

What makes opportunistic GP interventions effective? An analysis of behaviour change techniques used in 237 GP-delivered brief interventions for weight loss.

Abstract:

Background: Evidence shows that clinician-delivered brief opportunistic interventions are effective in obesity, and guidelines promote their use. However, there is no evidence on *how* clinicians should do this, and guidelines are not based on clinical evidence.

Purpose: A trial (BWeL) showed that brief opportunistic interventions on obesity that endorsed, offered, and facilitated referral to community weight management service (CWMS) led to 77% agreeing to, 40% attending, and significantly greater weight loss than control at 12 months. We assessed which behaviour change techniques (BCTs) doctors used that were associated with CWMS attendance.

Methods: We coded 237 recorded BWeL interventions using the [BCTTv1](#) taxonomy. We also coded the BWeL training video, to examine delivery of recommended BCTs. Mixed effects logistic regression assessed the association between each BCT, the total number of BCTs, and delivery of recommended BCTs, with patient's agreement-to-attend, and actual CWMS attendance.

Results: Of 237 patients, 133 (56%) agreed to attend, and 109 (46%) attended. 13 BCTs were used more than 8 times but none of the 13 were associated with increased attendance. One, 'practical social support', was significantly associated with increased patient agreement (OR=4.80, 95%CI=1.15, 20.13). Delivery of recommended BCTs and the total number of BCTs used were both associated with increased agreement (OR=1.56, 95%CI=1.09, 2.23 and OR=1.34, 95%CI=1.03, 1.75 respectively), but not attendance at CWMS (OR=1.20, 95%CI=0.98-1.47 & OR=1.08, 95%CI=0.94-1.24 respectively).

Conclusions: There is no evidence that particular BCTs increase the effectiveness of brief opportunistic interventions for obesity in adults. However, using more BCTs and delivery of recommended BCTs may increase agreement-to-attend community weight management services.

Key Words:

Brief Intervention; Behaviour change techniques; Taxonomy; Behaviour change interventions; Weight management; Primary care;

Introduction:

Guidelines recommend that clinicians use brief interventions to support patients with obesity to lose weight[1]. Brief interventions are an approach to motivating change on behaviours that are a current or potential future health risk, such as smoking, or lack of physical activity[2]. The activities that comprise brief interventions vary. They usually include raising the topic of the target behaviour and delivering brief advice, or signposting sources of support or information, including referral to specialist services. International guidelines on brief interventions for weight loss recommend offering opportunistic referral to effective behavioural services, including community weight management services (CWMS), to support patient weight loss[3–5]. These guidelines recommend that primary health care clinicians should identify adults who have a BMI>30, opportunistically discuss weight, and offer referral to effective behavioural services. In the UK, to be eligible as an NHS referral site, these services should include dietary advice, physical activity advice, and behaviour change components[6–8]. However, there is currently a lack of evidence to support these guidelines[9], and subsequently they provide vague and unspecific advice to support intervention delivery. The Canadian Task Force on Preventive Health Care, for example, states that clinicians should “Have a discussion with your patient, and offer or provide referral to structured behavioural interventions aimed at weight loss”[5] and the U.S. Preventive Services Task Force (USPSTF) merely states “Offer/provide this service”[4]. UK NICE guidelines are the most specific, comprising of two recommendations which advise clinicians to “Refer overweight and obese adults to Tier 2 weight management services” (recommendation 6), and to “address the expectations and information needs of adults thinking about attending” (recommendation 7)[3]. They also suggest how doctors should approach the intervention, including measuring BMI, and discussing this in the context of medical importance and benefits of weight loss[3].

Although there is evidence that attendance at these services results in weight loss[10], doctors report that they rarely initiate opportunistic brief interventions about weight management with their patients[11]. The literature indicates that doctors tend to avoid initiating conversations about weight[12], citing a lack of training as a significant barrier. For instance,

Foster et al. reported that less than 50% of doctors feel competent referring patients with obesity to weight management programmes[13]. To our knowledge there is no research into how doctors can make opportunistic interventions that optimise uptake of effective weight management programmes.

In this paper we examine audio-recorded doctor-delivered brief interventions from the intervention arm of the Brief Interventions for Weight Loss (BWeL) trial[10], where doctors endorsed, offered, and facilitated a free CWMS referral to consecutively attending adult patients with obesity who were not actively seeking to lose weight. In the BWeL trial, patients who were offered referral lost a mean of 2.4kg, 1.4kg more than the control group, and this effect was primarily mediated through attending an evidence-based weight management programme. Seventy-seven percent of participants agreed to attend the CWMS and 40% did so. Existing literature shows that this intervention, if implemented, would reduce overall NHS spend, and improve length and quality of life[14]. Doctors in the trial were trained to deliver the intervention with a training video, but were encouraged to deliver the content in their own way. Through identifying the type and frequency of the components that comprised an intervention, and their relationship to patient attendance behaviours it is possible to identify which intervention components were more effective. Identifying how doctors delivered brief interventions that were associated with increased agreement and attendance could generate an evidence base of effective practices that are likely to change patient behaviour. This could be used to inform guidelines and training to help doctors tailor their brief interventions to include these effective intervention components, optimising their effectiveness for changing behaviour.

The behavioural change techniques version one ([BCTTv1](#)) taxonomy[15] provides a robust framework to define components in interventions aiming to change behaviour. This taxonomy comprises 93 behaviour change techniques (BCTs). A BCT is “an observable, replicable, and irreducible component of an intervention designed to alter or redirect causal processes that regulate behaviour; that is, a technique is proposed to be an ‘active ingredient’”[15]. BCTs in the v1 taxonomy are clustered into 16 groups (domains) where the BCTs share similar mechanisms of change. Using this taxonomy to categorise intervention components can be useful for “synthesis, comparison, and replication of trials[16]”, as well as intervention reporting and development. The taxonomy is designed to be applicable to all behaviour change (for instance, it has previously been

used for smoking cessation[17], and healthy eating and physical activity interventions[18]), but can also be adapted to make it more specific to a particular intervention[16]. The BCTs used to deliver the intervention might have influenced the outcome of the consultation. If so, identifying them could guide clinical practice and future guidelines and intervention design.

There is a rich literature examining the use of BCTs in interventions aimed to encourage dietary and physical activity changes in adults with obesity. For example, evidence from a recent systematic review of 48 studies where adults received advice or counselling for overweight and obesity showed that ‘goal-setting’ and ‘self-monitoring of behaviour’ were effective intervention components in encouraging changes to diet or physical activity[18]. However, the intervention analysed in this study is novel it is very brief (designed to be delivered in 30 seconds) and aimed to encourage attendance at a CWMS where health behaviour change will be supported, rather than change diet and physical activity in and of itself. Although the [BCTTv1](#) taxonomy has been used in brief interventions focussing on reducing problematic alcohol use[19], as yet it has not been applied to very brief interventions for weight loss which incorporate the offer of referral to CWMS. Therefore, we do not yet know if and, if so *which*, BCTs are associated with with attendance behaviours at CWMS, and this is the evidence gap we plan to address. Subsequently, the main aim of this study was to assess whether the individual BCTs doctors used for intervention delivery were associated with agreement-to-attend, and attendance at CWMS.

Our secondary aim was to identify the association between the total number of BCTs incorporated into a very brief intervention and patient agreement and attendance. This is because there is currently mixed evidence showing that, in some interventions, increasing the total number of BCTs could also increase the potential for positive intervention results[18,20,21], but in others it may not[22–24]. The reason for this may depend on context, target-behaviour, or population. Therefore, as this is the first study to examine very brief advice incorporating the offer of referral to CWMS for adults with obesity, we do not currently know if increases in BCTs delivered through very brief advice will increase attendance at CWMS referrals. This analysis will enable to ascertain if use of more BCTs is associated with increased potential for positive intervention results in this particular context.

We also sought to assess the approach to the consultation recommended by NICE guidance[25]. The advice to assess a patient’s BMI, and then discuss this in the context of medical importance and benefits of weight loss (such as associations with current or future health problems) is in effect a combination of two BCTs – ‘biofeedback’ and ‘information about health consequences’.

Combining BCTs in this way might be more or less effective than using either on their own. We therefore planned to assess the BCTs these actions represent individually and in combination.

Finally, we aimed to investigate whether delivery of BCTs recommended in the 90-minute video mediated training that doctors were given was associated with increased patient agreement and attendance. This training was comprised of eight online modules which introduced: the rationale of the trial, evidence for the medical benefits of weight loss and the effectiveness of behavioural support to enhance weight loss, details of the mechanics and logistics of running the trial, and details of how to carry out the interventions in practice. These consisted of filmed, acted, consultations with a commentary. The aim was to support GPs to assimilate the skills necessary to deliver interventions confidently and to follow appropriate procedures. This was an aim because ours is the first study to examine BCTs used in very brief advice for weight loss, which incorporates the offer of referral. Identifying BCTs recommended in training, and examining which of these were actually delivered, and if additional BCTs were used, will enable to find out if the recommended BCTs increase positive intervention results and, if not, which BCTs may be likely to do so. This can provide evidence on if the existing training is effective and, if not, how to iterate the existing training resource to better incorporate effective BCTs, so that GPs can be trained to use effective strategies.

Methods:

Context and participants

In the BWeL trial intervention arm, 137 doctors offered 940 adult patients a free referral to CWMS. Half of these patient consultations (470) were chosen at random to be audio-recorded. Sessions were audio recorded by doctors who started recording at the point in the consultation where they delivered the BWeL intervention. However, some doctors did not record, or did not make an offer of referral. Some participants did not consent to be recorded, some recordings were rendered unusable for technical reasons, and some recordings were not uploaded as the researchers did not consider it a priority. This meant that of 470 potential recordings, a total of two-hundred and thirty-seven audio-recordings (50%) from 77 doctors at 37 different practices were available for these analyses.

The BWeL trial is registered with the ISRCTN Registry, number ISRCTN26563137 and further details are available in the trial protocol and report[26]. The methods and statistical analysis plan for this specific analysis were prespecified, and are publicly available[27].

Data analysis

BCT coding

We coded all transcripts of recorded BWeL consultations using the [BCTTv1](#) taxonomy[15]. All authors had completed training in using the [BCTTv1](#) taxonomy. The first twenty transcripts were independently coded by three authors (JB, CA, and KF). The coders then discussed how they coded each consultation, agreeing on definitions for each technique found in the data. Disagreements in coding decisions were resolved through discussion, and referral to Michie's coding guide[15]. The [BCTTv1](#) taxonomy is designed to be applicable to all behaviour change interventions. However, as with previously conducted analyses[28], we adapted the existing taxonomy to make it more relevant to this research. We added a new technique named "Additional Information" to better capture provision of information specifically about what would happen at the CWMS if the patient attended. This was defined as "Provide information over and above 'instruction on how to perform the behaviour'. This can include information about the social and behavioural content of referral," and seemed to be used to convince or persuade the patient who seemed initially unsure through providing further detail. Having agreed definitions within the team, each technique was clearly outlined with contextual examples in a codebook (Appendix 2) to promote consistency across the 237 consultations. Further details of our coding rules are available on the Open Science Framework[29]. The primary coder then coded all consultations, and the secondary and tertiary coders each coded twenty further transcripts at random to ensure that the predetermined definitions were adhered to, preventing coder drift. All of the coders were blinded to the patients' index of multiple deprivation (IMD) scores, age, gender and initial BMI, as well as their agreement and attendance at CWMS.

Statistical analysis

Outcomes were agreement-to-attend CWMS and actual attendance. We defined agreement as a positive reaction to the direct question of whether they were interested in attending. We classified positive reaction as an affirmative response (e.g. 'yes', or 'yes please'), or a display of 'marked positive stance[30]' (E.g. 'lovely', or 'that sounds good'). Patient attendance was defined as attending at least one of the CWMS sessions, as reported by the weight management service.

We prespecified potential confounders of the relationship between BCTs and outcomes. These were age, gender, body mass index (BMI) and Index of Multiple Deprivation (IMD) decile. IMD is the official measure of relative deprivation for areas in England[31].

Before looking at outcomes or building regression models we limited analyses to the 14 BCTs that doctors used in more than 3% of the consultations. This was an arbitrary cut-off designed to exclude infrequently used BCTs, for which we would be unable to get meaningful results. To guard against including collinear BCTs in regression models we examined correlations between all possible pairs of BCTs using the product-moment correlation coefficient. This coefficient ranges from 1 (perfect linear positive correlation) to -1 (perfect negative linear correlation) with 0 representing no correlation[32].

To examine the relationship between individual BCTs and our outcomes we first used univariate logistic regression. We then built mixed effects logistic regression models. These models included each of the 14 BCTs and the pre-specified potential confounders (age, sex, BMI and Index of Multiple Deprivation decile) as the fixed effects, and GP identifier as a random effects term.

NICE guidelines recommend measuring BMI, and discussing this, including stating the medical importance and benefits of weight loss[7]. It is possible that the combination of BCTs recommended by guidelines are more effective than BCTs used individually. To investigate this we then built a mixed effects model for each outcome using the same covariates and included a pre-specified interaction term between the BCTs ‘information about health consequences’ (relating a patient’s weight to a health condition) and biofeedback (providing numerical information about weight). Evidence of an interaction would mean the effect of using both of these together was greater (or less) than we would expect from examining them individually.

We then undertook sensitivity analyses to check the results from the main analyses were robust. We used two approaches to reduce the number of terms in the regression models. We used automated backwards stepwise elimination to reduce the number of terms in the models for each outcome. These fixed effects logistic regression models started with all the BCTs and covariates. The process was to remove the term with the largest p value, and then repeat the modelling, followed by dropping the next least significant variable. We applied a threshold, so variables with a p value of 0.1 or less were not removed from the model.

We also did a sensitivity analyses for each outcome by aggregating BCTs into their higher-level domains (such as ‘shaping knowledge’ or ‘goals and planning’). We undertook univariate logistic regression for each domain with each outcome. We examined BCT domains for pairwise correlation and then built mixed effects logistic regression models including all the domains, age, sex, BMI, and IMD decile and a random effects term for GP identifier.

To examine the association between the number of BCTs used and the outcomes we added up the number of BCTs used in each consultation. We counted a BCT as present or absent, so multiple use of the same BCT did not increase the score. This analysis was also limited to the 14 most commonly used BCTs. We examined the relationship between the number of BCTs and the outcomes by univariate logistic regression and with multivariate mixed effects logistic regression. We used the pre-specified potential confounders (age, sex, BMI and Index of Multiple Deprivation decile) with a GP identifier as a random effects term.

To examine if GPs used the BCTs recommended in the training video we listed the BCTs used in the training video and compared consultations against this list. We awarded a point for each BCT used by a GP that was also present in the video. We counted multiple uses of a BCT once only. To examine the effect of GPs using the recommended BCTs we modelled univariate logistic regression for each outcome using ‘recommended BCTs’ as a continuous term. We then performed adjusted analyses with mixed effect logistic regression models using the same list of potential confounders as the other analyses with GP identifier as a random effects term.

Statistical analyses were conducted by the lead author (JB) and JJL using Stata version 14.

Public Patient Involvement (PPI)

People with obesity were part of the steering committee for the BWeL trial. We also sought advice from people with obesity to guide this analysis. They were recruited through a standing departmental database. We asked about their opinions on the use of certain BCTs in the context of weight management brief interventions, which helped refine the contextual definitions. For instance, in response to feedback highlighting the ambiguity of the word “goal”, we adjusted the contextual examples for “goal setting (outcome)”. Similarly, the PPI group emphasised the difference between asking a patient to come back to assess successful performance of the target behaviour (E.g. “come back in a month and we’ll see how you’re getting on”), and asking a patient to come back to assess a potential outcome of performing the target behaviour (E.g. “come back in a month and I’ll weight

you”). This informed our decision to code the former as “review behaviour goals” and the latter as “feedback on outcomes of behaviour”. This input from patient experts ensured patient-focused research, and addressed a patient articulated need for effective conversations about weight management.

Results:

Of 237 adult patients with recorded consultations, 126 were female and 111 were male. The mean age was 56.0 (SD 17.7) years, the mean initial BMI was 34.6 (range: 25.6-58.6), and the mean IMD score was 16.4. Overall 20 patients (8%) were from minority ethnic groups. In total, 56% of the patients agreed to the referral and 46% attended the CWMS.

We identified 21 different BCTs, across 8 domains, 13 of which were used 8 or more times (Table 1). Of these, adding objects to the environment (n= 177) and instruction about how to perform behaviour (n= 128) appeared most frequently. There was no correlation between any of these 14 BCTs greater than 0.28.

The training video showed doctors using 8 BCTs: problem solving, review behaviour goals, , feedback on outcomes of behaviour, social support (unspecified and practical), instruction about how to perform behaviour, credible source and adding objects to the environment. The mean score for using recommended BCTs during the trial was 3.56 (SD = 1.73) (Table 1).

Agreement to CWMS referral

In the univariable analysis, using more BCTs in a brief intervention was associated with greater agreement to referral, and adjustment did not change the strength of association (Table 1). Of the individual BCTs, reviewing behaviour goals, social support practical, instructions as to how to perform the intervention, and additional information were associated with increased agreement, but only social support practical was significantly associated on adjustment (OR=4.80, 95% CI=1.15, 20.13). This BCT typically meant a doctor saying for example: “It would be local and it would be fitted in with you, so it would be when it's convenient for you to do it”. There was a significant negative association between the use of problem solving and acceptance of the referral (Adjusted OR 0.01, 95% CI 0.00-0.25) (example BCT Appendix 1). There was no evidence that the interaction between ‘biofeedback’ and ‘information about health consequences’ played any role, though with wide confidence intervals (Adj OR 16.12, 95% CI 0.92-285.34). There was clear evidence that each

additional BCT that was used in the training videos was associated with increased agreement (Adj OR 1.56 95% CI 1.08-2.23, Table 1).

Attendance

Univariable analyses showed associations with attendance that were not present after adjustment. This was the case for the number of BCTs used (crude OR 1.17, 95% CI 1.04-1.32, Adj OR 1.08 95% CI 0.94-1.24) reviewing behaviour goals (crude OR 2.13, 95% CI 1.23-3.67, Adj OR 1.05, 95% CI 0.51-2.14), social support practical (crude OR 2.92 95% CI 1.07-5.01, Adj OR 1.65, 95% CI 0.77-3.56), and using BCTs recommended by training (Crude OR 1.25, 95% CI 1.07-1.46, Adj OR 1.20, 95% CI 0.98-1.47). The main

Sensitivity analyses

Sensitivity analyses supported the primary analyses. In the models built by backwards elimination, agreement was significantly predicted by the BCTs reviewing behaviour goals, instructions on how to perform the behaviour and social support practical. Problem solving was strongly associated with lower agreement rates. Attendance was predicted by age, and 'social support practical' (Appendix 3).

Our analysis grouping the 14 BCTs into their eight domains from the v1 taxonomy also supported the primary analyses (Appendix 4). The domains 'social support' and 'shaping knowledge' were significantly associated with greater agreement-to-attend in unadjusted and adjusted analyses. Univariable analyses showed attendance was associated with 'social support' and 'shaping knowledge' but no domains were significantly associated with attendance after adjustment for potential confounders.

	Behaviour change techniques		Patient Agreement to Attend CWMS			n (%) attended
		Use of BCTs n (%) or mean (sd)	n (%) agreed to attend	BCT- crude odds ratio (95% CI)	BCT- adjusted odds ratio (95% CI)	
BCT v1 taxonomy number, and behaviour Change Techniques used by doctors	Number used by doctors (all BCTs)	4.7 (sd = 2.2)	133 (56%)	1.31 (1.16-1.50)	1.34 (1.03-1.75)	111
	1.2 Problem Solving	17 (7.17%)	5 (3.76)	0.23 (0.10-0.88)	0.01 (0.00-0.25)	11
	1.3 Goal Setting (outcome)	8 (3.38%)	2 (1.50)	0.25 (0.05-1.26)	0.06 (0.00-4.15)	2
	1.5 Review Behaviour Goals	80 (33.76%)	63 (47.37)	4.61 (2.47-8.57)	2.06 (0.59-7.25)	47
	2.7 Feedback on Outcomes of Behaviour	66 (27.85%)	42 (31.58)	1.54 (0.86-2.76)	1.69 (0.39-7.33)	30
	2.6 Biofeedback	72 (30.38%)	42 (31.58)	1.13 (0.65-1.99)	0.84 (0.21-3.27)	31
	3.1 Social Support (unspecified)	102 (43.04%)	62 (46.62)	1.40 (0.83-2.35)	2.50 (0.69-9.10)	45
	3.2 Social Support (practical)	95 (40.08%)	70 (52.63)	3.51 (2.00-6.17)	4.80 (1.15-20.13)	59
	4.1 Instruction about how to perform behaviour	128 (54.01%)	91 (68.42)	3.92 (2.28-6.75)	2.29 (0.63-8.38)	70
	+Additional Information	62 (26.16%)	43 (32.33)	2.14 (1.15-3.96)	4.19 (0.69-25.64)	31
	5.1 Information about Health Consequences	101 (42.62%)	59 (44.36)	1.18 (0.70-1.98)	0.68 (0.19-2.44)	51
	9.1 Credible Source	178 (75.11%)	101 (75.94)	1.01 (0.61-2.00)	1.45 (0.33-6.31)	86
	6.2 Social Comparison	19 (8.02%)	12 (9.02)	1.37 (0.52-3.62)	1.93 (0.20-18.44)	7
	12.5 Adding Objects to the Environment	172 (72.6%)	101 (75.94)	1.16 (0.65-2.09)	0.88 (0.19-4.01)	86
Other outcomes	Use of 8 training video recommended BCTs	3.55 (sd = 1.73)	-	1.48 (1.25-1.76)	1.56 (1.09-2.23)	
	Interaction between health consequences and biofeedback	-	-	-	16.12 (0.92-285.34)	

⁺Additional Information was added to capture further information giving in this study, and was not present in the [BC](#)

Table 1: association between individual BCTs and BCT domains with patient agreement and attendance. Number of BCTs used adjusted for age, sex, IMD decile, and BCT domain. Multivariable models included all individual BCTs, age, sex, IMD decile, and random effects term for GP identifier. GP identifier

Discussion:

Principal findings

Our primary analysis of 237 recorded interventions, in which adult patients were offered a free CWMS referral, showed that no behaviour change techniques were associated with patient CWMS attendance. One BCT, provision of social support (practical) was positively associated with patient agreement-to-attend in the consultation. Similarly, use of more BCTs, and using BCTs recommended during training, was positively associated with in-consultation patient agreement, but was not associated with patient CWMS attendance.

Findings in the context of existing research

The BWeL trial was the first and, to our knowledge, only RCT of brief opportunistic interventions to support adult weight loss. As such, the analyses presented are novel. Research indicates that doctors tend to avoid initiating conversations about weight[12]. When they do, evidence suggests that practitioners feel more comfortable discussing weight management in the context of other health conditions[33]. However, this work found no association between discussing the health implications of obesity ([i.e. use of the BCT ‘information about health consequences’](#)) and patient attendance at CWMS.

One study has also applied Michie’s taxonomy to examine the effective elements of GP brief opportunistic interventions, focussing on reducing problematic alcohol use. It showed that the BCT taxonomy could be used to reliably code intervention components and that 16 BCTs were specified in the protocols or reports of the trials[19]. The authors’ meta-regression of randomised controlled trials of these brief interventions using BCTs in the interventions as predictors found that two of the 16 BCTs, namely prompting immediate commitment to reduce alcohol and prompting patients to record their drinking, explained almost three quarters of the between study heterogeneity in change in alcohol consumption. In this model, neither BCT was significantly associated with reduced alcohol consumption, although studies with these two BCTs had a significantly larger effect on reducing alcohol than studies that included neither. Our study adds to this small, but growing body of literature examine BCTs used in brief interventions.

A previous study examined relationship between BCTs and attendance at classes to treat musculoskeletal pain. They also found that an increased number of BCTs was not associated with class attendance[21]. Evidence showing the number of BCTs is associated with positive intervention results is mixed, and may be context or population dependent. Our results here align with this previous study and indicate that when motivating adult patients to attend a class to support behaviour change, increasing the number of BCTs used is likely not effective. Future studies should consider this during intervention design.

Strengths and Limitations

A strength of this study was the use of trial recordings of opportunistic brief interventions on obesity. These brief interventions are rarely given in practice, such that a database of 300 GP consultation recordings included no examples of these interventions[34,35], even though guidelines suggest that doctors should have given interventions in a third of these consultations. Our use of the [BCTTv1](#) taxonomy enabled reliable identification and description of individual intervention components. We adapted the taxonomy to include a new BCT, specific to this context, which we termed “Additional Information” (meaning that the doctor informs the patient about what happens at CWMS), and created a codebook to enhance reliability of coding by producing definitions of the other BCTs that applied directly to this context, rather than using the generic definitions. This ensured that the generic taxonomy was relevant to brief interventions for weight loss. The trial protocol allowed doctors to deliver the intervention content in their own way and thus the data on BCTs reflected everyday use in trained doctors. A key strength of this analysis is that we were able to link the use of BCTs to their direct consequence- agreeing to a referral, and the most proximal behaviourally relevant outcome, attending the CWMS. BCT coding often depends on the quality of reported content[36] . A strength of this research was the use of over two-hundred transcribed consultation recordings linked to behavioural outcome data from the BWeL trial. This eliminated recall and reporting bias, and enabled access to large quantities of patient data, and good participant follow up. It is possible that doctors may intervene differently when they know they are being recorded[37], which may mean that the BCTs used by doctors in the BWeL trial, who were trained and recorded, may not reflect BCTs used in usual

practice. However, evidence suggests that recording consultations seems to have minimal impact on doctor or patient behaviour[38].

A limitation of this study is that our data are observational and clinicians were not randomised to use or not use particular sets of BCTs in their interventions. Reverse causality is likely to play a role. For example, it is likely that the negative association between problem solving and patient agreement and attendance arose because doctors were trying to persuade patients who expressed reluctance. Doctors typically used problem solving to address barriers that patients had presented. Similarly, provision of social support (practical) which was associated with agreement to attend, usually followed some initial tentative agreement from patients. We observed that a greater number of BCTs was associated with agreement to attend but not attendance. The former association may also be subject to reverse causation in that doctors who met initial refusal of the offer to attend a CWMS often terminated the brief intervention immediately and thus employed fewer BCTs. It is also possible that doctors employed some BCTs when they met with initial reluctance and that these were effective in overcoming reluctance. However, this reluctance lowered overall agreement and attendance and this masked the effectiveness of particular BCTs. Finally, the analysis of individual BCTs lacked power to detect modest associations, as in many cases the confidence intervals that overlapped the null included effects of moderate size. We sought to overcome this by analysing domains, but the estimates were still somewhat imprecise. Another limitation is that regression analyses have low power to detect interactions. A 2018 scoping review[39] evaluating BCT effectiveness outlined that the number of BCT permutations may mean interactions are difficult to detect. There is also potential for ‘high bias and error of outcome measurement[39]’. We therefore suggest readers consider this analysis as exploratory. It is possible that the otherwise ineffective BCTs ‘health consequence’s and ‘biofeedback’ became effective when used together, but that we couldn’t detect the effect due to low power. Whilst we did not find clinical evidence to support the recommendations in NICE guidelines[25], neither can we claim evidence of no effect. A limitation of using a pre-existing taxonomy is that it may not be fine-tuned enough to identify more subtle ways of communication. For example, this research did not evaluate the sequence in which BCTs were used, and whether using specific BCTs in combination with one another (with the exception of the pre-specified interaction) was associated with an increased likelihood of CWMS attendance – these research questions were beyond the scope of this analysis, but could be examined in further research.

Clinical Implications

The wider data from the BWeL trial show that the difference between intervention and control was mediated by much greater use of effective behavioural weight loss programmes, chiefly those advocated by doctors, in the intervention group compared with the control group. In this study we found no evidence that more complex interventions where a greater number of BCTs were deployed led to greater uptake, so there is no basis for recommending these more complex interventions for use in consultations with adults. In this study we also found no evidence that using guideline recommended strategies, either individually or together, increased attendance at weight management referrals.

The BWeL intervention as a whole, in which doctors endorsed, offered, and facilitated a referral to a weight management increased the proportion of adult patients taking effective weight loss action fivefold. This analysis of individual BCTs, domains, and total number suggested that the large behavioural effect we observed in the main trial results cannot be explained by the modest effect sizes suggested in this study. Perhaps therefore it is the content and meaning of the words used that were crucial. Another factor that may have led to this large effect is a BCT that was not delivered by the GP but instead was delivered by protocol to everyone in the intervention group. This BCT is further provision of social support practical outside of the consultation, which in this trial meant that the research assistant and the participant identified a local CWMS that was conveniently located and timed and wrote the details of this down on the referral voucher. Two previous trials have shown a nine- to tenfold higher uptake of support when arranging to provide support rather than advising participants of its availability, and a fivefold increase in behaviour change in the one trial that measured this[40,41]. This BCT is defined in the v1 taxonomy as ‘advise on, arrange, or provide practical help’. Thus, the definition of this BCT appears to conflate two activities, ‘advise on’ and ‘arrange or provide’ that have markedly different behavioural outcomes. Taken together, the evidence supports an approach that pares down the necessary content of an opportunistic brief intervention to one focused on content and without undue emphasis on behavioural counselling skills, which may add little, but with a clear mechanism to arrange or provide support for those who agree to it.

The only guidelines we are aware of that include specific information on how clinicians should make brief opportunistic interventions on obesity are those for England and Wales produced by NICE[7]. These suggests clinicians use problem solving, goal setting, and social support, but we found no evidence that these were associated with adult patient agreement to, or uptake of, weight management programmes. Incorporating more BCTs is likely to lengthen the consultation, and this may deter doctors from giving these interventions. We found no evidence that incorporating more BCTs improves effectiveness.

Recommendations for further research

In common with most studies investigating heterogeneity of outcomes, we used the [BCTTv1](#) taxonomy and an observational design to explain this heterogeneity. We found little evidence that BCT use explained effectiveness. Future research may benefit from packaging related BCTs into related clusters and using randomised designs, such as multiphase optimization strategy trials (MOST). Clustering theoretically related BCTs in this way may create a coherent package that is more effective than one BCT alone. Given that the content of brief opportunistic interventions is perhaps critical to success, it may be productive to examine how the content is conveyed using a finer grained analysis, such as conversation analysis, which focuses on interactional actions that are achieved, and the order in which they are delivered. This could identify ways that clinicians motivate behaviour change in very brief interventions that may not be captured by the [BCTTv1](#) taxonomy approach.

Current training and guidelines are largely based on post-hoc reports and expert opinion, rather than a detailed analysis of recoded interventions, as presented in this study. The methods used here illuminate what occurs in the ‘black box’ of the clinical consultation, accurately describing intervention components at the granular level. Employing these methods in future studies can inform choices on the BCTs to use in opportunistic interventions, and provide an evidence-base of what is actually effective in practice. Guidelines should draw on this evidence base to provide accurate detail on how best to communicate during behaviour change interventions.

Conclusions:

Clinicians avoid opportunistic weight management interventions, as they feel under-trained[42,43]. Evidence from our [BCTTv1](#) analysis of 237 recorded weight management interventions with adults shows that the usage of more BCTs is associated with greater acceptance of the referral, but not attendance at the CWMS. In the absence of evidence that interventions which incorporate more BCTs are associated with CWMS attendance, a simpler approach, that does not require extensive time and training, may be more efficient for clinicians. Evidence from the trial and elsewhere suggests that focusing on conveying key aspects of this brief intervention to endorse, offer, and facilitate referral is what is required to motivate behaviour change in adults and we still have no evidence that longer and more complex interventions incorporating more techniques make a significant difference.

Compliance with Ethical Standards:

Informed consent was obtained from all individual participants included in the BWeL trial, and no identifiable information was used as part of this study.

Appendices

Patient: Also depends on the day as well. Cos, I work in the evenings.

Doctor: Okay, yeah. But you see that can all be adjusted.

Patient: Yeah.

Doctor: And that's the whole point. Because this is a research trial, the advantages of that for you is that we can fit very much around you, so you just go back and knock on Sarah's door and she will, can talk to you about all the different programmes that are available, and fit it around your work.

Appendix 1: An example of the BCT problem solving.

BCT	Contextual example	Illustrative quote
1.2 Problem Solving	GP provides a potential solution to a barrier to attendance that the patient raises.	"I know you can't drive, but there's a good bus service you can use to get there".
1.3 Goal Setting (outcome)	GP gives clear, numerical weight loss target for the patient (in terms of BMI or weight).	"You should lose about 20kg".
1.5 Review	Doctor suggests follow-up	"Come back to see me in a

Behaviour Goals	appointment, to review whether the patient has been attending the CWMS.	month, and we can see how you're getting on with it".
2.6 Biofeedback	Doctor gives numerical information about weight/BMI, or states that weight/BMI is too high.	"Your BMI is 32, which is higher than it should be".
2.7 Feedback on Outcomes of Behaviour	The doctor will check the patient's weight once they've been to the CWMS. Not enough to say "we'll see how you're getting on".	"Come back in a month, and we'll weigh you again and see if you've lost some weight".
3.1 Social Support (unspecified)	GP suggests that the group will help/support the patient lose weight - detail about the nature of this support is unnecessary here.	"If you go along, they'll help you to lose weight".
3.2 Social Support (practical)	Doctor suggests practical ways that friends/family can support the patient, or explains how the researchers will support attendance.	"The researchers will book it all for you, saving you the effort once you get home".
4.1 Instruction about how to perform behaviour	Doctor gives clear instruction to the patient about speaking to the researcher and signing up to CWMS.	"Go and speak to the researcher, and they'll give you information and sign you up".
+Additional Information	Doctor informs the patient about what happens at CWMS.	"You go along once a week, and you get weighed and then talk about diet and exercise with a group of like-minded people".

5.1 Information about Health Consequences	Doctor gives a named or specific health consequence of attending the CWMS/losing weight.	"Losing weight will improve your blood pressure, and your arthritis too".
6.2 Social Comparison	Doctor compares people who attend CWMS to those who do not.	"Everyone who goes to the weight management programme loses more weight than people who try to do it by themselves".
9.1 Credible Source	Doctor describes how evidence/experts/credible people support attendance at CWMS.	"Scientific evidence shows that going to a weight management programme helps weight loss".
12.5 Adding Objects to the Environment	Doctors says that CWMS sessions are free/ refers to vouchers.	"I can offer you twelve free sessions today".

Appendix 2: The codebook of BCT definitions and examples, used to identify BCTs in the transcripts. ⁺Additional Information was added to capture further information giving in this study, and was not present in the [BCTTv1](#) taxonomy

Behaviour change techniques		Patient Agreement to Attend CWMS			Patient Attendance at CWMS		
Behaviour Change Techniques used by Doctors	Use of BCTs n (%) or mean (sd)	n (%) agreed to attend	BCT- crude odds ratio (95% CI)	BCT- adjusted odds ratio (95% CI) *	n (%) attended	BCT- crude odds ratio (95% CI)	BCT- adjusted odds ratio (95% CI)*
(All BCTs)		133 (56%)	1.56 (1.35-1.8)	-	110 (46%)	1.21 (1.09-1.36)	-
1.2 Problem Solving	17 (7.17%)	5 (3.76)	0.23 (0.10-0.88)	0.05 (0.01-0.26)	11 (10.00)	2.24 (0.80-6.27)	Not included in final model
1.3 Goal Setting (outcome)	8 (3.38%)	2 (1.50))	0.25 (0.05-1.26)	0.10 (0.001-0.26)	2 (1.82)	0.37 (0.07-1.89)	Not included in final model
1.5 Review Behaviour Goals	80 (33.76%)	63 (47.37))	4.61 (2.47-8.57)	2.45 (1.04-5.75)	47 (42.73)	2.13 (1.23-3.67)	Not included in final model
2.7 Feedback on Outcomes of Behaviour	66 (27.85%)	42 (31.58)	1.54 (0.86-2.76)	Not included in final model	30 (27.27))	0.95 (0.54-1.68)	Not included in final model
2.6 Biofeedback	72 (30.38%)	42 (31.58)	1.13 (0.65-1.99)	Not included in final model	33(30.00)	0.97 (0.55-1.69)	Not included in final model
3.1 Social Support (unspecified)	102 (43.04%)	62 (46.62)	1.40 (0.83-2.35)	2.16 (0.96-4.86)	45 (40.91)	0.85 (0.51-1.43)	Not included in final model

3.2 Social Support (practical)	95 (40.08%)	70 (52.63)	3.51 (2.00-6.17)	3.28 (1.28-8.39)	59 (53.64)	2.92 (1.07-5.01)	1.92 (1.02-3.64)
4.1 Instruction about how to perform behaviour	128 (54.01%)	91 (68.42)	3.92 (2.28-6.75)	2.03 (0.90-4.58)	70 (63.64)	2.08 (1.23-0.86)	Not included in final model
+Additional Information	62 (26.16%)	43 (32.33)	2.14 (1.15-3.96)	2.69 (0.92-7.87)	31 (28.18)	1.22 (0.68-2.17)	Not included in final model
5.1 Information about Health Consequences	101 (42.62%)	59 (44.36)	1.18 (0.70-1.98)	Not included in final model	51 (46.36)	1.33 (0.79-2.23)	Not included in final model
9.1 Credible Source	178 (75.11%)	101 (75.94)	1.01 (0.61-2.00)	Not included in final model	86 (78.18)	1.36 (0.75-2.48)	Not included in final model
6.2 Social Comparison	19 (8.02%)	12 (9.02)	1.37 (0.52-3.62)	Not included in final model	7 (6.36)	0.65 (0.25-1.72)	Not included in final model
12.5 Adding Objects to the Environment	172 (72.6%)	101 (75.94)	1.16 (0.65-2.09)	Not included in final model	86 (78.18)	1.42 (0.78-2.57)	Not included in final model

Appendix 3: Sensitivity analysis building fixed effects multivariable models with backwards stepwise elimination with variable significance of $p > 0.1$ as the threshold for removal from model. Attendance adjusted for age only. + The BCT 'Additional information' was added as part of this

study, and is not part of the [BCTTv1](#) taxonomy

			Patient Agreement to Attend CWMS			Patient Attendance at CWMS		
			n (%) agreed to attend	BCT-crude odds ratio (95% CI)	BCT Domains – adjusted odds ratio* (95% CI)	n (%) attended	BCT-crude odds ratio (95% CI)	BCT Domains – adjusted odds ratio (95% CI) **
Behaviour Change Techniques used by Doctors to deliver intervention	Behaviour change technique domains	Use of domains n (%) or mean (sd)						
All	All		133 (56%)	-	-	110 (46%)	-	-
1.2 Problem Solving	Goals and Planning	98 (41.35)	67 (50.38 %)	2.39 (1.39-4.10)	0.98 (0.30-3.23)	54 (49.09%)	1.81 (1.07 - 3.07-)	1.01 (0.50-2.01)
1.3 Goal Setting (outcome)								
1.5 Review Behaviour Goals								
2.7 Feedback on Outcomes of Behaviour	Feedback and Monitoring	117 (49.37%)	71 (53.38)	1.04 (0.63-1.75)	0.82 (0.22-3.09)	55 (50.00%)	1.05 (0.63-1.75)	0.86 (0.42-1.79)

2.6 Biofeedback			%))		
3.1 Social Support (unspecified)	Social Support	162 (68.35%)	106 (79.70%)	2.21 (1.25-3.91)	6.58 (1.37-31.63)	85 (77.27%)	2.21 (1.24-3.91)	1.50 (0.69-3.22)
3.2 Social Support (practical)								
4.1 Instruction about how to perform behaviour	Shaping Knowledge	148 (62.45%)	99 (74.44%)	1.84 (1.08-3.15)	6.05 (1.31-27.91)	77 (70.00%)	1.84 (1.08-3.15)	1.10 (0.52-2.32)
+Additional Information								
5.1 Information about Health Consequences	Natural Consequences	101 (42.62%)	59 (44.36)	1.18 (0.70-1.98)	0.36 (0.96-1.32)	51 (46.36)	1.33 (0.79-2.23)	1.11 (0.56-2.20)
9.1 Credible Source	Comparison of Outcomes	178 (75.11%)	101 (75.94)	1.01 (0.61-2.00)	1.59 (0.33-7.71)	86 (78.18)	1.36 (0.75-2.48)	2.25 (0.96-5.29)
6.2 Social Comparison	Comparison of Behaviour	19 (8.02%)	12 (9.02)	1.37 (0.52-3.62)	1.17 (0.13-10.40)	7 (6.36)	0.65 (0.25-1.72)	0.44 (0.14-1.42)
12.5 Adding Objects to the Environment	Antecedents	172 (72.6%)	101 (75.94)	1.16 (0.65-2.09)	1.40 (0.30-6.48)	86 (78.18)	1.42 (0.78-2.57)	1.11 (0.49-2.48)

Appendix 4: sensitivity analysis showing association between BCT domains and agreement and attendance at CWMS. * adjusted for age, sex,

IMD decile, and BMI, with a random effects term for GP identifier, p for likelihood ratio test comparing mixed and fixed effects models 0.0001.

*** adjusted for age, sex, IMD decile, and BMI, with a random effects term for GP identifier, GP random effects 0, p=1.00 for LRT. + The BCT*

‘Additional information’ was added as part of this study, and is not part of the [BCTTv1](#) taxonomy

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