The NHS Low-Calorie Diet Digital Programme: Fidelity of behaviour change technique delivery

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The NHS Low-Calorie Diet Digital Programme: Fidelity of behaviour change technique delivery

Running title: Digital LCD Programme behaviour change technique fidelity

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Manuscript word count: 3,340

Abstract word count: 195

Conflict of interest disclosures: none

Novelty statement

- Intervention fidelity (whether an intervention is implemented as intended) is associated with better intervention outcomes. Previous research has illustrated a drift in the fidelity of behaviour change techniques during the delivery of the NHS Low-Calorie Diet pilot provided through face-to-face group or one-to-one behavioural support models.

- Analysis of the digital behavioural support model found behaviour change techniques to be delivered with good fidelity to the NHS programme specification and providers programme plans.
- Digital delivery models may provide a more consistent approach to the delivery of behaviour change techniques than face-to-face group or one-on-one behavioural support models.

Acknowledgements

The authors would like to acknowledge the Patient and Public Involvement team that have worked on the coproduction of the Re:Mission study, including Ken Clare, Abimbola Ojo, Jennifer Teke, Mike Willis, Gulsoom Akhtar, Beth Clegg and Clair Goddard.

Members of the steering and oversight groups are also acknowledged by the authors for their input and involvement in the Re:Mission study, including the clinical lead Dr Mark Ashton.

The Re:Mission study includes a multidisciplinary team of academics from across the North of England. The authors would like to acknowledge all members of the team including Dr Catherine Homer, Dr Keven Drew, Dr Jamie Matu, Prof Jim McKenna, Dr Maria Maynard, Pat Watson, Dr Susan Jones, Dr Simon Rowlands, Karina Kinsella, Dr Tanefa Apekay, Dr Stuart Flint, Prof Janet Cade, Dr Adam Martin, Dr Maria Bryant, Dr Tamara Brown, Dr Wendy Burton, Mick Martson and Pooja Dhir.

Funding

This work was supported by the National Institute for Health Research, Health Services and Delivery Research [NIHR 132075]. The NHS LCD programme is funded by NHS England.

Abstract

Background: NHS England commissioned independent service providers to deliver the NHS Low-Calorie Diet Programme pilot. Previous research has illustrated a drift in the fidelity of behaviour change techniques (BCTs) during the delivery of the programme provided through face-to-face group or one-to-one behavioural support. The aim of this study was to assess the delivery fidelity of the BCT content in the digital delivery of the programme

Methods: Online, app chat and phone call support content was coded using The Behaviour Change Technique Taxonomy (BCTTv1). BCTs delivered by each service provider (N=2) were calculated and compared to the BCTs specified in the NHS service specification and those specified in the providers programme plans.

Results: Between 78% and 83% of the BCTs identified in the NHS service specification were delivered by the service providers. The fidelity of BCT delivery to those specified in providers' programme plans was 60-65% for provider A, and 82% for provider B.

Conclusions: The BCT content of the digital model used in the NHS-LCD programme adhered well to the NHS service specification and providers' plans. It surpassed what has been previously observed in face-to-face services provided through group or one-on-one behavioural support models.

Key Words: Type 2 Diabetes, Obesity, Low Calorie Diet, Re:Mission Study, Behaviour Change, Fidelity

Introduction

Obesity and type 2 diabetes (T2D) are recognised as major public health concerns. In England, obesity affects 26% of adults[1] and 3.2 million people live with T2D[2]. Recent systematic reviews[3-7] and clinical trials[8-10] have demonstrated that for some people living with obesity a low calorie diet (LCD) achieved by Total Diet Replacement (TDR), can lead to significant weight loss, remission of T2D, and improved quality of life.

The NHS Long-Term Plan therefore made a commitment to pilot an LCD programme, for people living with excess weight and T2D.[11] In 2020, NHS England commissioned independent commercial service providers to pilot the NHS Low-Calorie Diet (NHS-LCD) programme (now known as NHS Type 2 Diabetes Path to Remission Programme) in ten geographically diverse areas. The programme consists of 12 weeks of TDR, 4-6 weeks phased food re-introduction and a 34-36 week weight maintenance phase, delivered using one of three models of behaviour change support: group, one-to-one and digital. The programme was available to adults (18-65 years) with a BMI ≥27kg/m² (adjusted to ≥25kg/m² for Black, Asian and other ethnic groups) and a T2D diagnosis within the last 6 years (full eligibility criteria[12]).

As part of the commissioning procedure for the NHS-LCD programme, NHS England produced a service specification detailing the features required, including the key behaviour change techniques (BCTs).[13] BCTs are defined as the active ingredients of interventions designed to modify the cognitive and psychological processes underlying behaviour (e.g., goal setting, monitoring behaviour and social support).[14] As previously reported by our research group, the NHS-LCD specification[13] (and clinical guidelines for behaviour change (NICE PH6[15] & PH49[16]) referenced in the specification) included 23 expected BCTs.[17] Review of service provider documentation indicated between 17 and 20 of these were planned as part of their programme, with between seven and 24 additional BCTs planned, that were not in the NHS specification.

When delivering a programme, particularly at scale, the fidelity of delivery (the extent to which a programme is delivered as planned) is a key consideration. For BCTs to exert their desired effects on

health behaviours, they must be implemented as intended. Although most BCTs were included within NHS-LCD providers' programme documentation, inclusion does not denote actual delivery. This was evidenced by our previous research evaluating the NHS-LCD service delivery of group-based and one-to-one delivery models, where BCTs were delivered with low-to-moderate fidelity, ranging from 33-70% across samples.[18]

Digital delivery models, where a substantial portion of the content can be standardised and does not rely on human delivery, have the potential for high fidelity. Indeed, evaluation of the BCT delivery for the NHS Diabetes Prevention Programme demonstrated higher fidelity for the digital delivery model than face-to-face delivery.[19] The aim of this study was therefore to assess the delivery fidelity of the behaviour change content in the digital delivery of the NHS-LCD programme. Specifically, we aim to assess the fidelity of programme delivery to the 23 BCTs outlined in the NHS England service specification and the BCTs specified in the providers' programme design documentation.

Methods

Design

An analysis of the BCT content delivered by the two digital service providers of the NHS-LCD programme pilot.

Behaviour change techniques present in the NHS programme specification and provider programme plans

The NHS England service specification documents, and each provider's programme design documents were previously coded by the research team using the BCT Taxonomy[14] (REF) as described.[17] Coding of the NHS specification identified 22 distinct BCTs and one group of BCTs targeting self-belief. No information was specified in the NHS England service specification on whether one or all four BCTs in the group targeting self-belief should be delivered, therefore the group of BCTs targeting self-belief was coded as one BCT, giving a total of 23 BCTs (Table 1). Coding of provider A's documentation

indicated 20 (87%) of the 23 NHS specification BCTs in their programme design, and an additional 23 not included in the NHS specification (Table 1). Coding of provider B's documentation indicated 18 (78%) of the 23 NHS specification BCTs in their programme design, and an additional 10 not included in the NHS specification (Table 2).

Behaviour Change techniques present in programme delivery

Materials

The following materials were reviewed for BCT content:

Online/app content: 34 modules for one provider and 29 modules for the other, containing articles, videos, podcasts and quizzes. Modules were released sequentially throughout the year long programme at set points.

App chat messages: Provider A, the app chat messages between the programme coach and three service users (messages on between 56 and 83 separate days). Service users were randomly selected by the research team from the total number of programme completers who started in November 2020 (N=15).

Phone calls: Provider B, the phone calls between the programme coach and two service users for the first five weeks of the programme (five calls between 7 and 16 minutes for service user one, four calls between 5 and 17 minutes for service user two). Services users were randomly selected by the research team from a list of 125 participants, provided by the service provider, who started the programme in November 2023. Phone calls were transcribed verbatim for analysis.

BCT coding

Behaviour change content was coded using The Behaviour Change Technique Taxonomy (BCTTv1).[14] BCTs were coded as delivered if they fulfilled the full BCTTv1 definition and they addressed the programme's target behaviour(s) or outcome(s). A set of BCT coding rules to guide identification of BCT presence and dose (S1), which modified the coding rules set out in the evaluation of the NHS-

DPP[20], and a data extraction sheet were developed by TE, consistent with the BCT coding rules in our previous evaluations of programme designs and face-to-face service delivery.[18] BCT coding was conducted independently and in duplicate by JM and CK, after which meetings were held to discuss interpretations and achieve consensus with support from TE. Coding researchers undertook training in BCT coding.[21]

Analysis

BCTs were labelled and the dose (frequency) of their delivery reported. The BCTs delivered by each service provider were calculated and compared to the 23 BCTs specified in the NHS programme specification and those specified in the service providers programme plans. Cohen's kappa coefficient was conducted to determine the inter-rater reliability of coding the presence of BCTs.[22]

Ethical Approval

The study was approved by Leeds Beckett University Research Ethics Committee (ref: 107887). Participants provided both oral and written informed consent to participate in the study, including consent for publication.

Results

A detailed breakdown of the BCTs in the NHS programme specification, those specified in the service providers programme plans and those delivered by service providers are provided in Tables 1 and 2.

Delivery of BCTs in the NHS specification

Provider A delivered 18-19 (78-83%) of the 23 BCTs included in the specification; 16 (69%) through their standardised online/app content and an additional 2-3 (9-13%) through app chat message interactions with service users. The app chat messages also delivered 4-7 BCTs that were included in the standardised online/app content. Three BCTs included in the specification were not delivered

through either the standardised online/app content or through app chat message interactions with service users.

Analysis of the dose of BCTs delivered indicated large variation in both the online/app content (1-23) and the app chat messages (range 1-23). The BCTs delivered most frequently via online/app content were Problem solving (n=11), Instruction on how to perform the behaviour (n=23) and Information about health consequences (n=23). The BCTs delivered most frequently via app chat messages were Feedback on outcome(s) of behaviour (n=6-20), Instruction on how to perform the behaviour (n=4-10) and Information about health consequences (n=3-17).

Provider B delivered 18 (78%) of the 23 BCTs included in the specification; 17 (74%) through their standardised online/app content and an additional 1 (4%) through phone calls with service users. The phone calls also delivered 5-7 BCTs that were included in the standardised online/app content. Five BCTs included in the specification were not delivered through either the standardised online/app content or through phone calls with service users.

Analysis of the dose of BCTs delivered indicated variation in both the online/app content (1-9) and phone calls (range 1-5). The BCTs delivered most frequently via online/app content were Problem solving (n=9), Action planning (n=7) and Information about health consequences (n=9). The BCTs delivered most frequently via app chat messages were Problem solving (n=3), and Instruction on how to perform the behaviour (n=3-5).

Delivery of BCTs in the provider programme plans

Provider A's programme plans included 43 BCTs in total (20 of which were in the NHS specification and an additional 23 BCTs that were not). Provider A delivered 26-28 (60-65%) of the planned 43 BCTs; 26 (60%) through their standardised online/app content and an additional 0-2 (0-5%) through app chat message interactions with service users. The app chat messages also delivered 5-8 BCTs that were included in the standardised online/app content. Fourteen BCTs included in the programme plans

were not delivered through either the standardised online/app content or through app chat message interactions with service users.

Analysis of the dose of the 23 additional BCTs that were not included in the NHS specification, indicated BCTs were delivered infrequently, with only one BCT (Behaviour substitution) delivered greater than five times.

Provider B's programme plans included 28 BCTs in total (18 of which were in the NHS specification and an additional 10 BCTs that were not). Provider B delivered 23 (82%) of the planned 28 BCTs; 22 (79%) through their standardised online/app content and an additional 1 (3%) through phone calls with service users. The phone calls also delivered 6-8 BCTs that were included in the standardised online/app content. Five BCTs included in the programme plans were not delivered through either the standardised online/app content or through phone calls with service users.

Analysis of the dose of the 10 additional BCTs that were not included in the NHS specification, indicated BCTs were delivered infrequently, with only one BCT (Behaviour substitution) delivered greater than five times.

[Tables 1 and 2 near here]

Inter-rater reliability

Analysis of inter-rater reliability[22] for BCT presence indicated strong agreement for provider A (k = .0.828, p <.001), weak agreement for provider B (k = .0.449, p <.001) and moderate agreement for provider A and B combined (k = .0.650, p <.001),

Discussion

The NHS-LCD specification (and clinical guidelines for behaviour change referenced in the specification) identified 23 BCTs that service providers were expected to incorporate into their programme.

Evaluating fidelity to the BCTs outlined in the specification is important because they have the strongest evidence supporting their effectiveness in altering health behaviours. Our previous evaluation of providers programme documentation highlighted a drift in fidelity in the implementation of the NHS-LCD during the design phase, whereby 87% and 78% of the 23 BCTs outlined in the NHS specification were included by provider A and B, respectively.[17] The current analysis indicated actual fidelity during the deliver phase was 78-83% and 78% of the 23 BCTs identified in the specification by provider A and B, respectively; it should be noted that there were 1 or 2 BCTs delivered that were in the specification but were not in providers' programme plans.

Hawkes et al., recently evaluated fidelity of BCT delivery for the four providers commissioned to provide the digital arm of the NHS Diabetes Prevention Programme (NHS-DPP).[19] Similar to our findings, they reported good fidelity of the BCT intervention content, with providers delivering between 74-89% of the 19 BCTs in the NHS-DPP programme specification. In agreement with the present study, they also reported that the majority of BCTs were delivered via online content. The NHS-DPP programme was also commissioned to be delivered using group-based behavioural support. Evaluation of the group-based delivery found that although providers' plans included 74% of the 19 BCTs in the NHS service specification, only between 47% and 68% were delivered; with only 37% delivered across all eight sites observed.[23]

Apart from the BCTs specified in the NHS service specification, the programme plans of providers identified an additional 23 (provider A) and 10 (provider B) BCTs that were not listed. Assessing fidelity of the delivery of BCTs not in the NHS specification is important because only when there is a high degree of awareness of all the active ingredients designed to modify the cognitive and psychological processes underlying behaviour for a given programme is it possible to establish the possible reason for its (in)effectiveness.[19,24] The current analysis indicated that the fidelity of BCT delivery to those specified in providers' programme plans was 60-65% of the planned 43 BCTs for provider A, and 82% of the planned 28 BCTs for provider B. These findings are similar to our previous evaluation of the NHS-

LCD programme delivered using group-based behavioural support model, where fidelity of BCT delivery to providers programme plans ranged from 50-79%, but noticeably higher compared to one-to-one behavioural support, where fidelity of BCT delivery to providers programme plans ranged from 33-60%[18]. Considering delivery of only the additional BCTs in providers programme plans (i.e. not those in the NHS service specification), highlighted a greater drift in fidelity compared to delivery of the BCTs outlined in the NHS specification, with provider A delivering 48-52% and provider B delivering 70%. These findings contrast those of NHS-DPP group-based delivery, where between 70% and 89% of BCTs specified in programme manuals were delivered, compared to between 47% and 68% of those specified in the NHS service specification.[23]

Whilst it is unlikely that programme effectiveness increases linearly as more BCTs are added to an intervention, as previously noted by Hawkes et al.,[19] some of the techniques specified in digital providers' programme plans that were not in the NHS service specification, have shown some evidence of being effective in interventions targeting similar populations. For instance, the technique of 'demonstrating the behaviour' has been linked to decreased blood glucose levels in individuals with T2D.[25] Some evidence also suggested that interventions containing a larger number of BCTs may be more effective. A systematic review of the BCT and digital features in technology driven T2D prevention interventions suggested that interventions containing a larger number of BCTs were more likely to achieve clinically significant weight loss.[26] However, it is important to highlight that the number of BCTs in the reviewed interventions was notably lower than those delivered by providers in the NHS-LCD programme, with interventions that achieved short term effectiveness including an average of 11.3 BCTs (range: 4–14), compared to 5.4 (range: 1–10) among non-effective interventions, and interventions that achieved long term effectiveness using an average of 11.5 BCTs (range: 10–13), compared to 7.8 (range: 1–13) among non-effective interventions. Moreover, a distinct group of only seven BCTs were commonly found in interventions that were effective over both the short- and long-term: goal setting (behaviour), problem solving, goal setting (outcome), feedback on behaviour, self-monitoring of behaviour, self-monitoring of outcome(s) of behaviour, and social support (unspecified).

All seven of which were included in the NHS service specification, but not consistently delivered by the providers. Provider A delivered four of the seven BCTs via both online content and in at least one instance via app chat messages (goal setting (behaviour), problem solving, self-monitoring of behaviour, social support (unspecified)), two of the seven BCTs only in at least one instance via app chat messages (feedback on behaviour, self-monitoring of outcome(s) of behaviour) and failed to deliver goal setting (outcome). Provider B delivered five of the seven BCTs via both online content and in at least one instance via phone calls (problem solving, goal setting (outcome), self-monitoring of behaviour, self-monitoring of outcome(s) of behaviour, social support (unspecified)), one of the seven BCTs only via online content (goal setting (behaviour) and failed to feedback on behaviour. Additional research is therefore necessary to understand the effects of employing higher or lower numbers of BCTs in interventions for T2D and the impact this has on outcomes.

The current study, supported by findings reported for the NHS-DPP, indicates that fidelity of BCT delivery in digital programmes is good and may be substantially greater than the same programmes delivered using in person group of one-to-one behavioural support models. In part, this can be understood through the standardisation of content, which reduces dependence on human delivery. Examining the barriers and facilitators to BCT delivery using group and one-to-one delivery models, our previous work highlighted the influence of both coach-level and programme-level factors on fidelity, including the skill level of the coach in delivering BCTs; session time management; group-based settings sometimes hindering individual engagement with a BCT; and deviations from the session plans.[18]

It is important to note that the inclusion of BCTs within providers' programmes does not necessarily signify participant engagement. The National Institute of Health Behaviour Change Consortium (NIH-BCC) model describes five domains of fidelity: study design (the extent to which the programme design reflects the evidence base); provider training (the extent to which deliverers are trained in a programme's components); treatment delivery (the extent to which the programme is delivered with

adherence to the design); treatment receipt (the extent to which programme content is understood by participants); and treatment enactment (the extent to which participants apply the programme content in their daily lives).[24] Whilst digital interventions may be more robust on treatment delivery, they may be relatively weaker on treatment receipt. Further, the importance of the combination of delivered BCTs requires further investigation. Whilst one-to-one behavioural support models had lower fidelity to the number of BCTs delivered, staff may have tailored BCT deliver based on the needs of the service users.

Although dose was not specified in the programme specification documents, consideration should also be given to the dose (frequency) of BCTs. The potential importance of the frequency of BCT delivery was highlighted in the Norfolk Diabetes Prevention Study, where it was found that the greater the number of action plans set across the course of the programme, the greater the subsequent weight loss[27]. The reported information in this study, will permit useful insights when comparing participant outcomes, and further the evidence base for BCTs in diabetes programmes, as more research is needed on "how much" of a BCT is necessary to improve T2D management.[25]

Strengths and limitations

Whilst all online module content was analysed, the research team were not able to review all text reminders, app notifications, emails between service providers and participants, any support group functionalities, and phone calls beyond the first weeks for provider B. Given our findings and those of NHS-DPP found the majority of BCTs were delivered via online content, it is unlikely that this would have had a significant impact of our conclusions, however, it is possible that the fidelity of BCTs is unreported. Further, only a small sample of phone calls and app chat messages were analysed, and no wider information was available to determine the representativeness of the data (e.g. the average number of phone calls or app messages for the programmes). For the material that was available, a strength of this study was the rigorous approach to BCT coding, whereby all material was double coded by trained researchers. Although, inter-rate reliability indicated weak agreement for provider B, all

discrepancies (not just a sample as often undertaken) where discussed with a third trained researcher until consensus was reached. It should also be noted that data was obtained from different timepoints, November 2020 for Provider A and November 2023 for provider B. November 2020 was the timepoint identified in the initial research protocol but when agreement was reached with Provider B to share the date it became apparent that historical data was no longer available . Finally, it is important to recognise that delivery of BCTs is not sufficient for digital behaviour change programmes to be effective. Further investigation is required to understand how and if participants engage with features of the intervention, the extent to which intervention content is understood by participants, and the extent to which participants apply the intervention content in their daily lives).[24]

Conclusion

The current study revealed that the BCT content of the digital model used in the NHS-LCD programme adhered well to the NHS service specification and providers' plans. It surpassed what has been previously observed in face-to-face services provided through group or one-on-one behavioural support models.

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Table 1. Fidelity and dose (in parentheses) of BCT intervention delivery to A) NHS programme spec, and B) Provider A's programme plans

Behaviour change technique	NHS programme spec	Provider A presence in programme plans	Provider A presence in delivery			
			Online/app content	Service user 1 app chat messages	Service user 2 app chat messages	Service user 3 app chat messages
Goal setting (behaviour) [1.1]	✓	✓	✓ (5)		✓ (2)	✓ (2)
Problem solving [1.2]	✓	✓	✓ (11)	✓ (1)	✓ (2)	
Goal setting (outcome) [1.3]	✓	✓				
Action planning [1.4]	✓	✓	✓ (6)			
Review outcome goal(s) [1.7]	✓	✓			✓ (2)	✓ (1)
Behavioural contract [1.8]	✓			✓ (1)	✓ (2)	✓ (2)
Feedback on behaviour [2.2]	✓	✓			✓ (1)	
Self-monitoring of behaviour [2.3]	✓	✓	✓ (4)		✓ (2)	✓ (1)
Self-monitoring of outcome(s) of behaviour [2.4]	✓	✓	✓ (8)	✓ (8)	✓ (3)	✓ (1)
Feedback on outcome(s) of behaviour [2.7]	✓			✓ (20)	✓ (6)	✓ (20)
Social support (unspecified) [3.1]	✓	✓	✓ (3)			
Social support (practical) [3.2]	✓	✓	✓ (2)			
Social support (emotional) [3.3]	✓		✓ (2)			
Instruction on how to perform the behaviour [4.1]	✓	✓	✓ (23)	✓ (10)	✓ (4)	✓ (6)
Information about antecedents [4.2]	✓	✓	✓ (5)			
Information about health consequences [5.1]	✓	✓	✓ (23)	✓ (17)	✓ (3)	✓ (5)
Information about social and environmental consequences [5.3]	✓	✓	✓ (5)			
Social comparison [6.2]	✓	✓				
Habit formation [8.3]	✓	✓				
Graded tasks [8.7]	✓	✓	✓ (1)			
Social reward [10.4]	✓	✓	✓ (1)			
Restructuring the physical environment [12.1]	✓	✓	✓ (4)			
BCTs targeting self-belief [15]	✓	✓				
Verbal persuasion about capability [15.1]		✓				
Mental rehearsal of successful performance [15.2]						
Focus on past success [15.3]		✓	✓ (6)		✓ (1)	

Behaviour change technique	NHS programme spec	Provider A presence in programme plans	Provider A presence in delivery			
			Online/app content	Service user 1 app chat messages	Service user 2 app chat messages	Service user 3 app chat messages
Self-talk [15.4]			✓ (1)			
Review behaviour goal(s) [1.5]		✓	✓ (1)			
Discrepancy between current behaviour and goal [1.6]		✓				
Commitment [1.9]		✓	✓ (1)			
Monitoring of outcome(s) of behaviour without feedback [2.5]		✓				
Biofeedback [2.6]		✓				
Information about emotional consequences [5.6]		✓	✓ (3)			
Demonstration of the behaviour [6.1]		✓				
Information about others' approval [6.3]		✓				
Prompts/cues- [7.1]		✓	✓ (3)			
Behavioural practice/rehearsal [8.1]		✓				
Behaviour substitution [8.2]		✓	✓ (7)	✓ (2)	✓ (1)	
Credible source [9.1]		✓	✓ (2)			
Pros and cons [9.2]		✓	✓ (1)			
Comparative imagining of future outcomes [9.3]		✓	✓ (5)			
Self-incentive [10.7]		✓	✓ (1)			
Reduce negative emotions [11.2]		✓	✓ (4)			✓ (1)
Conserving mental resources [11.3]		✓				
Restructuring the social environment [12.2]		✓				
Avoidance/reducing exposure to cues for the behaviour [12.3]		✓				
Adding objects to the environment [12.5]		✓				
Identification of self as role model [13.1]		✓		✓ (1)		
Framing/reframing [13.2]		✓	✓ (4)			
Identity associated with changed behaviour [13.5]		✓				

Table 2. Fidelity and dose (in parentheses) of BCT intervention delivery to A) NHS programme spec, and B) Provider B's programme plans:

Behaviour change technique	NHS programme spec	Provider B presence in programme plans	Provider B presence in delivery		
			Online/app content	Service user 1 phone calls	Service user 2 phone calls
Goal setting (behaviour) [1.1]	✓	✓	✓ (5)		
Problem solving [1.2]	✓	✓	✓ (9)	✓ (3)	
Goal setting (outcome) [1.3]	✓	✓	✓ (1)		✓ (2)
Action planning [1.4]	✓	✓	✓ (7)		✓ (1)
Review outcome goal(s) [1.7]	✓		✓ (1)		
Behavioural contract [1.8]	✓				
Feedback on behaviour [2.2]	✓				
Self-monitoring of behaviour [2.3]	✓	✓	✓ (6)	✓ (1)	✓ (2)
Self-monitoring of outcome(s) of behaviour [2.4]	✓	✓	✓ (3)		✓ (2)
Feedback on outcome(s) of behaviour [2.7]	✓	✓		✓ (1)	✓ (1)
Social support (unspecified) [3.1]	✓	✓	✓ (4)	✓ (2)	
Social support (practical) [3.2]	✓	✓	✓ (4)		
Social support (emotional) [3.3]	✓		✓ (2)		
Instruction on how to perform the behaviour [4.1]	✓	✓	✓ (6)	✓ (3)	✓ (5)
Information about antecedents [4.2]	✓	✓	✓ (4)	✓ (1)	
Information about health consequences [5.1]	✓	✓	✓ (9)	✓ (2)	
Information about social and environmental consequences [5.3]	✓	✓	✓ (1)		
Social comparison [6.2]	✓	✓			
Habit formation [8.3]	✓				
Graded tasks [8.7]	✓	✓	✓ (6)		
Social reward [10.4]	✓	✓			
Restructuring the physical environment [12.1]	✓	✓	✓ (4)	✓ (2)	
BCTs targeting self-belief [15]	✓	✓			
Verbal persuasion about capability [15.1]					
Mental rehearsal of successful performance [15.2]		✓	✓ (2)		
Focus on past success [15.3]		✓	✓ (5)		

Behaviour change technique	NHS programme spec	Provider B presence in programme plans	Provider B presence in delivery		
			Online/app content	Service user 1 phone calls	Service user 2 phone calls
Self-talk [15.4]		✓			
Information about emotional consequences [5.6]		✓	✓ (2)		
Demonstration of the behaviour [6.1]		✓			
Prompts/cues- [7.1]		✓	✓ (2)		
Behavioural practice/rehearsal [8.1]		✓			
Behaviour substitution [8.2]		✓	✓ (8)	✓ (1)	✓ (1)
Pros and cons [9.2]		✓	✓ (1)		
Self-incentive [10.7]		✓	✓ (1)		
Self-reward [10.9]		✓			
Reduce negative emotions [11.2]		✓	✓ (1)		
Framing/reframing [13.2]		✓	✓ (1)		

S1. Behaviour change technique (BCT) coding rules

A BCT must only be coded if it is part of the core delivery (not an optional activity).

New BCTs would be coded on the commencement of a new activity or if a different health behaviour (e.g., diet, physical activity), or 'level' of behaviour (e.g., strength training, cardiovascular activity, sedentary behaviour) was targeted. This rule was modified by NHS-DPP evaluators who applied this to the BCT 'information about health consequences' but was applied to all BCTs in this study (e.g., if 'problem solving' was described for strength training and sedentary behaviour, this technique would be coded twice).

A coding rule established by NHS-DPP evaluators but removed for this study was the instruction to code as 'information about health consequences' when interrupted by other activities that did not comprise of 'information about health consequences', as the NHS-DPP study authors noted this leading to the BCT being coded more frequently than others. Through team discussions it was decided that 'information about health consequences' would be coded once per behavioural health consequence, per session (e.g., the effect of starchy carbohydrates on blood glucose) unless a new behaviour or level of behaviour was described.

BCTs were not coded if they were not linked to the programme target behaviours (e.g., information on how to manage side effects for safety purpose, measures taken for the purposes of safety or data collection such as blood pressure). This is in line with the BCTTv1 training.