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1 Effective behaviour change techniques in the prevention and management of childhood  
2 obesity

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5 Jilly Martin, PhD

6 Department of Psychology, University of Sheffield

7

8 Angel Chater, PhD

9 School of Pharmacy, University College London

10

11 Fabiana Lorencatto, MSc

12 Department of Clinical, Educational & Health Psychology, University College London

13

14 Address for correspondence:

15 Dr Jilly Martin

16 Department of Psychology

17 University of Sheffield

18 Western Bank

19 Sheffield

20 S10 2TN

21 Email. [jilly.martin@sheffield.ac.uk](mailto:jilly.martin@sheffield.ac.uk)

22 Tel. (+0044) 114 2226513

23

24

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## Abstract

26 Rates of childhood obesity are increasing, and it is essential to identify the active components  
27 of interventions aiming to prevent and manage obesity in children. A systematic review of  
28 behaviour change interventions was conducted to find evidence of behaviour change  
29 techniques (BCTs) that are most effective in changing physical activity and/or eating  
30 behaviour for the prevention or management of childhood obesity. An electronic search was  
31 conducted for Randomised Controlled Trials (RCTs) published between January 1990 and  
32 December 2009. Of 4,309 titles and abstracts screened, full texts of 135 articles were  
33 assessed, of which 17 published articles were included in this review. Intervention  
34 descriptions were coded according to the behaviour-specific CALO-RE taxonomy of BCTs  
35 (1). BCTs were identified and compared across obesity management ( $n = 9$ ) vs. prevention ( $n$   
36  $= 8$ ) trials. To assess the effectiveness of individual BCTs, trials were further divided into  
37 those that were effective (defined as either a group reduction of at least 0.13 BMI units or a  
38 significant difference in BMI between intervention and control groups at follow-up) vs. non-  
39 effective (reported no significant differences between groups).

40 We reliably identified BCTs utilised in effective and non-effective prevention and  
41 management trials. To illustrate the relative effectiveness of each BCT, effectiveness ratios  
42 were calculated as the ratio of the number of times each BCT was a component of an  
43 intervention in an effective trial divided by the number of times they were a component of all  
44 trials. Results indicated six BCTs that may be effective components of future management  
45 interventions (provide information on the consequences of behaviour to the individual,  
46 environmental restructuring, prompt practice, prompt identification as role model/position  
47 advocate, stress management/emotional control training, and general communication skills  
48 training), and one that may be effective in prevention interventions (prompting generalisation  
49 of a target behaviour). We identified that for management trials, providing information on the

50 consequences of behaviour in general was a feature of non-effective interventions and for  
51 prevention trials, providing information on the consequences of behaviour in general,  
52 providing rewards contingent on successful behaviour and facilitating social comparison  
53 were non-effective.

54 To design effective behaviour change programmes for the prevention and  
55 management of childhood obesity, we would recommend utilising the BCTs identified as  
56 effective in this review. The impact on intervention effectiveness of combining BCTs should  
57 be the topic of further research.

58

59	<i>Key words</i>
60	Childhood Obesity
61	Prevention
62	Management
63	Behaviour Change Techniques
64	Taxonomy
65	Effectiveness

66 Effective behaviour change techniques in the prevention and management of childhood  
67 obesity

68

69 Introduction

70 Given the dramatic rise in childhood obesity over the last decade (2-4), it is essential to  
71 design interventions that are effective in preventing and managing childhood obesity.

72 Behaviour modification or lifestyle change has become a burgeoning avenue of investigation  
73 in this area. Systematic reviews of interventions and clinical guidelines clearly indicate that  
74 successful interventions for preventing and managing obesity in children are complex and  
75 multi-component - aimed at changing both physical (or sedentary) activity and diet or healthy  
76 eating (e.g., 5-9) and comprise multiple, potentially interacting methods of changing  
77 behaviour. Despite the vast amount of active investigation in this area, little research has  
78 deconstructed interventions and identified which individual components are most successful  
79 in changing obesity-related health behaviour in children. A lack of consistent terminology for  
80 defining intervention components has also hindered interpretation and replication. It is  
81 currently unclear what the active ingredients for bringing about obesity-related behavioural  
82 change are and thus, evidence to support the content of effective obesity prevention and  
83 management interventions in children is still relatively weak (5, 10-12).

84 There is no lack of evidence that positive changes in behaviours linked to obesity can  
85 be effective in preventing and managing obesity in children. Hill, Wyatt, Reed and Peters  
86 (13) report that even small changes in behaviour that amount to a decrease in calorie intake of  
87 only 100Kcal per day can effectively prevent weight gain. Randomised Controlled Trials  
88 (RCTs) of lifestyle interventions have reported moderate success in changing obesity-related  
89 behaviour in prevention trials (5) and produce potentially clinically significant reductions in

90 overweight in management trials (7, 14). It is important that these positive findings can be  
91 replicated, thus, there is clear value in identifying the specific behaviour change techniques  
92 (BCTs) used in such interventions that are effective in achieving and sustaining behavioural  
93 change. The complex and multi-component nature of such interventions further underlines  
94 the need for developing methods to systematically deconstruct intervention content. This is a  
95 particularly imperative task for the successful prevention and management of obesity in  
96 childhood and adolescence, as it is important to identify specific BCTs that are particularly  
97 effective for this age group that may be distinct from those used in adult interventions. There  
98 may also be an important distinction between BCTs that are effective in preventing childhood  
99 obesity and those that manage obesity in children who are already overweight or obese.

100 Formally evaluating the content of interventions is inherently difficult. Recent  
101 guidelines in the field of health psychology aim to establish more open and detailed reporting  
102 of interventions to aid the scientific development of behaviour change interventions  
103 (CONSORT, 15; Workgroup for Intervention Development and Evaluation Research:  
104 WIDER, 16), though these are not universally adhered to and current reporting of  
105 intervention content is generally poor and inconsistent (17), thus limiting what we can learn  
106 about behaviour change (18).

107 Categorising the components of behaviour change interventions in the field of  
108 childhood obesity is complex and attempts to define BCTs are generally idiosyncratic (and  
109 potentially non-replicable). For example, some authors have developed their own  
110 classifications for extracting such data: Kamath et al. (5) extracted data concerning  
111 “informational, cognitive, behavioural, environmental and social support components”  
112 (p4607) of interventions, and Sargent, Pilotto and Baur (19) extracted information on  
113 “strategies to achieve behaviour change” (p4). Such classifications lack the benefit of precise  
114 and standard definitions that allow authentic replication and useful comparisons of BCTs

115 across intervention trials. More wholesome descriptions of common behaviour change  
116 methods in obesity interventions do exist (see e.g., 6, 20, 21) but it is not always clear how  
117 (or if) these descriptions apply to interventions aimed at children.

118 As part of the advancement of a science of behaviour change, Abraham and Michie  
119 (22) developed a taxonomy of 26 conceptually distinct component BCTs, which are  
120 described using consistent terminology and standard definitions. This taxonomy has been  
121 reliably applied to identify and categorise BCTs featured in obesity prevention programmes  
122 involving parents and children (23) and in healthy eating and physical activity interventions  
123 with adults (24). More recently, the original taxonomy (22) has been revised and extended  
124 into a behaviour specific taxonomy of 40 BCTs for physical activity and healthy eating  
125 behaviours (CALO-RE: 1). The CALO-RE taxonomy was developed by three teams of  
126 researchers to provide standard definitions to reliably identify techniques used for 1)  
127 increasing physical activity and healthy eating in obese adults with additional risk factors for  
128 morbidity, and 2) increasing self-efficacy to promote lifestyle and recreational physical  
129 activity. A total of 72 studies across a variety of populations, behaviours and settings were  
130 used as a basis of developing the taxonomy. The authors argue that the CALO-RE taxonomy  
131 is more comprehensive than the original, with fewer conceptual problems and less overlap  
132 between items, as well as clearer labels and definitions. This taxonomy can be used to  
133 analyse the content of behaviour change interventions in depth and also provides a means of  
134 improving reporting and aiding replication attempts by specifying BCTs. For the purposes of  
135 this review, this taxonomy was used to identify BCTs in physical activity and healthy eating  
136 interventions for the prevention and management of childhood obesity. To our knowledge,  
137 this taxonomy has not yet been applied to obesity-related behaviour change interventions  
138 with children and adolescents.

139 We conducted a systematic review to select RCTs of childhood obesity interventions  
140 that utilised BCTs as a means to prevent or manage obesity in children and adolescents. From  
141 this, we coded intervention descriptions using the CALO-RE taxonomy to identify BCTs that  
142 were used in such interventions. In order to work towards aiding intervention designers in the  
143 field to build effective BCTs into childhood obesity interventions, this paper aims to 1)  
144 identify and code BCTs used in a sample of prevention and management interventions for  
145 childhood obesity using the CALO-RE taxonomy, and 2) establish which individual BCTs  
146 are components of effective interventions to manage and prevent childhood obesity.

147

148 Method

149 *Study selection*

150 A systematic review was conducted of RCTs of obesity management or prevention  
151 conducted with children and adolescents (aged 2-18 years) that assessed the impact of  
152 interventions including at least one BCT from the CALO-RE taxonomy compared with a no-  
153 treatment control group. Interventions that solely tested the impact of physical activity,  
154 education, and/or calorie controlled diets with no behaviour change element were excluded,  
155 as were interventions that combined drug treatment or surgery with BCTs. Interventions  
156 could be carried out in any setting (e.g., school, clinic, community) and be delivered by any  
157 professional (e.g., health professional, teacher, therapist) over any length of time. It is  
158 important that desired health outcomes are maintained over time therefore to assess the  
159 maintenance of intervention effects; we selected only interventions that reported results 6  
160 months beyond the point when active intervention ended. The Transtheoretical Model (TTM:  
161 25) argues that long term changes in behaviour may be assessed only after this time period  
162 has elapsed. The primary outcome measure was Body Mass Index (BMI). BMI is the only  
163 indirect measure of adiposity in childhood that has been shown to be associated with future

164 risk of mortality from Coronary Heart Disease (CHD) in adulthood (11) and can be used as a  
165 physiological proxy measure of later health outcomes (26-28). BMI was also the only single  
166 comparative outcome reported across trials.

### 167 *Search Strategy and results*

168 An electronic search was conducted in the following electronic databases:  
169 MEDLINE, EMBASE, PsycINFO, Cochrane library (Cochrane Central Register of  
170 Controlled Trials), HMIC (Health Management Information Consortium), AMED (Allied and  
171 Complementary Medicine Database), and CINAHL (Cumulative Index to Nursing and Allied  
172 Health Literature) for Randomised Controlled Trials published between January 1990 and  
173 December 2009. Search terms (available as a supplementary electronic file) covered the  
174 concepts of ‘obesity’ ‘children’ ‘behaviour change interventions’ and ‘BMI’ and closely  
175 followed the search strategies of similar reviews (e.g., 5, 7) and published guidelines for  
176 identifying randomised controlled trials (29).

177 One reviewer (JM) screened 4,333 unique titles and abstracts for eligibility and a  
178 second reviewer (AC) screened a random (10%) sample of records, yielding 100% agreement  
179 between reviewers. After initial screening of title and abstract, full texts of 135 potentially  
180 relevant studies were screened for eligibility independently by the two reviewers. Three  
181 unpublished dissertations were unavailable for further screening and were excluded. We  
182 explored unpublished literature and received a good response from experts, but no further  
183 studies were included in the review from these avenues. Agreement regarding inclusion  
184 between reviewers was 70%, and disagreements were resolved through careful discussion.  
185 Seventeen published manuscripts were included in this review (30-46). The selection process  
186 for studies is presented in Figure 1.

187

188

189 *Coding of Behaviour Change Techniques*

190 To obtain more complete intervention descriptions and assist data extraction for  
191 BCTs, where intervention protocols were published or available elsewhere, the manuscript  
192 was located ( $n = 11$ ; 47-57) and the intervention characteristics were coded from both  
193 sources. The authors of the further 6 intervention studies were contacted (on up to two  
194 occasions) with a request for copies of the corresponding intervention protocol or any  
195 additional documents detailing the intervention content. Three authors did not reply; one  
196 author could not locate the original protocol; one author informed us that the protocol was  
197 available in Finnish language only, and another author provided further details of the  
198 intervention mechanisms, published elsewhere on which the intervention characteristics were  
199 coded.

200 The content of interventions was assessed by two reviewers (JM & AC) who  
201 independently coded the descriptions of each intervention using the CALO-RE taxonomy (1)  
202 for inclusion of BCTs. Intervention descriptions were read line-by-line and assigned a BCT  
203 label from the taxonomy where appropriate. A stringent coding method was applied so that in  
204 cases where further information was required to assess whether a BCT was present or absent,  
205 it was coded as absent. We chose not to seek further clarification from the authors, as we  
206 wanted to assess published information only.

207 The two coders practised coding on eight intervention studies not selected for the  
208 review, and discussed disagreements. All interventions were then coded independently and  
209 inter-rater reliability, assessed using percent agreement, was high (93%). Disagreements  
210 between the coders were discussed at length and a final decision on which BCTs were  
211 assigned to interventions was agreed. Based on the nature of disagreements, we refined BCTs  
212 in the taxonomy (see electronic supplementary material, Table 1 for a summary of our  
213 revisions to the CALO-RE taxonomy). To summarise the revision process, we took the

214 following steps: 1) we revised descriptions of techniques where agreement was reduced due  
215 to misapplication of the code; 2) we added examples specific to our sample of childhood  
216 obesity trials within technique definitions; 3) we clarified the difference between similar  
217 codes where we had encountered disagreements; and 4) one additional technique was  
218 identified and defined. We verified that the revised taxonomy was also effective in  
219 categorising BCTs in the same set of papers by having a third independent coder (FL) repeat  
220 the coding task using the revised taxonomy. Agreement remained high (88%) showing that  
221 these constructs exist independently in the selected set of papers.

222

### 223 *Assessing intervention and BCT effectiveness*

224 We divided coded interventions into those that aimed to prevent ( $N = 8$ ) vs. manage  
225 ( $N = 9$ ) childhood obesity. Prevention trials included both overweight and normal weight  
226 participants and management trials included overweight participants only.

227 We then divided up prevention and management trials into effective vs. non-effective  
228 using BMI outcome data. Effective management trials ( $N = 6$ ) were defined as trials in which  
229 the standardised difference in the mean value of BMI between groups at follow-up was at  
230 least  $\geq -0.13$  (this was the average effect size demonstrated from meta-analysis data, 58)  
231 Less stringent criteria were applied to prevention studies to take into consideration that not  
232 all of these trials targeted weight loss measured by a reduction in BMI. The criteria for  
233 assessing effectiveness in prevention trials was defined as a significant difference ( $p < .05$ ) in  
234 BMI at follow-up between groups ( $N = 4$ ).

235 To assess the effectiveness of BCTs, and to illustrate the relative weight of each BCT  
236 taking into consideration it potentially being a component of both effective and non-effective  
237 trials, a percentage effectiveness ‘ratio’ was calculated as the ratio of the number of times

238 each BCT was a component of an intervention in an effective trial divided by the number of  
239 times they were a component of all trials, including non-effective trials.

240 Results

241 First, we present the BCTs coded in effective and non-effective prevention and management  
242 interventions. Second, we present differences in BCTs and effectiveness ratios between  
243 effective and non-effective interventions for prevention and management trials.

244 *BCTs in effective and non-effective prevention and management interventions*

245 Out of the 40 BCTs in the taxonomy, we agreed that there was no (or insufficient)  
246 evidence that 11 of them were present in any of the interventions (representing 100%  
247 agreement between coders). For the remaining 29 BCTs, inter-rater reliability was good (59)  
248 for 17 (average kappa value = 0.71 [range = .485 to 1.00], average percentage agreement =  
249 92% [range = 71% to 100%]) and sub-optimal for the remaining 12 due to missing data and  
250 low counts of instances of BCTs across the studies. In the light of this, disagreements were  
251 discussed at length between the coders before final codes were applied. The coders also  
252 agreed a new code which was added to the CALO-RE taxonomy (Exposure to healthy  
253 choices) from our revisions ( $n = 41$  BCTs in total in revised CALO-RE taxonomy). This BCT  
254 was encountered as an additional method of achieving behaviour change within the pool of  
255 studies (see the supplementary file). The coding exercise did not identify any BCTs in any of  
256 the control groups.

257 Table 1 presents BCTs (and their frequency) coded in effective and non-effective  
258 prevention and management trials. BCTs that were unique features of management trials (i.e.,  
259 were not used in prevention trials) were: Prompt review of behavioural goals, relapse  
260 prevention/coping planning, shaping, provide information on where and when to perform the  
261 behaviour, environmental restructuring, prompt self-talk and motivational interviewing.  
262 BCTs that were unique to prevention trials were: Provide normative information about

263 others' behaviour, prompt rewards contingent on effort or progress towards behaviour, action  
264 planning, provide feedback on performance, teach to use prompts/cues, and facilitate social  
265 comparison.

266

### 267 *Effective BCTs in obesity management*

268 All but three out of the nine obesity management interventions selected for review  
269 were effective according to our criteria (30-32, 40, 42, and 43). An average of 7.5 (range = 3-  
270 15) BCTs from the CALO-RE taxonomy were identified at least once across these  
271 interventions (effective and non-effective) and there was little difference in mean number of  
272 BCTs coded in effective ( $M = 8$ ) vs. non-effective ( $M = 7$ ) interventions. Twenty-four out of  
273 41 (59%) BCTs were identified in at least one of the interventions. Thirteen of these  
274 techniques were unique to effective trials, two were unique to non-effective interventions and  
275 nine appeared at least once in both effective and non-effective trials. Figure 2 presents the  
276 ratio of effectiveness for BCTs appearing two or more times in trials. In order that the ratio  
277 was meaningful and to be satisfied that there was 'evidence' of effectiveness for individual  
278 BCTS, we required that a BCT must be a feature of two or more trials, therefore the five  
279 unique BCTs appearing only once in effective trials were excluded. These criteria have been  
280 used in previous studies assessing BCT effectiveness (60, 61). Six BCTs achieved 100%  
281 effectiveness ratios (Provide information on consequences of behaviour to the individual,  
282 Environmental restructuring, Prompt identification as role model/position advocate, Stress  
283 management/Emotional control training, General communication skills training and Prompt  
284 practice) and one BCT (Provide information on consequences of behaviour in general) had a  
285 100% non-effective ratio.

286

287



313 identified as uniquely effective (i.e., achieved 100% effectiveness ratios) in obesity  
314 management interventions and one BCT for obesity prevention interventions. Effectiveness  
315 ratios also demonstrated BCTs that were components of non-effective trials. One BCT was  
316 identified as uniquely non-effective for obesity management interventions and three BCTs for  
317 prevention interventions.

318         There is currently little evidence supporting the inclusion (or not) of BCTs in  
319 childhood obesity programmes. It is unknown in particular, 1) whether individual BCTs are  
320 more effective in the prevention or management of obesity, 2) whether (and how) the content  
321 of programmes may differ to those applied to adults, and 3) if particular BCTs may be more  
322 or less effective when applied to specific target groups (e.g., parents vs. children) or  
323 intervention modes (e.g., delivered in school vs. hospital). The only general guidance of this  
324 nature we have identified was included in the UK National Institute for Health and Clinical  
325 Excellence (NICE) guidance on the prevention, identification, assessment and management  
326 of overweight and obesity in adults and children (9). BCTs such as self-monitoring, goal  
327 setting and providing rewards are recommended in this guidance and no further information  
328 is offered in relation to the above issues. In our sample of papers, we found inconclusive  
329 evidence that self-monitoring and goal setting were consistently effective techniques in both  
330 prevention and management trials. Our findings suggest that providing rewards was actually  
331 ineffective for obesity prevention. The potential difference in content between programmes  
332 aimed at adults vs. children, and the effectiveness of BCTs applied to particular groups or  
333 modes of intervention delivery are important topics of further research in this area. From our  
334 work here however, we would recommend intervention designers in the field build into  
335 interventions the BCTs shown here in relation to specific prevention and management  
336 programmes for children and adolescents.

337           There are a number of issues we would like to highlight from this review. First,  
338 formally defining the content of trials is inherently problematic due to reporting  
339 inconsistencies and differences in terminology which may have resulted in providing an  
340 incomplete picture of some interventions and potentially led to exclusion of eligible studies  
341 in the selection stages of this review. We applied a stringent coding strategy where BCTs  
342 were not coded as present if there was insufficient description, therefore it may be the case  
343 that we coded as absent techniques that the authors of the intervention would argue were  
344 present. This issue has been identified in previous attempts to categorise intervention content  
345 (21). To advance and implement a science of behaviour change in the field of childhood  
346 obesity, we would echo calls for improving the quality of reporting of trials (15-18).  
347 Likewise, given that only a small pool of studies reached our stringent criteria, we would  
348 acknowledge the need for more studies in this field that are conducted as RCTs, contain  
349 control conditions, and report data at least 6 months after the intervention has ended.

350           Second, this is the first time to our knowledge that the CALO-RE taxonomy has been  
351 applied to interventions for children, and we made a number of revisions to the descriptions  
352 of BCTs. The authors of the original taxonomy themselves identify that the development of  
353 behaviour-specific taxonomies is an iterative process and revisions are inevitable and indeed  
354 welcome (1). However, we would stress that, even with our revisions, the CALO-RE  
355 taxonomy may not characterise every strategy used in childhood obesity interventions. In a  
356 larger sample, we would anticipate that the CALO-RE taxonomy may be revised further, and  
357 new BCTs added. For this reason, we would not recommend discarding BCTs in the CALO-  
358 RE taxonomy that we agreed were not present in any of the interventions in this review.

359           The third issue relates to the ability to isolate and assess the effect of individual BCTs  
360 in interventions. Our findings are limited to the impact of individual BCTs and we did not  
361 assess the effect of combinations of BCTs. We therefore cannot assess whether BCTs

362 demonstrated to be individually effective did not contribute to effective outcomes only as a  
363 combination, or whether, when combined differently, their effectiveness would alter. It is  
364 worth noting that the BCTs we have shown to be non-effective may well prove to be  
365 effective in (alternative) specific combinations, or applied to specific populations or different  
366 modes of intervention delivery. Dumbrowski et al. (62) assessed the effect of combining  
367 theory-congruent clusters of BCTs on outcomes of behaviour change interventions with  
368 obese adults and found that interventions that included BCTs congruent with Control Theory  
369 were associated with an increase in weight loss. Exploring combinations of BCTs according  
370 to other theories of behaviour change may also prove fruitful, for example, goal setting might  
371 be more effectively paired with action planning to enable the initiation and enactment of  
372 behavioural change according to the theory of implementation intentions (63). Our findings  
373 demonstrate the BCTs we have the best available evidence possible for, but this should not be  
374 at the expense of investigating other BCTs, individually or in combination. Evidence  
375 demonstrates that the most successful interventions contain combinations of BCTs therefore  
376 addressing these issues is of prime importance.

377         Finally, we would like to comment on the clinical value of using BCTs as components  
378 of childhood obesity interventions, since the effects of our sample of studies reviewed here  
379 were variable and there is currently little consensus on the clinical reductions that may  
380 reasonably be expected from behavioural modification. Unfortunately, evidence suggests that  
381 the effects of interventions to promote healthy eating are variable (18), and this variability  
382 was reflected in our sample of trials, potentially limiting our findings in relation to effective  
383 vs. non-effective BCTs. Smaller effect sizes may be explained by our measurement time  
384 frame (i.e., at least 6 months after the intervention had ended) as we would anticipate that  
385 differences between intervention and control groups would diminish over this time period,  
386 after initial weight loss in intervention groups had stabilised. However, we would argue that

387 this pattern of weight loss (and subsequent gain or stabilising) represents an accurate picture  
388 of weight loss maintenance and it is essential to be clear about the impact of behaviour  
389 change interventions over time. Observed effect sizes for trials in this review were small, and  
390 our method of classifying trials as effective vs. ineffective may have limitations compared to  
391 other methods of assessing effectiveness. However, our findings clearly illustrate that the  
392 effectiveness of interventions is currently being hampered by the inclusion of BCTs that are  
393 ineffective in achieving clinically valuable reductions in BMI, and this may explain why such  
394 interventions fare so poorly in achieving (and maintaining) larger reductions in BMI over  
395 time. We have reflected on the clinical meaning of our observed effect sizes and concluded  
396 that although small, such unit reductions in BMI can be related to reduced risks of adverse  
397 health outcomes. A linear relationship between BMI in childhood and risk of CHD (64) and  
398 diabetes (65) in adulthood has been demonstrated, for example, and reductions in BMI also  
399 impact upon ‘secondary’ health outcomes such as cholesterol levels, blood pressure, and  
400 psychological well-being that exist along with obesity (66).

401         There is currently no clear evidence upon which to include (or not include) BCTs in  
402 successful childhood obesity prevention and management programmes. It is absolutely  
403 essential to develop such knowledge so that intervention designers in the field can apply  
404 these findings to practice. We outline here a novel approach for establishing the effectiveness  
405 of BCTs in childhood obesity interventions: this is the first study of its kind (to our  
406 knowledge) in this behavioural domain to relate BMI outcomes at 6 months to intervention  
407 content.

408         We have outlined a number of issues remaining to be addressed; however, the  
409 methods used in this review represent an important first step towards establishing a method  
410 by which it is possible to distinguish between effective and non-effective components of  
411 interventions. The results of this study offer the first evidence for the inclusion of effective

412 BCTs in childhood obesity prevention and management programmes, and may contribute to  
413 our theoretical understanding of the mechanisms under-pinning obesity-related behaviour  
414 change. Identifying and utilising effective BCTs for childhood obesity interventions will aid  
415 the development of potentially more effective, replicable and targeted interventions, policies  
416 and guidelines for health professionals in the field, thus building a strong evidence-base to  
417 support obesity prevention and management in children.

418 Supplementary information is available at the journal's website

419 Conflict of interest statement: The authors have no conflicts of interest to declare

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615

616 *Table 1 Frequency of Behaviour Change Techniques coded in effective and non-effective*  
 617 *obesity prevention and management trials*

Behaviour Change Techniques	Prevention		Management	
	Effective	Non-effective	Effective	Non-effective
Provide information on consequences of behaviour in general	0	2	0	1
Provide information on consequences of behaviour to the individual	3	2	5	0
Provide normative information about others' behaviour	0	1	0	0
Goal setting (behaviour)	2	3	4	3
Action planning	0	1	0	0
Barrier identification	1	1	2	3
Set graded tasks	1	0	1	0
Prompt review of behavioural goals	0	0	3	1
Prompt rewards contingent on effort or progress towards behaviour	1	1	0	0
Provide rewards contingent on successful behaviour	0	2	3	3
Shaping	0	0	1	0
Prompting generalization of a target behaviour	2	0	1	0
Prompt self-monitoring of behaviour	4	3	3	1
Provide feedback on performance	1	1	0	0
Provide information on where and when to perform the behaviour	0	0	1	0
Provide instruction on how to perform the behaviour	1	2	3	2
Model/Demonstrate the behaviour	2	1	1	0
Teach to use prompts/cues	0	1	0	0
Environmental restructuring	0	0	3	0
Agree behavioural contract	1	0	1	3
Prompt practice	3	1	2	0
Facilitate social comparison	0	2	0	0
Plan social support/social change	2	3	2	1
Prompt identification as role model/position advocate	1	0	3	0
Prompt Self talk	0	0	1	0
Relapse prevention/coping planning	0	0	3	1
Stress management/Emotional control training	1	0	2	0
Motivational interviewing	0	0	0	1
General communication skills training	2	2	2	0
Exposure to healthy choices	1	1	1	0

618 Figure captions

619 *Figure 1 Flow chart of trials selected for review*

620

621 *Figure 2 Percentage effectiveness of Behaviour Change Techniques in obesity*

622 *management trials*

623

624 *Figure 3 Percentage effectiveness of Behaviour Change Techniques in obesity*

625 *prevention trials*





