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1 **The impact of interventions to promote healthier ready-to-eat meals (to eat in,**
2 **to take away, or to be delivered) sold by specific food outlets open to the**
3 **general public: a systematic review.**

4

5 **Running title: Promoting healthier food outlet meals**

6

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29 **Author contributions**

30 AA, JA, VAS, AAL, HM, CS and MW devised the concept for the research. CS was
31 responsible for the management of the study. CS, FHB, TB, HM and AAL developed
32 the study protocol and methods, with contributions from AA, JA, MW, VAS and CA.
33 HM and FHB conducted the searches. FHB conducted the screening with assistance
34 from HM, CS and AAL. All authors assisted with data extraction. TB, FHB, CS and
35 AR conducted the data validation and TB, FHB and CS conducted the data analysis.
36 TB, FHB, CS, CA, AA, JA, VAS and MW contributed to the interpretation of results.
37 CA and VAS provided specialised advice (behaviour change theory). FHB, TB and
38 CS drafted the manuscript. All authors have provided critical comments on drafts of
39 the manuscript and have read and approved the final version.

40

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65

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68

69 **Keywords:** ready-to-eat-meals, takeaways, restaurants, food environments, diet,
70 systematic review

71

72

73 **Abstract**

74 Introduction: Ready-to-eat meals sold by food outlets that are accessible to the
75 general public are an important target for public health intervention. We conducted a
76 systematic review to assess the impact of such interventions.

77

78 Methods: Studies of any design and duration that included any consumer or food
79 outlet-level before-and-after data were included.

80

81 Results: Thirty studies describing 34 interventions were categorised by type and
82 coded against the Nuffield intervention ladder: *Restrict choice* = trans-fat law (n=1),
83 changing pre-packed children's meal content (n=1), food outlet award schemes
84 (n=2). *Guide choice* = price increases for unhealthier choices (n=1), incentive
85 (contingent reward) (n=1), price decreases for healthier choices (n=2). *Enable choice*
86 = signposting (highlighting healthier/unhealthier options) (n=10), telemarketing
87 (offering support for the provision of healthier options to businesses via telephone)
88 (n=2). *Provide information* = calorie labelling law (n=12), voluntary nutrient labelling
89 (n=1), personalised receipts (n=1). Most interventions were aimed at adults in US
90 fast-food chains and assessed customer-level outcomes. More 'intrusive'
91 interventions which restricted or guided choice generally showed a positive impact
92 on food outlet and customer level outcomes. However, interventions which simply
93 provided information or enabled choice had a negligible impact.

94

95 Conclusion: Interventions to promote healthier ready-to-eat meals sold by food
96 outlets should restrict choice or guide choice through incentives/disincentives. Public

97 health policies and practice which simply involve providing information are unlikely to
98 be effective.

99

100 *Word count 200*

101

102

103 **Background**

104 Ready-to-eat meals (to eat in, to take away, or to be delivered) sold by specific food
105 outlets that sell ready-to-eat meals as their main business, are often more energy
106 dense and nutrient poor compared with meals prepared and eaten at home.¹
107 Furthermore, the consumption of these ready-to-eat meals is associated with higher
108 energy and fat, and lower micronutrient intake.² Eating takeaway or fast-food is
109 associated with excess weight gain and obesity.^{3, 4}

110

111 The popularity and availability of ready-to-eat meals has risen considerably over the
112 last few decades in many high and middle income countries.⁵⁻⁷ For example, around
113 one fifth to one quarter of the UK population eat takeaway meals at home at least
114 once per week.⁷ There is some evidence that food outlets selling takeaway meals
115 and fast-foods are clustered in areas of socio-economic deprivation.⁸ Ready-to-eat
116 meals sold by food outlets, particularly in deprived areas, are therefore an important
117 target for public health intervention.⁹

118

119 In some countries, national and local government health departments have worked
120 with national and regional food outlet chains to promote healthier ready-to-eat meals.
121 Many of these interventions have used ‘health by stealth’ approaches, such as

122 reformulation (particularly salt reduction, the removal of trans fats, and energy
123 reductions), and removing condiments from tables in sit-in eateries. Other
124 interventions have focused on promoting smaller portion sizes and providing
125 consumers with better nutritional information (for example calorie labelling on
126 menus).¹⁰

127

128 Bowen et al¹¹ recently completed a critical literature review, guided by a
129 socioecological framework, on the effects of different types of environmental and
130 policy interventions on healthy eating, from a US perspective. They concluded that,
131 whilst the evidence reviewed did not support menu labelling as an effective strategy
132 to change purchasing patterns, additional strategies to enhance menu-labelling
133 practices, and strategies beyond labelling (including implementation of nutritional
134 standards), may be useful. The authors concluded that this literature requires further
135 review.

136

137 The aim of this evidence synthesis was therefore to systematically review the
138 international literature on the impact^a of interventions to promote healthier ready-to-
139 eat meals (to eat in, to take away, or to be delivered) sold by specific food outlets
140 accessible to the general public.

141

^a Impact in this paper is used to describe change in an outcome of interest associated with an intervention. In uncontrolled before-and-after (or pre/post) studies, impact was assessed as the change in the outcome of interest from baseline to post intervention. In randomised controlled trials (RCTs) and non-RCTs, impact was assessed as the difference in change in the outcome of interest in the intervention group compared with the controls. Of note, where we report impact, we do so alongside the methodological quality of the study (strong, moderate, or weak); studies without a control could only achieve a quality assessment of moderate or weak. We appreciate that impact results from uncontrolled studies should be treated with caution (e.g. http://handbook.cochrane.org/chapter_21/21_4_assessment_of_study_quality_and_risk_of_bias.htm). The absence of a comparison group makes it impossible to know what would have happened without the intervention. Some of the particular problems with interpreting data from uncontrolled studies include susceptibility to problems with confounding (including seasonality) and regression to the mean.

142 For the purposes of this review, we have defined ready-to-eat meals as complete
143 meals that need no further preparation which are bought from food outlets, to eat in,
144 to take away, or to be delivered. For example, a bought sandwich or salad box would
145 be included in this definition. However, a packet of crisps/potato chips and a drink, or
146 a chocolate bar, would not be considered a ready-to-eat meal, even if the person
147 consuming them was doing so in replacement of a meal. We acknowledge that
148 terminology in this field is challenging. The literature in this field often includes
149 references to 'take-aways', 'fast food' and 'out of home eating'. In the US, the term
150 'take-out meals' is often used, and in Australia they speak of 'meals prepared outside
151 the home'. In the absence of a globally agreed definition, we have used the term
152 'ready-to-eat meals' throughout, and it includes 'take-aways', 'fast food', 'out of home
153 eating', 'take-out meals', and 'meals prepared outside the home'.

154

155 **Methods**

156 The systematic review was undertaken using established methods based on those
157 used by the National Institute for Health and Care Excellence (NICE)¹² and the
158 findings are reported according to the Preferred Reporting Items for Systematic
159 Reviews and Meta-Analyses (PRISMA) guidelines.¹³ The review is registered with
160 the International prospective register of systematic reviews (PROSPERO)
161 (registration no. CRD42013006931) and the protocol is published.¹⁴

162

163 ***Inclusion criteria:***

164 Setting: The specific food outlets we included were those that, as their main
165 business, sold ready-to-eat meals, and were openly accessible to the general public.
166 Supermarkets and general food stores selling ready-to-eat meals (e.g. salad boxes

167 and sandwiches) were not included, but cafes and restaurants within supermarkets
168 and other retail stores selling ready-to-eat meals were. Food outlets that provided
169 ready-to-eat meals free of charge (e.g. community based lunch clubs for the elderly
170 or homeless) were excluded. We also excluded food outlets which are not openly
171 accessible to the general public, including those based in schools, universities,
172 workplaces, and health/social care institutions. This was for two reasons: first, the
173 effects of interventions to promote the sale of healthier meals in these environments
174 have previously been reviewed.^{15 16 17} Second, the relationship between the provider
175 (e.g. on behalf of the education authority or employer) and consumer (e.g. student or
176 employee) of ready-to-eat meals in these institutions is somewhat different to that
177 between a business and the general public (e.g. the meals may be subsidised).

178

179 Interventions: Any type of intervention that aimed to change the practices of food
180 outlets in order to promote healthier menu offerings was included. Interventions
181 identified for review were assessed for type of intervention; 11 categories were
182 identified. Box 1 describes each type of intervention category as defined by the
183 review team and, for convenience, they are ordered by where they sit on the Nuffield
184 ladder¹⁸ (described below). Interventions which were categorised as ‘Signposting’
185 type studies were defined as those that highlighted to customers the healthier, or
186 less healthy, menu options available. This was usually done using symbols next to
187 menu items, but table signage and posters were other methods used. Signposting
188 differs from calorie labelling on menus as it provides some indication of the
189 ‘healthfulness’ of a menu items rather than just providing information. Interventions
190 which were categorised as ‘Telemarketing of healthy food choices’ type studies were
191 defined as those which involved a phone-based direct marketing strategy and a

192 variety of free services offered to businesses including menu guidelines for the
 193 provision of healthy choices.

194

195 Box 1. Summary description of the intervention categories

Intervention category and description of interventions identified by review	Nuffield intervention ladder definition^a
Trans-fat law: Restriction of all food service establishments, including both chain and non-chain food outlets, from using, storing, or serving food that contains partially hydrogenated vegetable oil and has a total of 0.5 g or more trans-fat per serving	<i>Restrict choice</i>
Changing pre-packed children's meal content: Pre-packed meal content changed to include healthier options, smaller portion sizes of less healthy options and/or removal of other less healthy options	<i>Restrict choice</i>
Food outlet award schemes: Interventions that include an assessment of food outlet practice(s) using pre-defined criteria, together with some sort of accreditation if the food outlet met the criteria	<i>Restrict choice (Variable depending on scheme, but those included in this review were all categorised as restrict choice)</i>
Price increases for unhealthier choices: Price increase applied to less healthy menu options	<i>Guide choice (disincentives)</i>
Incentive (contingent reward): A conditional reward is provided only after the target behaviour (e.g. choice of a healthier option) is performed	<i>Guide choice (incentives)</i>
Price reductions for healthier choices: Price reduction applied to healthier menu options	<i>Guide choice (incentives)</i>
Signposting: Interventions that highlighted to customers the healthier, or less healthy, menu options available	<i>Enable choice</i>
Telemarketing of healthy food choices: Phone-based direct marketing strategy; variety of free services offered to businesses including menu guidelines for the provision of healthy choices.	<i>Enable choice</i>
Calorie labelling law: Mandatory posting of calorie values of each option on menus in chain food outlets	<i>Provide information</i>
Voluntary calorie labelling: Voluntary posting of calorie values of each option on menus in chain food outlets	<i>Provide information</i>
Personalised receipts: Receipts that included personalised suggestions designed to reduce fat and calorie consumption	<i>Provide information</i>

196 ^aDefinition from the Nuffield ladder¹⁸ starting with the most intrusive; eliminate choice, restrict
197 choice, guide choice (disincentives), guide choice (incentives), guide choice (default policy),
198 enable choice, provide information, do nothing),

199

200 Outcomes: Any outcome that included consumer or food outlet outcomes.
201 Consumer outcomes could include dietary outcomes (e.g. energy intake), purchasing
202 behaviour (e.g. sales data), and attitudes towards healthier menu choice and
203 preferences. Food outlet outcomes could include changes in retail practices, process
204 outcomes and profit.

205

206 Study design: A scoping search of the literature, which we conducted in advance of
207 writing the protocol¹⁴ estimated that there would be insufficient evidence from
208 randomised controlled trials (RCTs) to allow us to answer our research question.
209 However, those working in public health policy and practice need to know how best
210 to improve the nutritional quality of ready-to-eat meals sold by food outlets. Thus, we
211 took an overarching approach that is used by the National Institute for Health and
212 Care Excellence,¹² to identify the best available evidence. Thus, studies of any ~~study~~
213 design that reported outcomes at least once pre and once post-intervention were
214 included (also called uncontrolled before and after studies). Studies with and without
215 comparators were included without restriction on the type of comparator.

216

217 **Search**

218 Searches identified studies published from January 1993 to October 2015 in the
219 following databases (and interfaces): ASSIA (ProQuest), CINAHL (Ebscohost),
220 Embase (Ovid), MEDLINE (Ovid), NHS EED (Wiley Cochrane) and PsycINFO

221 (Ebscohost). Searches were limited to articles written in English. Topic experts were
222 contacted for information about any additional relevant interventions not identified by
223 the electronic search. Key reviews¹⁹⁻²¹ were searched as well as reference lists of
224 included studies. Details of the search strategies can be found in the Supplementary
225 File, Fig S1.

226

227 Initial screening of titles and abstracts were conducted by one reviewer (FHB) with a
228 random 10% of the sample independently screened by a second reviewer (HM).
229 Agreement between the reviewers was fair (kappa = 0.50) as a result of the second
230 reviewer being more inclusive than the main reviewer. Disagreements between the
231 reviewers were resolved through discussion and it was agreed that studies initially
232 excluded by the main reviewer and included by the second reviewer were excluded
233 at this stage. Full-text articles of potentially relevant studies were independently
234 appraised by two researchers (FHB and CS). Agreement between the reviewers at
235 this stage was excellent (kappa = 0.80). Any disagreements between reviewers were
236 resolved by discussion.

237

238 ***Data extraction and quality assessment***

239 Data extraction and quality assessment were conducted independently by two
240 reviewers (all authors contributed), and any discrepancies between reviewers were
241 resolved through discussion with a third reviewer (TB). Data were extracted on study
242 characteristics, intervention type and outcomes. Study quality was assessed using
243 the Effective Public Health Practice Project Quality Assessment Tool for Quantitative
244 Studies²² as recommended by the Cochrane Public Health Review Group²³. This

245 was adapted for the purposes of this review, specifically in terms of the classification
246 of study designs (see Table 1).

247

248 ***Table 1 Adapted typology of study designs and quality about here***

249

250 Data on implementation, including context, collaboration, fidelity, sustainability and
251 differential effects by population demographics (using the PROGRESS [place of
252 residence, race/ethnicity/culture/language, occupation, gender/sex, religion,
253 education, socioeconomic status, and social capital] framework²⁴) were extracted,
254 using a checklist for obesity related interventions²⁵ adapted from workplace
255 interventions.²⁶ An implementation score (0-10) was assigned based on the number
256 of categories information was reported for. Any cost effectiveness data were also
257 extracted.

258

259 Data were extracted on the theoretical framework or behavioural model or strategy
260 underpinning each intervention. Interventions were coded according to the Nuffield
261 Intervention ladder in order to categorise the interventions in terms of their
262 “intrusiveness” and impingement on personal autonomy.¹⁸ We note that the Nuffield
263 Ladder uses the term ‘incentive’ loosely. Incentive has been technically defined to
264 mean a reward contingent on changing behaviour, which can be distinguished from a
265 simple price increase or decrease.^{27, 28} We have made these distinctions explicit in
266 our intervention categories. Interventions were also coded in terms of intervention
267 function and policy category using the Behaviour Change Wheel.²⁹

268

269 ***Data synthesis***

270 Given heterogeneity in study designs, intervention types and outcome measures, the
271 results are presented as a narrative synthesis following the ESRC Narrative
272 Synthesis Guidance.³⁰ A 'summary impact' of each study was reported (denoted by
273 an arrow), alongside the global rating of study quality (strong, moderate, or weak).
274 Studies were classed as 'effective' (↑); 'equally effective' as the comparison group
275 (↔); 'effectiveness mixed' by outcome or gender (↕); or 'not effective' (↓). Studies
276 without a control could only achieve a global quality of moderate or weak. Impact
277 was based on change in mean energy purchased where possible (where a decrease
278 in mean energy purchased signified a successful outcome of the intervention,
279 denoted as ↑). Where energy purchased was not reported, impact was based on the
280 primary outcome of the study (e.g. trans fat content of meal, healthy food purchases,
281 catering practices, health promotion practices, or menu items available). Impact was
282 assessed using the overall effect for the whole study sample and not by subgroup.
283 Studies with a control group were assessed on change in outcomes between groups
284 at follow-up; studies without a control group were assessed on change in outcomes
285 from baseline to follow-up.

286

287 **Results**

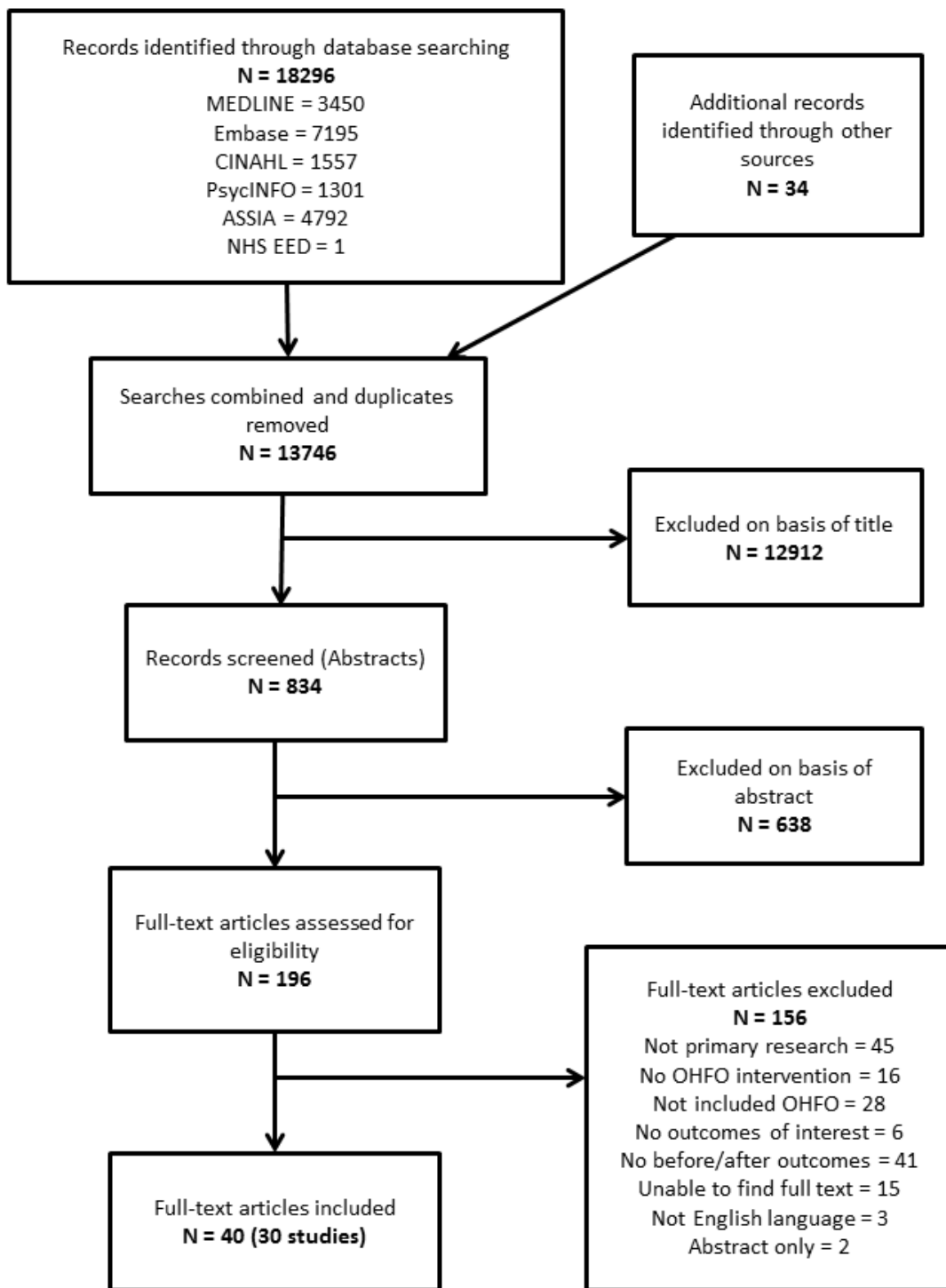
288 A total of 30 studies (reported in 40 articles), describing 34 interventions, were
289 included; study flow is reported in a PRISMA flowchart (Figure 1). Supplementary file
290 Table

291

292 S1 provides a list of included references. Details of studies that were excluded on
293 screening full-text articles are listed in Supplementary file Table S2.

294

295 **Figure 1 PRISMA Flowchart**



296

297

298

299 ***Characteristics of included studies***

300 Study characteristics are summarised in Supplementary File Table S3. Of the 30
301 included studies, 19 were repeat cross-sectional studies, seven with a comparison
302 control group³¹⁻³⁷ and 12 without.³⁸⁻⁴⁹ These studies were classified as cross-
303 sectional because the outcomes of the study were mainly measured at the consumer
304 level, so although the same food outlets were assessed at each time point, the
305 customers were most likely to be different. In three of these studies^{33, 44, 49} there were
306 subgroup cohorts of customers nested within the repeat cross-sectional data. Five
307 studies⁵⁰⁻⁵⁴ were classified as cohort studies. Two studies were controlled before-
308 after studies that reported outcomes in the same customers⁵⁵ or at the food outlet
309 level in the same food outlets at baseline and follow-up,⁵⁶ and four studies were
310 controlled trials.⁵⁷⁻⁶⁰

311
312 Twenty-seven of the 30 included studies were based in the USA; two studies were
313 based in Australia,^{44, 49} and one in the UK.⁵⁰ Twenty-two studies reported outcomes
314 for adults; three for parents and their children^{37, 55, 61} and one study reported child
315 outcomes only.⁴⁸ For the four remaining studies, food outlets, rather than individuals,
316 were the unit of observation and analysis. Study populations ranged from lower³⁴ to
317 higher SES^{31, 41, 55, 58} and more ethnically diverse samples⁵⁷ to mainly Caucasian
318 samples.^{39, 43, 45} Some studies targeted specific ethnic groups, including Mexican
319 Americans,⁵³ low-income African-Americans⁵⁹ and low-income Latino-Americans.⁴⁶
320 Many of the studies did not report on population characteristics in detail.

321
322 In terms of the types of food outlets targeted; 18 studies focused on chain food
323 outlets and 12 studies were set in other types of food outlet; including three studies

324 in non-chain food outlets;^{45, 47, 60} and one study each in takeaway food outlets;⁵⁹ a
325 delicatessen-style food outlet;⁵⁸ privately owned fast-food-style Mexican food
326 outlets;⁵³ community food outlets which included both counter and table-service;⁴²
327 Latino family-owned food outlets;⁴⁶ licensed retail food outlets;⁵² licenced hotels,
328 clubs and nightclubs;⁴⁹ restaurants and cafes;⁴⁴ and small independent catering
329 outlets.⁵⁰ Most of the chain food outlets were fast-food counter-service, but other
330 food outlet types included table-service or take-away only. One study was set in food
331 service areas of a large discount department store.⁴¹

332

333 Study samples of food outlets varied greatly in size, for example one study included
334 just one outlet⁵⁸, and another included over 300.³¹ Study duration ranged from
335 minutes⁵⁴ to seven years³⁷ and data points ranged from two time points³⁴ to weekly
336 purchase information for a 125-week period.³²

337

338 Only four studies were assigned a global quality rating of 'strong', ten were rated as
339 'moderate' and 16 were rated 'weak' (Supplementary File Table S4). In terms of
340 implementation, scores ranged from 3 to 9 (Supplementary File Table S6). Papers
341 that described the study intervention in detail were more likely to score higher for
342 implementation; however, low scores were not necessarily an indication of poor
343 reporting just that a number of organisational and implementation factors were not
344 used or explored for the intervention (e.g. theoretical underpinning, collaborative
345 approaches to development and delivery, fidelity of intervention delivery, stakeholder
346 support).

347

348 Tables 2a (for studies with customer level outcomes) and 2b (for studies with food
349 outlet level outcomes) summarise the design, intervention type, context, and results
350 for the included studies. Where a study included more than one intervention arm, the
351 results for each have been reported separately (often in different intervention types).
352 Some of the interventions focused on changing customer behaviour directly (e.g.
353 signposting); and some on changing outlet behaviour in an attempt to change
354 customer behaviour (e.g. awards). For more detailed information on study
355 interventions see Supplementary File Table S4, and for study results see
356 Supplementary File Table S5.

357

358 ***Tables 2a Summary of included studies with customer level outcomes (n=23)***
359 ***and 2b Summary of included studies with food outlet level outcomes (n=7)***

360 ***about here***

361

362 ***Studies with customer level outcomes***

363 ***Trans fat law (n=1)***

364 Only one study (moderate quality, repeat cross-sectional) investigated the effects of
365 the trans fat law introduced in New York City. Trans fat law was associated with a
366 significant reduction in trans fat content per purchase along with a small, but
367 significant, increase in saturated fat content per purchase. Results did not differ
368 according to the poverty rate of the neighbourhood in which the food outlet was
369 located. However, the effect of the law was inconsistent and varied between fast-
370 food chain types.

371

372 ***Changing pre-packed children's meal content (n=1)***

373 One repeat cross-sectional study (weak quality) investigated the effects of changing
374 the side items included (decrease in portion size of fries and addition of apple slices)
375 in pre-packed children's meals on energy purchased from these meals.⁴⁸ The
376 intervention also included a slight change to in-restaurant and television promotions
377 to include non-fat chocolate milk in addition to 1% fat plain milk. The study found a
378 decrease in total energy purchased, which was mainly explained by the reduction in
379 energy due to the change in side items. Sales of non-fat chocolate milk also
380 increased, and sales of regular carbonated drinks decreased from baseline to follow-
381 up, which resulted in a small but significant contribution to the overall decrease in
382 energy. Of note, there was no change in the percentage of customers choosing the
383 lowest energy option. Whilst there did not appear to be any compensatory effects in
384 terms of other pre-packed meal components, compensatory effects in terms of
385 additional foods were not reported.

386

387 **Price increases for unhealthy choices (n=2)**

388 One strong quality, controlled trial investigated the effects of two interventions that
389 included price increases of unhealthy menu items: 1) price increase alone and 2)
390 price increase with signposting of the unhealthy options.⁶⁰ The study found no
391 intervention effect when only a price increase was applied, but when combined with
392 signposting there was a decrease in unhealthy main dishes ordered.⁶⁰

393

394 **Incentives (contingent rewards) (n=1)**

395 A moderate quality, brief, cohort study investigated the effects of offering a non-food
396 incentive (entry to a \$10, \$50 or \$100 lottery) with a smaller portion size option.⁵⁴
397 Customers who had intended to order a full sized sandwich were offered a half sized

398 sandwich plus lottery option (at the same price of the full sized sandwich). The
399 proportion of customers who changed their menu choice from a full sized to a half
400 sized sandwich varied by the size of the lottery prize from 5% (\$10 lottery), 8% (\$50
401 lottery) to 22% (\$100 lottery).⁵⁴

402

403 **Price reductions for healthier choices (n=2)**

404 One weak quality, controlled study investigated the effects of two price reduction
405 interventions to promote purchases of healthier options: 1) price reduction alone and
406 2) price reduction alongside health promotion techniques to highlight the healthier
407 options to customers). Both interventions resulted in a proportional increase in sales
408 of healthier items compared to other items.⁵⁸

409

410 **Signposting (n=8)**

411 Eight studies investigated the effects of nine interventions that involved signposting.
412 In three studies signposting was implemented alone^{41, 46, 60}; in two studies
413 signposting was incorporated with menu changes^{45, 59}, and three studies were of
414 health promotion or social marketing campaigns which included signposting.^{31, 42, 58}

415

416 One controlled trial (strong quality), found that, overall, adding a symbol to menus
417 that identified 'unhealthy' main dishes resulted in a decrease in the number of
418 unhealthy main dishes ordered.⁶⁰ However, when gender effects were explored, it
419 was found that this effect was driven predominately by women.

420

421 A repeat cross-sectional study (weak quality) showed that sales of some healthier
422 items increased after the addition of 'healthy' signposting, but for some, sales

423 decreased or were not affected, resulting in no significant overall change in sales of
424 all 'healthy' items.⁴¹ However, study authors report that the items that showed
425 decreased sales may have been prone to seasonal effects. Another repeat cross-
426 sectional study (weak quality) found no effect of healthy signposting on the purchase
427 of healthy main meals when added to an existing award intervention.⁴⁶ This
428 intervention was also culturally tailored; Latino community members helped to
429 translate the messages on small menu stickers into Spanish and provided specific
430 examples of culturally used saturated fats and other ingredients to tailor the national
431 dietary guidelines.

432

433 Two studies investigated effects of signposting plus menu changes. One controlled
434 trial (strong quality) found that an intervention promoting new healthier choices was
435 effective in increasing sales of healthy food items.⁵⁹ However, a repeat cross-
436 sectional study (weak quality) found that an intervention of table signage promoting
437 new alternative healthier options had no effect on the purchase of healthy choices.⁴⁵
438 In the first study,⁵⁹ food outlets were given support with monetary value in the form of
439 initial stock. In addition, both the menu items and intervention materials aimed to be
440 culturally appropriate through formative research with African-American customers
441 and building rapport with the Korean-American and African-American takeaway
442 owners, for example by using and learning greetings in Korean.

443

444 Four studies investigated the effects of interventions that primarily aimed to increase
445 customer awareness of healthy options in the participating food outlets. As well as
446 simple menu signposting these interventions used social marketing or health
447 promotion campaigns to achieve this.^{31, 42, 53, 58} The intervention investigated by

448 Acharya and colleagues using a repeat cross-sectional design with control groups
449 (moderate quality) found a significant, small effect on the purchase of healthy menu
450 items compared with controls.³¹ Holders of campaign discount coupons were 17%
451 more likely to purchase healthy menu items.

452

453 A weak quality repeat cross-sectional study investigated an intervention delivered in
454 community food outlets that also included 'persuasion' intervention functions
455 (advertisements and articles in local newspaper and newsletters, and promotional
456 material).⁴² A trend towards a slight increase in the percentage of healthy items sold
457 was observed but this did not reach significance. A culturally tailored social
458 marketing campaign, conducted in Mexican American food outlets, which included
459 the provision of guidelines and training to food outlet owners, incentives (for outlet
460 staff and customers) and newspaper advertising, increased the number of healthier
461 food options provided in the majority of the participating outlets (cohort study; weak
462 quality).⁵³ In this study all materials were given to food outlet owners in English and
463 Spanish, and were image-oriented, or comprised simple checklists. Finally, a weak
464 quality, controlled trial found that displaying in-store posters listing healthier options
465 led to increases in sales of the healthier options.⁵⁸

466

467 **Calorie labelling law (n=10)**

468 The highest number of studies (n=10) assessed the effects of mandatory calorie
469 labelling on menus. Four of these assessed the King County nutrition labelling law;^{36,}
470 ^{39, 43, 55} four assessed the New York City calorie labelling law;^{33, 34, 40, 57} one study
471 assessed the Philadelphia calorie labelling law³⁵ and one study assessed calorie
472 labelling laws across 18 US states and localities.³⁷

473

474 One repeat cross-sectional study with control (rated strong for quality) showed a
475 statistically significant decrease in average energy purchased following menu calorie
476 labelling in one large coffee chain (Starbucks) compared to control.³³ One repeat
477 cross-sectional study (weak quality) described an increase in the number of
478 customers who reported seeing and acting on the calorie information following
479 introduction of mandatory menu labelling.³⁹ The remaining studies (one weak, five
480 moderate and one strong quality) reported no association between introduction of
481 mandatory menu calorie labelling and average energy purchased.^{34-37, 40, 43, 55}

482

483 One controlled study (moderate quality) investigated the effects of providing
484 customers with calorie recommendation information before and after the New York
485 City calorie labelling law was implemented.⁵⁷ The study found that calorie
486 recommendations did not significantly affect food purchases.

487

488 **Voluntary calorie labelling (n=1)**

489 A moderate quality repeat cross-sectional study found that voluntary nutrient
490 (calories, fat, sodium and carbohydrates) labelling in non-chain food outlets resulted
491 in significant decreases in energy, fat and sodium content of customer purchases,
492 with no change in carbohydrate content⁴⁷. The study also found that 71% of
493 customers surveyed reported noticing the nutrition information, with 20% (of all
494 customers) stating that this resulted in choosing a lower energy main meal and 17%
495 reported ordering a lower fat main meal.

496

497 **Personalised receipts (n=1)**

498 One study (repeat cross-sectional; weak quality) assessed a receipt-based
499 intervention.³² The receipts consisted of three components: information, motivation
500 and recommendations. The personalised receipts were associated with an increase
501 in healthier item substitutions that were encouraged by the messages, such as
502 substituting ham for sausage in a breakfast sandwich, or substituting frozen yogurt
503 for ice cream. However, there was no significant change in total energy or total fat
504 per transaction. The intervention was also associated with a small increase in
505 revenue (3.2%).

506

507 ***Studies with food outlet level outcomes***

508 **Award schemes (n=2)**

509 Two studies explored the effects of award scheme type interventions where food
510 outlets received some kind of recognition or certificate for meeting pre-defined
511 criteria.^{50, 52} The criteria in each award scheme covered a range of intervention
512 features and both included restricted choice (e.g. recipe reformulation, default
513 healthy drinks with children's meals). Both studies followed cohort study designs
514 (weak quality) and observed increases in healthier catering practices and healthy
515 options available. However, Bagwell et al⁵⁰ found that only a small number of
516 changes were needed for outlets to achieve the award.

517

518 **Signposting (n=1)**

519 One weak quality study investigated the effects of a social campaign which included
520 the intervention team working with food outlets to encourage them to add, and
521 signpost, healthier options to their menus.⁵³ The majority of food outlets changed
522 practices either by simply distributing health education materials (94% of 16 food

523 outlets) or introducing or promoting healthier side options (81%), whilst half began
524 promoting healthier main meal options.

525

526 **Telemarketing of healthy food choices (n=2)**

527 Two Australian studies^{44, 49} appear to be related to one telemarketing health
528 promotion intervention which included an element of healthy food provision; with one
529 paper focusing on outcomes for hotels, clubs and nightclubs⁴⁹ and the other paper
530 on outcomes for restaurants and cafes.⁴⁴ Both studies used a repeat cross-sectional
531 study design, with the same cohort of premises evaluated at both time points, and
532 were rated weak for quality. Licata et al⁴⁴ found no significant change in the
533 percentage of restaurants and cafes undertaking nutrition-related health promotion
534 practices between 1997 and 2000, in either the cross-sectional or cohort samples.
535 However, Wiggers et al⁴⁹ found the prevalence of healthy food choices increased
536 significantly in hotels, clubs and nightclubs, in both cross-sectional and cohort
537 samples.

538

539 **Calorie labelling law (n=2)**

540 Two studies investigated the effects of the King County, USA, calorie labelling law on
541 food outlet level outcomes. In one cohort study (weak quality), there was a significant
542 decrease in the energy content of main meals available in fast-food chain food
543 outlets following the introduction of calorie labelling.⁵¹ One strong quality controlled
544 study found no association between the introduction of mandatory menu calorie
545 labelling and the 'healthfulness' of menus.⁵⁶

546

547 ***Analysis of theoretical framework / behavioural model***

548 Only seven of the 30 studies reported using a theoretical framework or behavioural
549 model; including a consumer behaviour model based on the Theory of Reasoned
550 Action,³¹ an asset-based community development approach where community
551 members are active agents of change,⁵³ participatory research⁴⁶ and creating
552 'supportive environments'.⁴⁹ One study⁵⁸ reported using the Health Belief Model, and
553 a matching model,⁶² which predicts that, because the interval between food choice
554 and eating is short, the proximal satisfaction of a tasty meal would prevail over the
555 distal goal of good health.⁶³ Two studies^{45, 59} reported using Social Cognitive Theory;
556 one of these studies also reported using a Social Marketing approach using the Four
557 Ps: Product, Price, Place, and Promotion.⁵⁹ Our review protocol¹⁴ included plans to
558 code the use of behaviour change techniques in included interventions, but this
559 endeavour was abandoned *post hoc* because the necessary detail to allow us to do
560 this was only available for seven interventions.^{31, 45, 46, 49, 53, 58, 59} Attempts were made
561 to contact authors for further information, but only six authors responded to the
562 requests (see Figure S1). This conclusion was arrived at by experts (VAS and CA)
563 with considerable expertise in developing and coding behaviour change techniques
564 in systematic reviews.

565

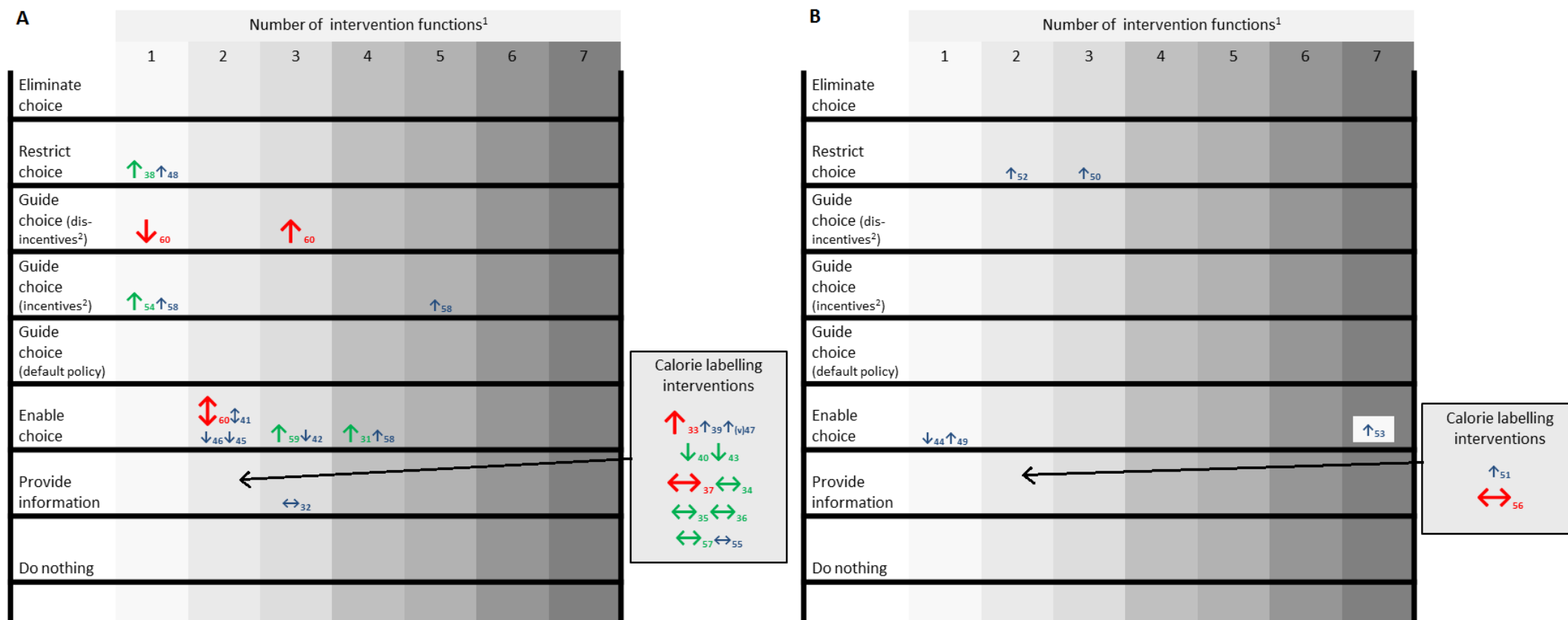
566 Figure 2 illustrates the findings from each intervention in the context of the
567 intervention coding according to the Nuffield intervention ladder,¹⁸ and the number of
568 intervention functions involved as coded from the Behaviour Change Wheel.²⁹ There
569 is a cluster of interventions lower down the intervention ladder, particularly around
570 providing information, and this mainly includes the calorie labelling law interventions.
571 Evidence for these interventions from the lower end of the Nuffield ladder is mixed.

572 Evidence from the small number of studies higher up the intervention ladder

573 **Figure 2: Intervention impact summary by Nuffield intervention ladder category and number of intervention functions for**

574 **customer level outcomes (A) and outlet level outcomes (B)**

575



Key: effective (↑); equally effective as the comparison group (↔); effectiveness mixed by outcome or gender (↕); not effective (↓) Red arrow = strong quality study, green arrow = moderate quality study, blue arrow = weak quality study

¹Intervention function coded from Michie et al (2011) Behaviour Change Wheel

²Incentive and dis-incentive are presented here as used in the Nuffield Ladder. Incentive includes both price reductions and contingent rewards. Disincentive includes price increases and contingent penalties.

576 suggests more consistent evidence of effectiveness. The only exception is seen
577 when choices are guided through using price increases, where positive effects were
578 only observed when in conjunction with other intervention elements (that sit further
579 down the ladder). Overall, however, the number of intervention functions does not
580 appear to influence intervention effectiveness.

581

582

583 ***Cost effectiveness of interventions***

584 There was no cost-effectiveness evidence reported in any of the included studies.

585

586 ***Impact of intervention by PROGRESS***

587 Eight studies reported on differential effects of the intervention by population
588 demographics on purchasing behaviour, six of which focussed on the impact of
589 calorie labelling. One high quality study of mandatory calorie labelling in Starbucks
590 restaurants showed a larger decrease in energy per transaction in 'zip' codes with
591 higher income and more educated residents.³³ This was also the only study of
592 mandatory calorie labelling that showed a statistically significant decrease in terms of
593 energy purchased post-labelling (approximately 15 calories per purchase). One
594 study found a differential effect of calorie labelling by gender: women but not men
595 significantly reduced mean energy purchased in coffee chains post labelling⁴³. Some
596 evidence suggests that *awareness* of calorie labelling is highest amongst women
597 and white, higher SES (income and education) and older adults.^{39, 40}

598

599 Two other studies also found differential effects by gender. In a study using a lottery
600 incentive to encourage customers to choose a smaller portion size, women were less

601 likely to take up the offer. There were no effects by age, BMI or hunger level.⁵⁴ In
602 another study, women appeared to respond strongly to signposting, whereas for men
603 decreases in unhealthy items purchased were only found when a price increase was
604 added to the signposting.⁶⁰

605

606 Overall, the limited evidence suggests there are no consistent differential effects (for
607 better or worse) of mandatory calorie labelling in terms of food purchases by gender,
608 age, race and SES. No studies reported data on differential effects of the
609 intervention by occupation, culture/faith/religion, or social capital.

610

611 **DISCUSSION**

612 ***Summary of main findings***

613 Thirty studies describing 34 interventions were identified which met the inclusion
614 criteria. Most of these studies (n=27) only collected customer level outcome
615 information. Indeed, the evidence is mainly from studies that collected data on meals
616 purchased by adults buying food in specific fast-food chains within the USA, which
617 limits the generalisability of the results. Information on the impact of interventions at
618 a food outlet level was scarce and weak in quality. We did not find any information
619 on the impact of interventions on food consumption, either by meal or total daily food
620 intake. The quality of evidence was generally poor, with few high quality designs,
621 which limits the strength of the results. Overall, the impact of interventions appears
622 negligible and inconsistent. However, when the impact of interventions was
623 assessed by the level of their intrusiveness^b, patterns emerged. The findings from

^b as defined by the Nuffield ladder¹⁸ starting with the most intrusive; eliminate choice, restrict choice, guide choice (disincentives), guide choice (incentives), guide choice (default policy), enable choice, provide information, do nothing),

624 this review provide useful insight from the best available evidence which will help to
625 inform future policy and intervention efforts.

626

627 Four interventions focussed on restricting choice and all had a positive impact on
628 customer level (n=2) and food outlet level (n=2) outcomes. These types of
629 interventions are sometimes termed 'health by stealth', and there is good evidence
630 that such interventions are effective and equitable.

631

632 Incentivisation, as defined in the Nuffield Ladder,¹⁸ may be a promising approach to
633 encouraging the choice of healthier menu items. Two studies that used a price
634 decrease for healthier options found positive effects on the purchase of healthier
635 food items. Three of four interventions that included price decreases in addition to
636 other intervention functions (targeted at customers and/or the food outlet) found
637 positive effects on healthier food purchases. However, it is unclear what proportion
638 of these positive effects can be attributed to the price changes in these studies. Price
639 increases of unhealthy foods alone were ineffective overall but, when combined with
640 signposting, resulted in a decrease in the purchase of unhealthy items. Eyles et al⁶⁴
641 have reviewed the literature around food pricing strategies and whether they
642 encourage healthy eating habits. Based on modelling studies, they found that taxes
643 on carbonated drinks and saturated fat and subsidies on fruits and vegetables would
644 be associated with beneficial dietary change, with the potential for improved health.
645 WHO have also concluded that there is the potential to influence consumer
646 purchasing in the desired direction through price policies that address affordability
647 and purchasing incentives; taxes on sugar sweetened beverages and targeted
648 subsidies on fruit and vegetables emerge as the policy options with the greatest

649 potential to induce positive changes in consumption. Although there is a dearth of
650 evidence around the effect of policy strategies which aim to promote healthier ready-
651 to-eat meals, the results for pricing interventions observed in this review fit with the
652 broader literature.⁶⁵

653

654 Signposting interventions showed mixed findings. Three signposting-only studies
655 found mixed or no effect. Six signposting-plus other intervention components varied
656 in effectiveness according to study quality. Studies assessed as moderate or strong
657 quality tended to show positive intervention effects, whilst the weak quality studies
658 tended to show no or mixed effects. Again, it is unclear what proportion of the effect
659 in these studies can be attributed to the signposting-only component.

660

661 Calorie labelling appears to be associated with an increase in awareness
662 (approximately half customers notice labels) and an increase in knowledge of the
663 energy content of fast-food menu items. The proportion of customers that notice and
664 act on calorie labelling do tend to purchase fewer calories, but this proportion
665 remains low (less than a third), and no information was available on their subsequent
666 purchases or the impact on overall energy intake.

667

668 Results suggest that it is the level of intrusiveness of an intervention, rather than the
669 type of policy function, which determines the impact of the intervention. More
670 'intrusive' interventions (e.g. restrict choice, manipulate price) appear more effective
671 than less intrusive interventions that simply include providing information and
672 enabling choice (e.g. calorie labelling law).

673

674 ***Strengths and weaknesses of the studies included in the review***

675 There was a dearth of high quality studies identified that met the inclusion criteria for
676 this systematic review. The fact that most of the included studies were conducted in
677 chain food outlets in the USA, focussed on customer level outcomes for adults only,
678 and were of low to moderate in quality means that caution is required in generalising
679 and interpreting the results. We appreciate that this type of real world public health
680 evaluation is complex, but would encourage more researchers and funders to
681 support this type of research, and when doing so to conduct evaluations which can
682 provide information on the cost effectiveness and the equity impact of interventions.
683 Although we included every type of outcome in this review, most of those reported
684 were not direct measures of dietary intake or health. Some of the studies reported
685 on the energy value count of food items purchased, but this may not necessarily
686 translate into energy consumed (e.g. during to food sharing and waste), and it
687 cannot be assumed that there were no compensatory effects in food intake at other
688 times in the day. Data on food wastage, food sharing, or the act of keeping a
689 proportion of the uneaten food for another meal (e.g. in a 'doggy bag') was not
690 collected or reported in the studies we included for review; there is evidence that this
691 is common practice, at least in the USA.⁶⁶

692

693 The difficulties in identifying behaviour change techniques employed in the studies
694 included in this review may reflect two problems. First, descriptions of interventions
695 in published reports are often poor. This means that the research identified is not
696 replicable and offers limited options for evidence synthesis. This is a widely
697 acknowledged problem⁶⁷ and has resulted in the development of the TIDieR
698 guidelines for the reporting of interventions.⁶⁸ Second, because current taxonomies

699 of behaviour change techniques have been inspired by individual behaviour change
700 interventions, it is possible that environmental interventions (e.g. changes to
701 information provided in the menus), like the ones included in this review, are not as
702 well reflected in these taxonomies, making coding difficult.

703

704 ***Strengths and weaknesses of the review***

705 The primary strength of this systematic review is its scope, in that it assessed the
706 international literature for evidence on this topic, without substantial restriction to any
707 particular intervention, study design or outcome. This novel approach allowed us to
708 comprehensively draw together the best available evidence relating to interventions
709 which promote healthier ready-to-eat meals sold by specific food outlets open to the
710 general public. This evidence base can contribute to local and national public health
711 policy given the increasing consumption popularity of ready-to-eat meals and
712 international cuisines in many countries.^{7, 69} That said, this resulted in the assembly
713 of a heterogenous group of interventions which have a number of different targets for
714 change; some intended to change food outlet practices and others aimed to change
715 customer behaviour. Previous reviews have focused on calorie labelling^{19, 20, 70} or
716 community-based interventions only.²¹ Our findings regarding the impact of calorie
717 labelling on sales are in line with these recent systematic reviews^{19, 20, 70} which found
718 inconsistent and negligible changes in 'real-world' food outlet settings. Two of these
719 reviews^{19, 20} included experimental-type studies conducted in laboratory and training
720 restaurants, which we did not include (because they were not open to the general
721 public). Calorie labelling in these experimental (efficacy) studies was found to be
722 efficacious. It would appear that these effects are not translated to 'real world'
723 settings (effectiveness).

724

725 **Meaning of the study: possible mechanisms and implications for practitioners**
726 **and policymakers**

727 We found a preponderance for interventions lower down the Nuffield Ladder –
728 particularly in the provide information and enable choice ‘rungs’. This reflects the
729 suggestion made by others that public health policymakers and practitioners may
730 favour those interventions that are less intrusive.⁷¹ Unfortunately, our findings, and
731 those of others,⁷¹⁻⁷⁴ suggest that these interventions are likely to be less effective
732 and equitable than those higher up the ladder.

733

734 The Nuffield Ladder was originally developed to help public health practitioners and
735 policymakers determine what level of intervention was ‘proportionate’ for a particular
736 ‘problem. ‘Intrusiveness’, evidence of effectiveness and the extent of the ‘problem’
737 addressed are all identified as being important considerations.¹⁸ Our findings
738 suggest that interventions higher up the Nuffield Ladder are likely to be justified as
739 ones lower down seem of limited effectiveness. We also found some evidence that
740 price and incentive-based interventions may be particularly promising. However,
741 overall there is very little evidence on interventions on ‘rungs’ above ‘enable choice’,
742 and further effort is required both to develop and evaluate new approaches.

743

744 We also found evidence that less intrusive interventions lower down the Nuffield
745 ladder were more likely to be associated with less equitable effects. The tendency for
746 less intrusive interventions to be less equitable has been discussed by others.^{71, 75-78}
747 Whilst this could be interpreted as a limitation, it also serves to highlight that different
748 interventions are required for different population groups and that a range of

749 interventions are required to achieve change across the whole population.⁷¹
750 Although some interventions included in this review included a number of different
751 components, we are not aware of any substantial, multi-sectorial attempts to achieve
752 wholesale improvement in the healthfulness of the out-of-home food sector.

753

754 Whole system change across the out-of-home food sector would require concerted
755 and joined up action across a range of private and public sector organisations. Such
756 action is dependent on political will which is, in part, dependent on public perceptions
757 of the seriousness of the problem addressed and the effectiveness of the solutions
758 offered.⁷⁹ Recent changes in the public acceptability of, for example, smokefree
759 legislation⁸⁰ and taxes on sugar sweetened beverages,⁸¹ suggest that public opinion
760 on public health topics is amenable to change.

761

762 **Unanswered questions and future research**

763 We found limited evidence of interventions across the full spectrum described in the
764 Nuffield Ladder. Further work is required to develop, and evaluate, a wider range of
765 interventions, particularly those higher up the ladder that may be more effective and
766 achieve more equitable effects. This should be conducted in partnership with those
767 working in public health policy and practice.

768

769 The quality of evidence included in the review was generally low, limiting the
770 conclusions that can be drawn. Those developing, delivering and evaluating
771 interventions should make greater efforts to ensure that higher quality evaluations
772 are conducted, particularly in terms of capturing longitudinal data on outcomes that
773 can be directly related to diet and health. This may require focusing evaluative

774 resources on answering very specific questions well, rather than more diffuse
775 questions less well.⁸²⁻⁸⁴

776

777 We also found that many interventions were very poorly described. Guidance is now
778 available on describing interventions, and intervention components, to facilitate
779 replication and syntheses.^{68, 85} Researchers and journal editors should make greater
780 efforts to ensure more consistent use of these tools.

781

782 Finally, whilst we found some evidence of differential effects of interventions across
783 population sub-groups, such analyses were mostly absent. Many evaluation studies
784 may have been under-powered to explore such effects. However, there is good
785 theoretical, and growing empirical, evidence that some interventions – particularly
786 those lower down the Nuffield Ladder – are likely to be less effective in those with
787 fewer access to resources.^{71, 75-78} Researchers should consider where differential
788 effects may be most likely to occur and design evaluations in such a way that they
789 are able to draw firm conclusions on whether or not such effects occurred.

790

791

792 **CONCLUSIONS**

793 Most interventions identified focused on providing information aimed at adults in US
794 fast-food chains and collected only customer level outcomes; some of these
795 interventions included a function of enabling choice. Overall, most studies were of
796 low or moderate quality. More 'intrusive' interventions which restricted or guided
797 choice generally showed a positive impact on food outlet and customer level
798 outcomes. However, interventions which simply provided information or enabled
799 choice had a negligible impact. Qualitative findings were reported for many studies,
800 particularly around acceptability and process, and these provide useful learning to
801 inform the development of interventions. Interventions involving incentives, and more
802 'intrusive' interventions (functions further up the Nuffield ladder, e.g. restrict choice,
803 'incentives') generally showed consistent positive effects on catering practices and
804 the energy value of foods purchased by customers.

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1049 **Table 2 Adapted typology of study designs and quality**

Study design	Study design quality score
Repeat cross-sectional	Weak
Repeat cross-sectional with control	Moderate
Repeat cross-sectional with cohort subgroup	Moderate
Cohort	Moderate
Repeat cross-sectional with control and controlled cohort subgroup	Strong
Controlled before-after (same participants)	Strong
Controlled trial	Strong

1050

Table 2a Summary of included studies with customer level outcomes (n=23)

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔↓ (global quality assessment score) ²
Trans fat law (n=1)							
Angell 2012 ^{38**}	Repeat cross-sectional	11 fast-food chains, NYC, USA	Restrict choice	Environmental restructuring	Environmental/social planning; legislation	5	↑ (moderate)
Changing pre-packed children's meal content (n=1)							
Wansink 2014 ⁴⁸	Repeat cross-sectional	McDonald's restaurants (fast-food chain), USA	Restrict choice	Environmental restructuring	Environmental/social planning; communication/marketing	3	↑ (weak)
Price increases for unhealthier choices (n=2)							
<i>Price increases for unhealthier choices only</i>							
Shah 2014 ⁶⁰ (<i>sin tax menu arm</i>)	Controlled clinical trial	One moderately priced restaurant, which specialised in 'small plates' to share, USA	Guide choice (disincentives)	Coercion	Fiscal	5	↓ (strong) unhealthy items ordered by men and women
<i>Price increases for unhealthy choices + signposting</i>							
Shah 2014 ⁶⁰ (<i>unhealthy label + sin tax menu arm</i>)	Controlled clinical trial	One moderately priced restaurant, which specialised in 'small plates' to share, USA	Guide choice (disincentives)	Environmental restructuring; education; coercion	Communication/marketing; environmental/social planning; fiscal	5	↑ (strong) decrease in unhealthy items ordered by men and women
Incentives (contingent rewards) (n=1)							
Reimann 2015 ⁵⁴	Cohort	Chain sandwich restaurant, USA	Guide choice (incentives)	Incentives	Unclear (customers)	7	↑ (moderate) customers

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔ (global quality assessment score) ²
					offered half portions for same price as full portion, plus a lottery ticket)		choosing half sized portions
Price reductions for healthier choices (n=2)							
<i>Price reduction for healthier choices only</i>							
Horgen & Brownell 2002 ⁵⁸	Controlled clinical trial	Delicatessen-style restaurant (cafeteria), USA	Guide choice (incentives)	Incentives	Fiscal	6	↑ (weak) healthy food purchase
<i>Price reduction for healthier choices + health promotion</i>							
Horgen & Brownell 2002 ⁵⁸	Controlled clinical trial	Delicatessen-style restaurant (cafeteria), USA	Guide choice (incentives)	Environmental restructuring; education; incentives; persuasion; enablement	Communication/marketing; environmental/social planning; fiscal	6	↑ (weak) healthy food purchase
Signposting (n=8)							
<i>Signposting only</i>							
Shah 2014 ⁶⁰ (<i>unhealthy label menu arm</i>)	Controlled clinical trial	One moderately priced restaurant, which specialised in 'small plates' to share, USA	Enable choice	Environmental restructuring; education	Communication/marketing; environmental/social planning;	5	↓ (strong) decrease in unhealthy items ordered
Eldridge 1997 ⁴¹	Repeat cross-	Food service areas of large discount department	Enable choice	Environmental restructuring;	Communication/marketing;	6	↓ (weak) sales of 'healthier' food

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔↓ (global quality assessment score) ²
	sectional	store chain, USA		education	environmental/ social planning;		items
Pandya 2013 ⁴⁶	Repeat cross-sectional	Latino family-owned restaurants, Kansas, USA	Enable choice	Environmental restructuring; education	Communication/ marketing; environmental/ social planning	7	↓ (weak) healthy food purchases
<i>Sign posting + menu changes</i>							
Nothwehr 2013 ⁴⁵	Repeat cross-sectional	Non-chain owner-operated full menu, sit-down restaurants with typical Midwestern fare, Iowa, USA	Enable choice	Environmental restructuring; education	Communication/ marketing; environmental/ social planning;	8	↓ (weak) healthy food purchases
Lee-Kwan 2013 ⁵⁹	Controlled clinical trial	Non-franchised small local food establishments that sell ready-to-eat food and beverages for off-premise consumption, Baltimore, USA	Enable choice	Environmental restructuring; education; incentives	Communication/ marketing; environmental/ social planning;	8	↑ (moderate) healthy food purchases
<i>Signposting + health promotion/social marketing campaign</i>							
Fitzgerald 2004 ⁴²	Repeat cross-sectional	Community restaurants varied from counter service to table-service, USA	Enable choice	Environmental restructuring; education; persuasion	Communication/ marketing; environmental/ social planning;	6	↓ (weak) sales of 'heart healthy' menu items
Acharya 2006 ³¹	Repeat cross-sectional with control	Restaurant chains (fine-dining and moderately priced, family-style restaurants (Mexican,	Enable choice	Environmental restructuring; education; incentives;	Communication/ marketing; environmental/ social planning;	6	↑ (moderate) healthy food purchases

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔ (global quality assessment score) ²
		upscale pizza, and 40s-style diner), California, USA		persuasion			
Horgen & Brownell 2002 ⁵⁸ (<i>health promotion condition</i>)	Controlled clinical trial	Delicatessen-style restaurant (cafeteria), USA	Enable choice	Environmental restructuring; education; persuasion; enablement	Communication/marketing; environmental/social planning	6	↑ (weak) healthy food purchase
Calorie labelling law (n=10)							
<i>Calorie labelling law only</i>							
Bollinger 2011 ³³	Repeat cross-sectional with control plus subgroup cohort	Starbucks Cafes, New York City (NYC), USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	5	↑ (strong)
Chen 2015 ³⁹	Repeat cross sectional	Regulated chain or fast food restaurants in King County, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	5	↑ (weak) saw and used calorie information
Dumanovsky 2011 ^{40**}	Repeat cross-sectional	11 fast-food chains, NYC, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning;	5	↓ (moderate)

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔↓ (global quality assessment score) ²
					legislation		
Krieger 2013 ^{43***}	Repeat cross-sectional, retrospective	Restaurants from 10 chains Subway; McDonald's; Taco del Mar; Taco Time; Starbuck's; Quizno's; Tully's; Jack in the Box; Burger King; Taco Bell. King County, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	4	↓ (moderate)
Namba 2013 ³⁷	Repeat cross-sectional with control	Large chain fast food restaurants, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	3	↔ (strong) adults and children
Elbel 2009 ³⁴	Repeat cross-sectional with control	Chain restaurants with >15 establishments - McDonald's, Burger King, Wendy's, KFC in NYC, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	4	↔ (moderate) adults and children
Elbel 2013 ³⁵	Repeat cross-sectional (pre and post legislation) with control	Fast food restaurants (McDonald's and Burger King) in Philadelphia (which implemented calorie labelling policies) and Baltimore (which did not and acted as a	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	5	↔ (moderate)

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔↓ (global quality assessment score) ²
	cohort (<i>difference in difference design</i>)	matched comparison city), USA					
Finkelstein 2011 ³⁶	Repeat cross-sectional with control	Mexican fast-food restaurant chain - Taco Time Northwest, King County, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	3	↔ (moderate)
Tandon 2011 ⁵⁵	Controlled before and after study (same participants)	Chain restaurants, King County, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	4	↔ (weak) children
<i>Calorie labelling law + nutritional recommendation information</i>							
Downs 2013 ⁵⁷	Controlled clinical trial	2 McDonalds restaurants in NYC, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning;	4	↔ (moderate)
<i>Voluntary calorie labelling (n=1)</i>							
Pulos & Leng 2010 ⁴⁷	Repeat cross-sectional	Full service locally owned (non-chain) restaurants; 'casual, midrange', USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning	6	↑ (weak) energy, fat and sodium levels of foods purchased
<i>Personalised receipts (n=1)</i>							
Bedard & Kuhn 2013 ³²	Repeat cross-	Burgerville restaurants (fast-food chain),	Provide information	Environmental restructuring;	Communication/marketing	4	↔ (weak)

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔↓ (global quality assessment score) ²
	sectional with control	California, USA		education; persuasion			

¹ Implementation score was determined using a checklist for obesity related interventions²⁵ adapted from workplace interventions²⁶

²energy purchased unless otherwise stated, Key: effective (↑); equally effective as comparison group (↔); effectiveness mixed by outcome or gender (↓); or not effective (↓); **Dumanovsky 2011 and Angell 2012 used same data set; ***Krieger 2013 used the same data set as Saelens 2012 (food outlet level outcomes, Table 3)

Table 2b Summary of included studies with food outlet level outcomes (n=7)

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↕↔↑ (global quality assessment score)
Award schemes (n=2)							
Gase 2015 ⁵²	Cohort	Licensed retail restaurants, Los Angeles County, USA	Restrict choice	Restriction; Environmental restructuring	Regulation; Environmental/social planning	6	↑ (weak) reduced-sized portions available and 'healthier' children's meals
Bagwell 2014 ⁵⁰	Cohort	Small independent catering outlets, London, UK	Restrict choice	Restriction; Environmental restructuring; Education	Communication/marketing; Regulation; Environmental/social planning	2	↑ (weak) 'healthy' criteria met by businesses (inc. catering practices, 'healthy' options, health promotion)
Signposting (n=1)							
<i>Signposting + health promotion/social marketing campaign</i>							
Hanni 2009 ⁵³	Cohort	Taquerias - privately owned, fast-food-style Mexican restaurants, USA	Enable choice	Environmental restructuring; education; incentives; persuasion; enablement; training; modelling	Communication/marketing; environmental/social planning; guidelines	9	↑ (weak) promoting 'healthier' food items
Telemarketing of healthy food choices (n=2)							
Wiggers 2001 ^{49**}	Repeat cross-	Licensed hotels, clubs and nightclubs, New South	Enable choice	Education	Communication/marketing;	6	↑ (weak) serving healthier food

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔ (global quality assessment score)
	sectional plus subgroup cohort	Wales, Australia			environmental/social planning; service provision		options
Licata 2002 ^{44**}	Repeat cross-sectional plus subgroup cohort	Restaurants and cafés, New South Wales, Australia	Enable choice	Education	Communication/marketing; environmental/social planning; service provision	6	↓ (weak) nutrition-related health promotion practices
Calorie labelling law (n=2)							
<i>Calorie labelling law only</i>							
Bruemmer 2012 ⁵¹	Cohort	Chain restaurants with >4 establishments (sit down and fast food). Burgers (e.g., McDonalds, Burger King), pizza (e.g., Pizza Hut, Dominos), sandwich/sub (e.g., Subway, Blimpie), or Tex-Mex (e.g., Taco Time, Taco del Mar). King County, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning; legislation	3	↑ (weak) energy content of main meals
Saelens 2012 ^{56***}	Controlled before and after study (retrospecti	Fast food chain restaurants, King County, USA	Provide information	Environmental restructuring; education	Communication/marketing; environmental/social planning;	4	↔ (strong) 'healthfulness' of adult and children's menus

Study ID	Study design	Food outlet type	Nuffield intervention ladder	Intervention function	Policy category	Implementation score ¹	Summary impact ↓↑↔↓ (global quality assessment score)
	ve)				legislation		

¹ Implementation score was determined using a checklist for obesity related interventions²⁵ adapted from workplace interventions²⁶

Key: effective (↑); equally effective as the comparison group (↔); effectiveness mixed by outcome or gender (↓); or not effective (↓)

Licata 2002 and Wiggers 2001 used same data pool and split by different settings; *Saelens 2012 used the same data set as Krieger 2013 (customer level outcomes, Table 2)