and kcal consumed from one study (1/13). Given only one study with kcal consumed data, this secondary outcome was not meta-analyzed. Across the 13 studies, there were 40 intervention (higher availability) vs comparator (lower availability) comparisons, 20 of which were from higher SEP, and 20 from lower SEP samples. For primary analyses on food choice, there were 38 comparisons (19 higher, 19 lower SEP). For primary analyses, the size of the availability intervention (i.e. increase in healthy options from comparator to intervention) ranged from 1 (i.e. the same in higher vs lower availability conditions equating to no proportional difference, with only an increase reported in absolute number of healthier and less healthy options) to 5 (i.e. 5 x healthier options in higher vs lower availability conditions). For secondary analyses on kcal selected, there were 14 comparisons (7 higher, 7 lower SEP). For secondary analyses, the size of the availability intervention (i.e. difference in mean kcal content between comparator to intervention) ranged from an MD of 42 to 252 kcal.

3.2 | Quality assessment

Risk of bias assessments indicated that all studies were judged not to have a small sample size (13/13), and all online studies used data quality measures such as consistency and/or attention checks (10/10). All but one study was pre-registered (12/13), mentioned conflicts of interests (12/13), and used randomization to condition or order (12/13). Demand characteristics were judged to be addressed in all but three studies (10/13). See online supplementary materials for individual study risk of bias ratings.

3.3 | Primary analysis

3.3.1 | Healthier food availability on food choice

There was a main effect of healthier food availability (higher vs lower), with increased odds of choosing healthier foods in the higher availability condition (OR = 5.00 [95% CI: 3.27, 7.67], Z = 7.39, $p < .001$, $I^2 = 93.4\%$; Figure 2). There was no moderation effect by SEP ($X^2[1] = 0.20$, $p = .653$). In higher SEP the effect was OR = 5.04 ([95% CI: 3.30, 7.68], Z = 7.50, $p < .001$). In lower SEP the effect was OR = 4.90 ([95% CI: 3.00, 8.00], Z = 6.34, $p < .001$). There was a significant association between the size of the increase in % healthier foods in the higher availability condition compared to the lower availability condition and the overall effect size (b = .693 [95% CI: .484, 902], Z = 6.50, $p < .001$), with increased size of intervention associated with larger effects. For every doubling in the proportion of

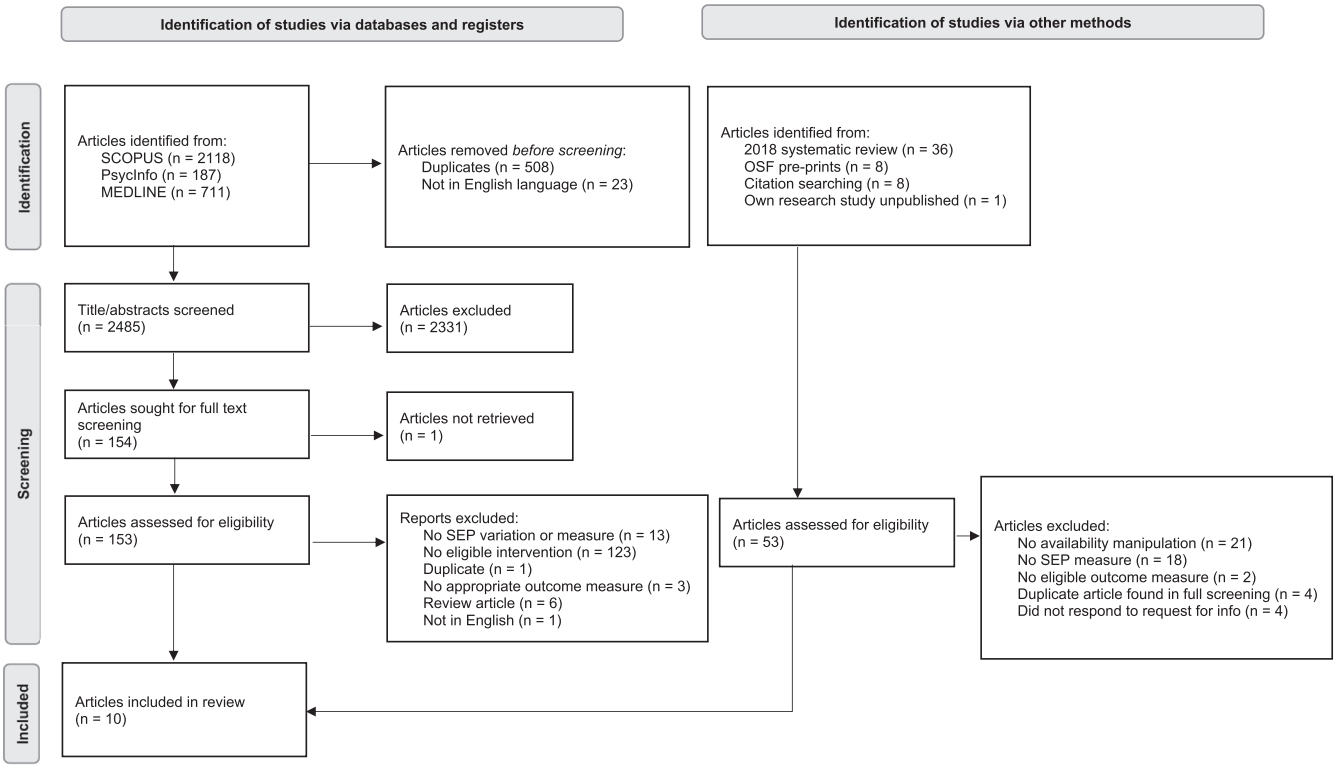

FIGURE 1 Flowchart of study selection progress.

TABLE 1 Characteristics included studies.

Study	Sample characteristics	SEP measure	Study design information	Concurrent intervention?	Hypothetical choices?
Aschemann-Witzel 2012[34]	Community sample recruited in shopping centers (Germany, Poland) 75% female (Germany) 80% female (Poland) 75% lower SEP (Germany); 73.8% lower SEP (Polish) Mean age: (Germany) mean age = 44.3 (SD = 14.4) (Poland) mean age = 40.8 (SD = 15.3) Mean BMI not reported	Lower SEP = Lower than degree Higher SEP = Degree or above	Within subjects Conditions varied in energy content of products available Outcome: Snack food total kcal selected	Yes, nutrition labels (ppts randomized to one of 10 BS conditions) (fully crossed, i.e. not confounded)	Yes – questionnaire conducted in shopping Centre
Blackwell 2020[18]	Online panel (UK) 44% female 32.9% lower SEP Mean age = 38.2, (SD = 12.2) Mean BMI NR	Lower SEP = A levels or lower Higher SEP = Above A level	Between subjects Conditions varied in alcohol content of products available Outcomes: Drink choice (choosing a non-alcoholic drink)	Yes – study also manipulated high vs low cognitive resource (time pressure vs not) (fully crossed, i.e. not confounded)	Yes – online study
Langfield 2022[14]	Online panel (UK) 51% female 48% lower SEP Mean age = 41.69 (SD = 11.51) Mean BMI = 30.71 (SD = 7.90)	Lower SEP = A levels or lower Higher SEP = Above A level	Within subjects Conditions varied in energy content of products available Outcomes 1, Main + side meal total kcal selected 2, Main/side meal choice (choosing a healthier main [≤400 kcal] or side [≤300 kcal])	No	No – online study involving food delivery
Marty 2020a (S1)[11]	Online panel (UK) 48% female 53.7% lower SEP Mean age = 35.5 (SD = 13.4) Mean BMI 26.5 (SD = 5.78)	Lower SEP = A levels or lower Higher SEP = Above A level	Between subjects Conditions varied in energy content of products available Outcomes: 1, Main/side/drink total kcal selected 2, Main meal food choice (choosing a healthier main [≤400 kcal])	Yes – study also manipulated kcal labeling (fully crossed, i.e. not confounded)	Yes – online study
Marty 2020a (S2)[11]	Online panel (UK) 53% female 53.9% lower SEP Mean age = 36.1 (SD = 12) Mean BMI = 27.1 (SD = 5.98)	Lower SEP = A levels or lower Higher SEP = Above A level	Between subjects Conditions varied in energy content of products available Outcomes: 1, Main/side/drink total kcal selected 2, Main meal food choice (choosing a healthier main [≤400 kcal])	Yes – study also manipulated kcal labeling (fully crossed, i.e. not confounded)	Yes – online study
Marty 2020b[24]	Online panel (UK) 51% female 62.3% lower SEP Mean age = 39.5 (SD = 13.1)	Lower SEP = A levels or lower Higher SEP = Above A level	Between subjects Conditions varied in energy density of products available Outcomes:	Yes – study also manipulated healthy tick badge (fully crossed, i.e. not confounded)	Yes – online study

TABLE 1 (Continued)

Study	Sample characteristics	SEP measure	Study design information	Concurrent intervention?	Hypothetical choices?
	Mean BMI = 27.0 (SD = 5.8)		1, Supermarket products total kcal selected (total across 10 items) 2, Supermarket product food choice (mean N choosing healthier [≤ median ED for each food category] across the 10 items)		
Marty 2021 (S1)[13]	Online panel (US) 53% female 35.1% lower SEP Mean age = 35.3 (SD = 12.7) Mean BMI = 28.2 (SD = 7.75)	Lower SEP = High school or lower Higher SEP = Above high school	Between subjects Outcomes 1, Main meal total kcal selected (mean across 6 meal choices) 2, Main meal food choice (mean N choosing healthier main [≤600 kcal] across the 6 menus)	Yes – study also manipulated kcal labeling (fully crossed, i.e. not confounded)	Yes – online study
Marty 2021 (S2)[13]	Online panel (US) 57% female 35.6% lower SEP Mean age = 44.9 (SD = 18.5) Mean BMI = 28.1 (SD = 7.43)	Lower SEP = High school or lower Higher SEP = Above high school	Between subjects Outcomes 1, Main meal total kcal selected (mean across 6 meal choices) 2, Main meal food choice (mean N choosing healthier main [≤600 kcal] across the 6 menus)	Yes – study also manipulated kcal labeling (fully crossed, i.e. not confounded)	Yes – online study
Pechey 2018[15]	Online panel (UK) 46.6% female 35.6% lower SEP (17.6% still studying/prefer not to say/foreign qualification) Mean age = 49.6, (SD = 15.4) Mean BMI NR	Lower SEP = Lower than degree Higher SEP = Degree or above	Between subjects Conditions varied in energy content of products available Outcome: Snack food choice (healthier [≤100 kcal] /less healthy [≥200 kcal])	Yes (not component in factorial design), cognitive load (high vs. low) confounded with availability comparison	Yes – online study
Pechey 2021a[10]	Community sample (UK) 55.6% female 50.4% lower SEP Mean age = 40.02 (SD = 13.83) Mean BMI NR	Lower SEP = GCSE or lower Higher SEP = Degree or above	Between subjects Conditions varied in energy content of products available Outcome: Snack food choice (healthier [≤100 kcal] /less healthy [≥200 kcal])	No	No – lab study
Pechey 2021b[19]	Community sample (UK) 68.3% female 19.6% lower SEP Mean age = 40.6 (SD = 14.1) Mean BMI NR	Lower SEP = GCSE or lower Higher SEP = A levels or above	Between subjects Conditions varied in energy content of products available Outcome: Snack food choice (healthier [≤100 kcal] /less healthy [≥200 kcal])	Yes, implied popularity (tray fullness): low vs high (fully crossed, i.e. not confounded)	No – lab study
Pechey 2022 (S1) – snack[8]	Online panel (UK) 51% female 50% lower SEP	Lower SEP = GCSE or lower	Within subjects Conditions varied in energy content of products available	Yes, branded vs. unbranded snacks (fully crossed, i.e. not confounded)	Yes – online study

(Continues)

TABLE 1 (Continued)

Study	Sample characteristics	SEP measure	Study design information	Concurrent intervention?	Hypothetical choices?
	Mean age = 61.4 (SD = 11.4) BMI information: 36% BMI < 25; 35% BMI 25–30; 20.6% BMI > 30; 8.4% missing	Higher SEP = A level or above	Outcome: Snack food choice (healthier [≤100 kcal] /less healthy [≥200 kcal])		
Pechey 2022 (S1) - main	Online panel (UK) 51% female 50% lower SEP Mean age = 61.4 (SD = 11.4) BMI information: 36% BMI < 25; 35% BMI 25–30; 20.6% BMI > 30; 8.4% missing	Lower SEP = GCSE or lower Higher SEP = A level or above	Within subjects Conditions varied in energy content of products available Outcome: Main meal food choice (healthier [<500 kcal] /less healthy [≥500 kcal])	No	Yes – online study
Pechey 2022 (S2)[8]	Online panel (UK) 50% female 50% lower SEP Mean age = 47.3 (SD = 16.9) BMI information: 41.9% BMI < 25; 28.2% BMI 25–30; 20.1% BMI > 30; 9.7% missing	Lower SEP = GCSE or lower Higher SEP = A level or above	Within subjects Conditions varied in energy content of products available Outcome: Main meal food choice (healthier [<500 kcal] /less healthy [≥500 kcal])	No	Yes – online study

Abbreviations: EPH, equal proportion healthy; HPH, higher proportion healthy; LPH, lower proportion healthy; SEP, socioeconomic position.

TABLE 1 (Continued)

Study	Ppts in analysis	Foods manipulated	Availability conditions	Findings
Aschemann-Witzel 2012[34]	N = 1,000	Survey - participant selected snack foods	Lower availability condition (LPH) Mean kcal = 809 kcal (SD = 336.34) 25% healthier, 75% less healthy Higher availability condition (HPH) Mean kcal = 743.38 (SD = 312.8) 75% healthier, 25% less healthy	**LOWER SEP** Lower availability condition (LPH) 860.93 kcal selected (SD = 397.47) Higher availability condition (HPH) 771.33 kcal selected (SD = 341.63) **HIGHER SEP** Lower availability condition (LPH) 865.33 kcal selected (SD = 388.32) Higher availability condition (HPH) 755.21 kcal selected (SD = 341.34)
Blackwell 2020[18]	N = 803	Questionnaire - participant selected a drink	Availability condition 1 (EPH) 50% healthier (N = 2) 50% less healthy (N = 2) Availability condition 2 (EPH) 50% healthier (N = 4), 50% less healthy (N = 4) Availability condition 3 (HPH) 75% healthier (N = 6), 25% less healthy (N = 2) Availability condition 4 (LPH)	**LOWER SEP** Availability condition 1 (EPH) 41.33% chose the healthier drink Availability condition 2 (EPH) 40.68% chose the healthier drink Availability condition 3 (HPH) 46.27% chose the healthier drink Availability condition 4 (LPH) 23.33% chose the healthier drink **HIGHER SEP**

TABLE 1 (Continued)

Study	Ppts in analysis	Foods manipulated	Availability conditions	Findings
			25% healthier (N = 2), 75% less healthy (N = 6)	Availability condition 1 (EPH) 35.71% chose the healthier drink Availability condition 2 (EPH) 38.85% chose the healthier drink Availability condition 3 (HPH) 49.63% chose the healthier drink Availability condition 4 (LPH) 26.76% chose the healthier drink
Langfield 2022[14]	N = 77	Menus – participant selected a main + side	Lower availability condition (LPH) Mean kcal = 486.69 (SD = 177.41) 31.25% healthier, 68.75% less healthy Higher availability condition (HPH) Mean = 367.88 (SD = 150.87) 68.75% healthier, 31.25% less healthy	**LOWER SEP** Lower availability condition (LPH) 956.76 kcal selected (SD = 177.03) 45.9% chose a healthier main or side Higher availability condition (HPH) 746.95 (SD = 230.97) 78.4% chose a healthier main or side **HIGHER SEP** Lower availability condition (LPH) 969.45 kcal selected (SD = 220.61) 45% chose a healthier main or side Higher availability condition (HPH) 694.78 kcal selected (SD = 169.77) 95% chose a healthier main or side
Marty 2020a (S1)[11]	N = 868	Menus – participant selected a Main, side and drink	Lower availability condition (LPH) Mean kcal = 782.4 (SD = 197.1) 25% healthier, 75% less healthy Higher availability condition (HPH) Mean kcal = 530.7 (SD = 195.8) 75% healthier, 25% less healthy	**LOWER SEP** Lower availability condition (LPH) 910 kcal selected (SD = 187) 8.64% chose a healthier main Higher availability condition (HPH) 841 kcal selected (SD = 235) 56.05% chose a healthier main **HIGHER SEP** Lower availability condition (LPH) 930 kcal selected (SD = 183) 5.45% chose a healthier main Higher availability condition (HPH) 841 kcal selected (SD = 247) 55.50% chose a healthier main
Marty 2020a (S2)[11]	N = 875	Menus – participant selected a Main, side and drink	Lower availability condition (LPH) Mean kcal = 814.7 (SD = 206.4) 25% healthier, 75% less healthy Higher availability condition (HPH) Mean kcal = 571.3 (SD = 212.5) 75% healthier, 25% less healthy	**LOWER SEP** Lower availability condition (LPH) 960 kcal selected (SD = 193) 8.47% chose a healthier main Higher availability condition (HPH) 894 kcal selected (SD = 256) 55.36% chose a healthier main

(Continues)

TABLE 1 (Continued)

Study	Ppts in analysis	Foods manipulated	Availability conditions	Findings
				HIGHER SEP Lower availability condition (LPH) 916 kcal selected (SD = 193) 11.50% chose a healthier main Higher availability condition (HPH) 858 kcal selected (SD = 257) 60.10% chose a healthier main
Marty 2020b[24]	N = 899	Supermarket products – participant selected 10 items	Lower availability condition (LPH) Mean kcal = 314 (SD = 64) 33% healthier, 67% less healthy Higher availability condition (HPH) Mean kcal 272 (SD = 62) 67% healthier, 33% less healthy	**LOWER SEP** Lower availability condition (LPH) 11,163 kcal selected (SD = 4,121) 39.18% chose a healthier item (mean across 10 items) Higher availability condition (HPH) 10,346 kcal selected (SD = 3,987) 60.96% chose a healthier item (mean across 10 items) **HIGHER SEP** Lower availability condition (LPH) 10,800 kcal selected (SD = 4,110) 39.88% chose a healthier item (mean across 10 items) Higher availability condition (HPH) 9,906 kcal selected (SD = 2,982) 61.99% chose a healthier item (mean across 10 items)
Marty 2021 (S1)[13]	N = 1,001	Menus – participant selected a main meal from 6 menus	Lower availability condition (LPH) Mean kcal = 937.13 (SD = 262) 10% healthier, 90% less healthy Higher availability condition (EPH) Mean kcal = 760.2 (SD = 318) 50% healthier, 50% less healthy	**LOWER SEP** Lower availability condition (LPH) 960 kcal selected (SD = 102) 9.2% chose a healthier main (mean across 6 menus) Higher availability condition (EPH) 832 kcal selected (SD = 129) 36.72% chose a healthier main (mean across 6 menus) **HIGHER SEP** Lower availability condition (LPH) 950 kcal selected (SD = 113) 8.48% chose a healthier main (mean across 6 menus) Higher availability condition (EPH) 822 kcal selected (SD = 138) 39.38% chose a healthier main (mean across 6 menus)
Marty 2021 (S2)[13]	N = 1,090	Menus – participant selected a main meal from 6 menus	Lower availability condition (LPH) Mean kcal = 967.66 (SD = 265.2) 10% healthier, 90% less healthy Higher availability condition (EPH) Mean kcal = 778.23 (SD = 329.9) 50% healthier, 50% less healthy	**LOWER SEP** Lower availability condition (LPH) 954 kcal selected (SD = 96) 7.37% chose a healthier main (mean across 6 menus) Higher availability condition (EPH) 839 kcal selected (SD = 147) 34.85% chose a healthier main (mean across 6 menus) **HIGHER SEP**

TABLE 1 (Continued)

Study	Ppts in analysis	Foods manipulated	Availability conditions	Findings
				Lower availability condition (LPH) 953 kcal selected (SD = 112) 10.36% chose a healthier main (mean across 6 menus) Higher availability condition (EPH) 815 kcal selected (SD = 149) 40.29% chose a healthier main (mean across 6 menus)
Pechey 2018[15]	N = 1,243	Menus - participant selected a snack food	Availability condition 1 (EPH) 50% healthier, 50% less healthy Availability condition 2 (HPH) 75% healthier, 25% less healthy Availability condition 3 (LPH) 25% healthier, 75% less healthy	**LOWER SEP** Availability condition 1 (EPH) 34.12% chose a healthier snack Availability condition 2 (HPH) 52.72% chose a healthier snack Availability condition 3 (LPH) 8.65% chose a healthier snack **HIGHER SEP** Availability condition 1 (EPH) 39.57% chose a healthier snack Availability condition 2 (HPH) 53.30% chose a healthier snack Availability condition 3 (LPH) 15.29% chose a healthier snack
Pechey 2021a[10]	N = 417	Menus - participant selected a snack food	Availability condition 1 (EPH) 50% healthier, 50% less healthy Availability condition 2 (HPH) 75% healthier, 25% less healthy Availability condition 3 (LPH) 25% healthier, 75% less healthy	**LOWER SEP** Availability condition 1 (EPH) 53.62% chose a healthier snack Availability condition 2 (HPH) 61.43% chose a healthier snack Availability condition 3 (LPH) 14.08% chose a healthier snack **HIGHER SEP** Availability condition 1 (EPH) 34.33% chose a healthier snack Availability condition 2 (HPH) 69.86% chose a healthier snack Availability condition 3 (LPH) 28.36% chose a healthier snack
Pechey 2021b[19]	N = 128	Menus - participant selected a snack food	Lower availability condition (LPH) 33% healthier, 67% less healthy Higher availability condition (HPH) 67% healthier, 33% less healthy	**LOWER SEP** Lower availability condition (LPH) 11.11% chose a healthier snack Higher availability condition (HPH) 47.06% chose a healthier snack **HIGHER SEP** Lower availability condition (LPH) 25.45% chose a healthier snack Higher availability condition (HPH) 25.53% chose a healthier snack

TABLE 1 (Continued)

Study	Ppts in analysis	Foods manipulated	Availability conditions	Findings
Pechey 2022 (S1) – snack[8]	N = 1976	Menus - participant selected a snack food	Lower availability condition (LPH) 25% healthier, 75% less healthy Higher availability condition (HPH) 75% healthier, 25% less healthy	**LOWER SEP** Lower availability condition (LPH) 28.00% chose a healthier snack Higher availability condition (HPH) 72.00% chose a healthier snack **HIGHER SEP** Lower availability condition (LPH) 25.55% chose a healthier snack Higher availability condition (HPH) 72.03% chose a healthier snack
Pechey 2022 (S1) - main	N = 1976	Menus – participant selected a main meal	Lower availability condition (LPH) 25% healthier, 75% less healthy Higher availability condition (HPH) 75% healthier, 25% less healthy	**LOWER SEP** Lower availability condition (LPH) 19.42% chose a healthier main Higher availability condition (HPH) 67.82% chose a healthier main **HIGHER SEP** Lower availability condition (LPH) 23.14% chose a healthier main Higher availability condition (HPH) 69.72% chose a healthier main
Pechey 2022 (S2)[8]	N = 1,078	Menus - participant selected a main meal	Lower availability condition (LPH) 25% healthier, 75% less healthy Higher availability condition (HPH) 75% healthier, 25% less healthy	**LOWER SEP** Lower availability condition (LPH) 8.3% chose a healthier main Higher availability condition (HPH) 36.67% chose a healthier main **HIGHER SEP** Lower availability condition (LPH) 10.78% chose a healthier main Higher availability condition (HPH) 47.21% chose a healthier main

Abbreviations: EPH, equal proportion healthy; HPH, higher proportion healthy; LPH, lower proportion healthy; SEP, socioeconomic position.

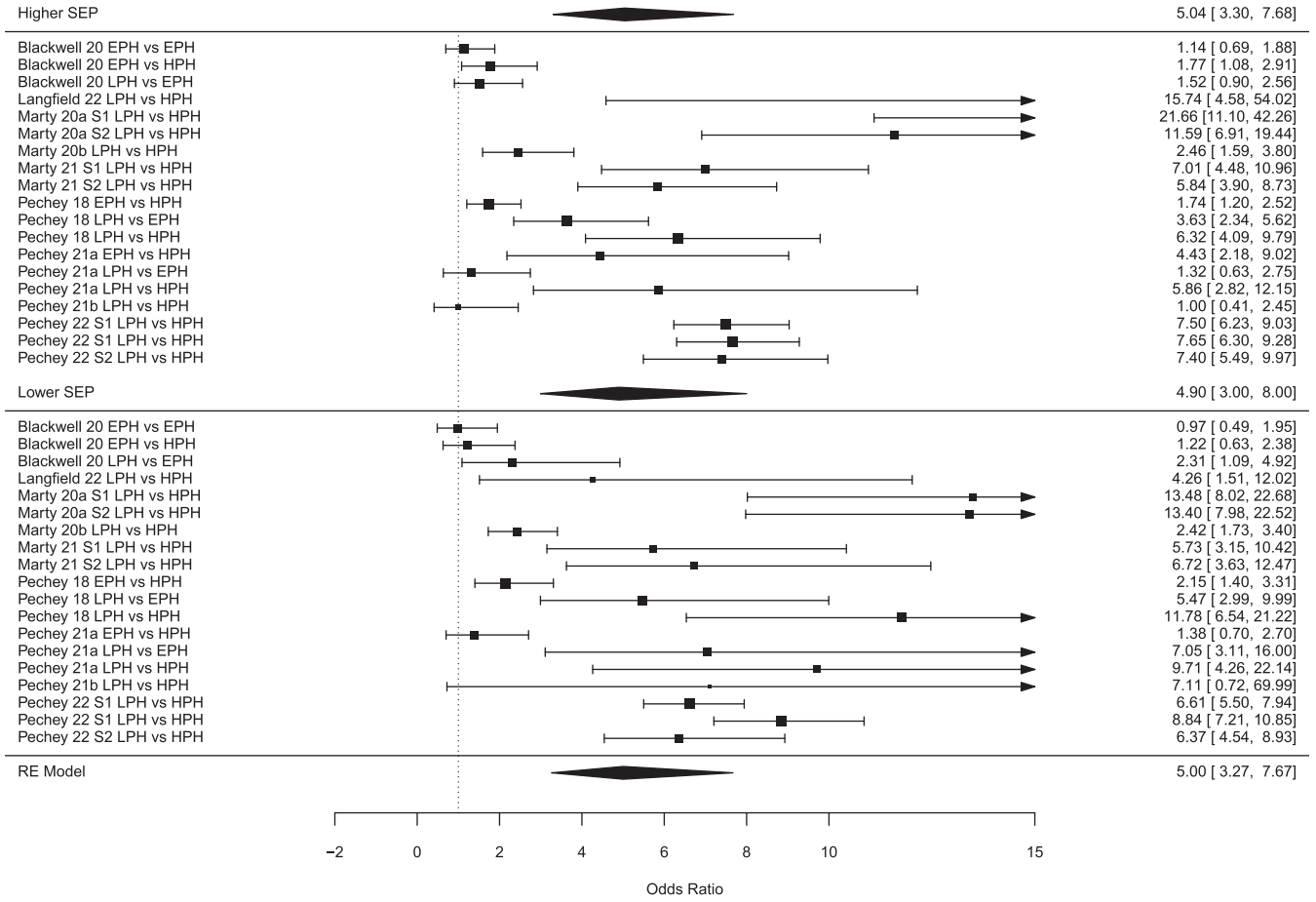

FIGURE 2 Forest plot of studies in meta-analysis, showing subgroup analysis by SEP (higher and lower). Plots odds ratios (95% CIs) of choosing a healthier food, in the higher vs lower availability condition, with subgroup analysis (higher vs lower SEP). *Note*. LPH refers to lower proportion healthier (vs less healthy), EPH refers to equal proportion healthier (vs less healthy), and HPH refers to higher proportion healthier (vs less healthy).

healthy foods available, the odds of a healthier choice increased by OR = 2.00. There was no significant interaction between the size of the increase in % healthier foods in the higher availability condition compared to the lower availability condition and SEP (Z = 0.06, $p = .951$).

There was no significant effect of study type (online vs lab) on the effect size ($X^2[1] = 1.79$, $p = .181$). Pooled effect sizes in lab-based studies were OR = 3.31 ([95% CI: 1.74, 6.30], Z = 3.65, $p = <.001$), and in online studies were OR = 5.68 ([95% CI: 3.57, 9.01], Z = 7.36, $p < .001$). There was no interaction between SEP and study type ($X^2[3] = 0.99$, $p = .324$) on likelihood of choosing healthier foods. As there was only one field study, it was not included in a subgroup analysis. There was no moderating effect of SEP in the study.

3.3.2 | Outliers

No effect sizes had a DFBETA > 1. Trim and Fill did not impute any studies. Egger's test was non-significant (Z = 0.28, $p = .773$). The funnel plot is shown in Figure 3. There were 12 effect sizes identified as outliers, in that their 95% CIs did not overlap with the pooled effect. Removal of these outliers reduced the heterogeneity of the model, but had limited impact on the pooled effect size (OR = 5.68 ([95% CI: 4.33, 7.43], Z = 12.58, $p < .001$, $I^2 = 83.8\%$). The moderation effect by SEP remained non-significant ($X^2[1] = 0.29$, $p = .593$).

Removal of the smallest and largest effect sizes only did not substantially influence the pooled effect (OR = 5.04 [95% CI: 3.32, 7.66] and OR = 4.84 [95% CI: 3.23, 7.26] respectively), nor the moderation by SEP ($ps = .461$, and .521, respectively).

3.3.3 | Sensitivity analysis

All studies for the primary analysis used random allocation or counterbalancing, had large samples, were pre-registered and the majority (10/12) had appropriate data quality measures. Thirty-two effects from ten studies came from studies that appropriately addressed demand characteristics. The pooled effect size was OR = 4.63 [95% CI: 2.79, 7.67]. Moderation by SEP was not statistically significant, $X^2(1) = 0.30$, $p = .604$.

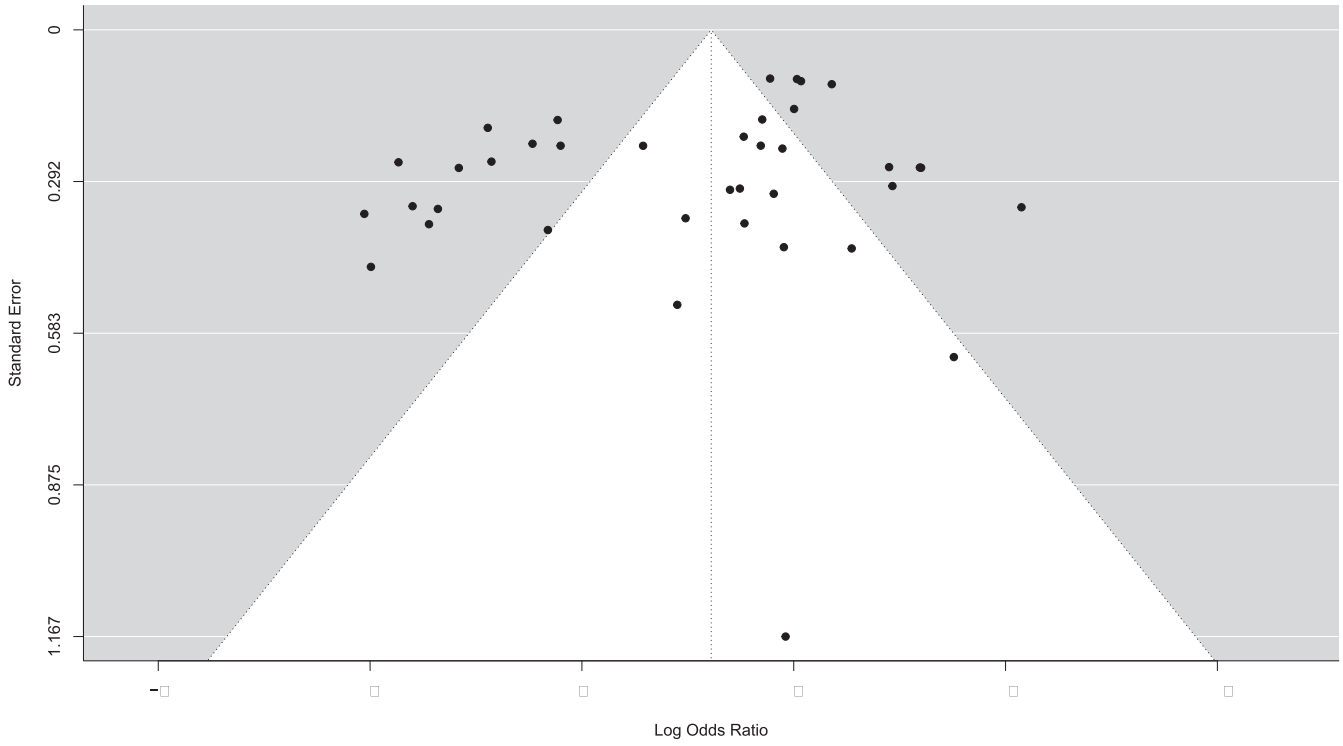

FIGURE 3 Funnel plot showing (log) odds ratios plotted against the study precision (standard error) for choosing a healthier food in the higher availability condition vs the lower availability condition.

3.4 | Secondary analysis

3.4.1 | Healthier food availability on kcal selected

There was a main effect of healthier food availability on kcal selected with fewer kcal selected (−122.19 kcal [95% CI: −78.06, −180.71]) from menus with higher availability of healthier foods ($Z = 3.98$, $p < .001$, $I^2 = 96.5\%$, see Figure 4). There was no moderation effect by SEP ($X^2(1) = 3.20$, $p = .074$). In higher SEP the reduction was −131.24 kcal ([95% CI: −75.79, −186.69], $Z = 4.63$, $p < .001$) and in lower SEP the reduction was −109.90 kcal ([95% CI: −73.33, −146.48], $Z = 5.89$, $p < .001$). There was no statistical evidence that the size of the difference in mean kcal content between higher and lower availability conditions was significantly associated with size of the effect on kcal selected (b = .494 [95% CI: −.340, 1.33], $p = .245$).

3.4.2 | Sensitivity analysis

Ten effect sizes from five studies used randomization or counterbalancing. Within these studies the reduction in kcals was −127.15 [95% CI: −67.40, −186.90], and the moderating effect of SEP was not significant ($X^2(1) = 1.94$, $p = .164$). The same studies appropriately assessed demand characteristics, were pre-registered and had conflicts of interests reported so results were identical for each analysis.

4 | DISCUSSION

The present systematic review and meta-analysis examined whether increasing the availability of healthier foods impacts on likelihood of choosing a healthier food and whether energy is selected or consumed similarly in higher and lower SEP groups. A total of 13 studies were included, which tended to compare the effect that increasing the proportion of healthier (vs less healthy) foods had on participants from higher (degree level or equivalent) vs lower (below degree) education level on hypothetical food choices (% choosing the healthier food) and kcal selected. The analysis revealed that SEP did not moderate the availability effect: the odds of choosing a healthier food were 5.04 times higher in the higher availability of healthier foods condition vs the lower availability of healthier foods condition for higher SEP and 4.90 times higher for lower SEP. The findings also showed that increasing the availability of healthier foods resulted in a reduction to kcal selected in the higher availability condition vs the lower availability condition, for both higher SEP (−131 kcal) and lower SEP (−110 kcal).

The finding that SEP did not moderate the effect of healthier food availability on food choice is consistent with previous systematic review findings that dietary interventions which target the food or choice environment (rather than the individual) tend to have beneficial effects for both higher and lower SEP groups (e.g.[25,26]). While these findings are promising, because the primary outcome in this review is relative (odds of choosing healthier when availability is increased

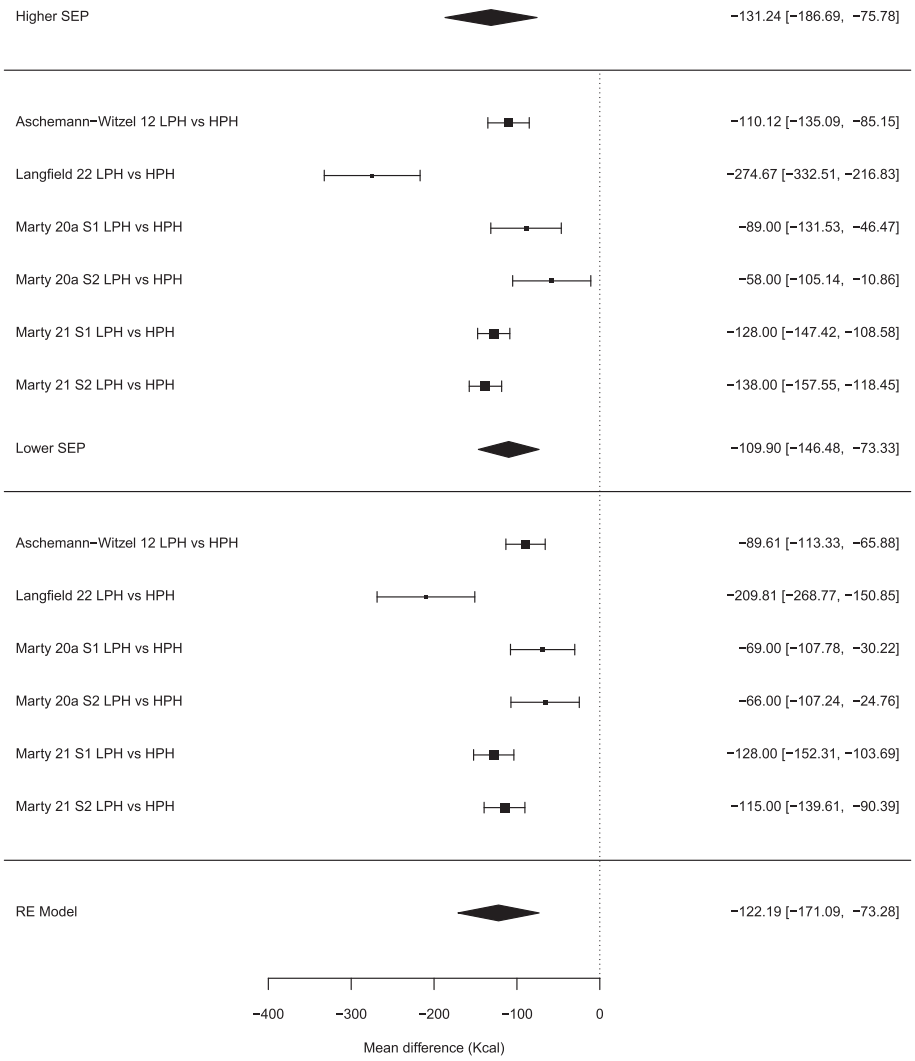

FIGURE 4 Forest plot of mean difference in kcal selected (95% CIs) between higher and lower availability conditions, with subgroup analysis (higher vs lower SEP). *Note*. LPH refers to lower proportion healthier (vs less healthy), and HPH refers to higher proportion healthier (vs less healthy).

vs. when it is standard), the extent to which availability interventions have potential to reduce, maintain, or widen inequalities in diet will depend on existing socioeconomic patterning of healthier vs less healthy food choices and proportions of the population already choosing healthier food options. For example, if a large majority of higher SEP individuals already choose healthier foods in a given food choice environment, then increasing the availability of healthier foods in that environment could have a larger absolute effect on the numbers of lower SEP individuals choosing healthier food options and therefore narrow inequality. However, if a very small minority of lower SEP individuals already chooses healthier options vs. a larger minority of higher SEP individuals, then increasing the availability of healthier foods could have a larger absolute effect on the numbers of higher SEP individuals choosing healthier food options and therefore exacerbate inequalities. It will be important that future work evaluating real-world impacts of availability interventions consider both absolute and relative effects on food choice, to determine whether such an intervention might reduce or widen inequalities.

Findings indicated high heterogeneity, suggesting the effect of availability varied across studies. Importantly, as discussed, subgroup analyses suggested that participant SEP did not contribute to this variation either within or across studies. We found some evidence that outliers contributed to this heterogeneity, and another likely important contributor was the size of the availability intervention, which varied substantially between studies. This source of heterogeneity was of interest, and analyses revealed a positive dose-dependent response between increasing the proportion of healthier foods and the likelihood of choosing a healthier food, whereby larger increases in relative availability of healthier foods were predictive of a greater likelihood of choosing healthier foods (e.g.[15]). Importantly, there was no evidence that this relationship differed by SEP. In practice, effectively implementing these findings would require that any changes to the availability of healthier foods and drinks should be considered in the context of the other foods available. Based on the present results, increasing the availability of healthier foods without a concurrent decrease in the relative availability of less healthy foods is likely to have a smaller impact on likelihood of choosing healthier foods. For the six studies measuring kcal selected, while higher availability conditions led to a reduction in kcal selected for both higher and lower SEP, there was no statistical evidence of a dose dependent response

(though the pattern of findings from the small number of studies were consistent with the expected effect).

This review had several strengths. It was the first to directly examine whether the impact of increasing availability of healthier foods on food choice, and the energy content of selections, differs by SEP (higher vs lower). The included studies had large samples that were relatively diverse in SEP. All included studies had low risk of bias, with only one study that was not pre-registered. There are also several limitations to the evidence. The vast majority of studies included in this review used hypothetical choices or assessment of food choice during one meal (for an exception see[14]). Individuals may feel licensed to overeat after making healthier food choices, leading some to "compensate" for choices by consuming more energy at later meals. This is particularly important given some evidence of socioeconomic differences in compensation for energy consumed, with one study finding that participants from lower SEP backgrounds were less likely to regulate energy intake based on how much they had recently consumed.[27] Though a single study in this review examined longer-term effects of availability interventions, and found there was no evidence that higher vs lower SEP individuals differed on whether they compensated for reduced energy intake,[14] the evidence base would benefit from further testing of this possibility. Relatedly, while there is some mixed evidence that the use of hypothetical choices in virtual environments can be a valid proxy for real dietary decisions (e.g.[28]; but see[29]), no studies included in this review required individuals to pay for their meals, which may be an important determinant of real-life choices, particularly when considering SEP. Given evidence that healthier foods tend to be more expensive than energy-dense options (e.g.[30]), cost is likely to play a substantial role in food choice regardless of what is available. This may also be important given that lower SEP individuals tend to be more motivated by cost when making food choices.[31] Indeed, there is evidence suggesting that lower food expenditure in part explains poorer dietary choices among lower SEP individuals (e.g.[32,33]). All of the included studies kept cost consistent for all choices, so it remains to be seen how the availability effect may operate when less vs. more healthy food options differ in price.

Another limitation of this review is that studies predominantly used education level as a proxy for SEP. It will be important to consider alternative measures of SEP (e.g. income, subjective social status, index of multiple deprivation), which may have distinct and separate effects on behavior (see[34]). Further, the studies tended to categorize individuals as lower SEP when they did not have higher education (for exceptions see[8,20]). It is plausible that this sampling approach resulted in a limited number of participants with no or minimal educational qualifications, and therefore our findings may not generalize to populations that would be considered very low SEP. While this review provides evidence that increasing healthier food availability appears to be effective in encouraging healthier food choice and reducing the energy content of selections, further research will need to examine dietary behaviors in real-world settings. In particular, in the designs of the included studies the participants were forced to choose one or several food items in both lower and higher availability conditions, which is not entirely representative of choice behavior in real-world settings. It would also be useful to test the effects using more diverse SEP populations, considering other indices of SEP beyond education level. It will be important to assess how increasing healthier food selection may impact energy intake and the potential for energy to be compensated for. Furthermore, assessing whether reductions in energy intake caused by altering availability of healthier foods are sustained in the long term and produce weight loss will help to inform public health policy ([35]).

5 | CONCLUSIONS

Increasing the proportion of healthier foods (relative to less healthy foods) increases the likelihood of choosing healthier food options and reduces energy content of food selections to a similar degree among higher and lower SEP individuals. Given the need to encourage healthier diets for all, policies that increase the availability of healthier food have potential as equitable strategies to reduce obesity and improve population health, though further experimental work is warranted to evaluate these effects in real world environments.

AUTHOR CONTRIBUTIONS

TL designed the research, conducted the research, had primary responsible for the final content and wrote the manuscript. AJ designed the research, conducted the research, analyzed data, and edited the manuscript. ER and LM designed the research and edited the manuscript. MI conducted the research and edited the manuscript.

ACKNOWLEDGMENTS

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 (H2020) research and innovation programme (Grant reference: PIDS, 803194).

CONFLICT OF INTEREST STATEMENT

All authors report no conflicts of interest. ER has previously received funding from the American Beverage Association and Unilever for projects unrelated to the present research.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Langfield T, Marty L, Inns M, Jones A, Robinson E. Healthier diets for all? A systematic review and meta-analysis examining socioeconomic equity of the effect of increasing availability of healthier foods on food choice and energy intake. *Obesity Reviews*. 2023;e13565. doi:10.1111/obr.13565