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Behaviour change techniques that constitute effective planning interventions to improve physical activity and diet behaviour for people with chronic conditions: a systematic review

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ABSTRACT

Objectives Action planning is a brief and effective behaviour change technique (BCT) to improve physical activity (PA) and diet behaviour (DB). This study aimed to identify critical BCTs and mechanisms of action (MoAs) to interpret the effectiveness of planning interventions based on the Health Action Process Approach (HAPA) model.

Design Systematic review.

Data sources PubMed, Web of Science, CINAHL (EBSCO), PsycINFO (EBSCO), Psychology and Behavioural Sciences Collection (EBSCO), psyARTICLES and Medline were searched for studies from January 1990 to September 2021 published in English.

Eligibility criteria Experiment involving action planning intervention to improve PA or DB in community-dwelling adult patients with chronic conditions.

Data extraction and synthesis Two reviewers independently coded the planning interventions into BCT combinations and MoA assemblies. Outcome was dichotomised according to the statistical power and Cohen's d. The Cochrane risk of bias assessment tool and the Risk of Bias in Nonrandomized Studies–of Interventions assessment tool were used to assess the quality of randomised controlled trials (RCTs) and non-RCTs, respectively.

Results From the 52 included studies, 46 BCTs were identified and linked to 21 MoAs. Long-term facilitators for planning intervention included 'self-monitoring of behaviour', 'problem solving', 'instruction on how to perform the behaviour' and 'adding objects to the environments'. The three most frequently occurring MoAs were 'intention', 'behavioural regulation', 'beliefs about capabilities'. The effective intervention groups had higher MoA scores that corresponded to the HAPA model constructs than the ineffective groups.

Conclusions The findings from this review may inform scientific and effective planning intervention designs for community-dwelling people with chronic conditions in the future.

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STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This review covered both randomised controlled trials (RCTs) and non-RCT research focusing on individuals with a variety of chronic diseases, resulting in a comprehensive analysis.
⇒ Both health outcome and behavioural outcome were taken into account to determine the effectiveness of action planning intervention.
⇒ The health action process approach model was used to conceptualise the key mechanisms of action.
⇒ Coding of interventions did not concern the intensity of each behaviour change technique.
⇒ Fidelity assessment failed to capture the degree of each fidelity item due to the dichotomous approach.

INTRODUCTION

It is well known that poor eating habits and physical inactivity are two major risk factors for non-communicable chronic diseases (NCDs), such as cardiovascular disease, type 2 diabetes mellitus (T2DM) and obesity,[1] and improvements in physical activity (PA) and diet behaviour (DB) can significantly benefit community-dwelling patients with NCDs.[2–4] In this patient population, there is an urgent need for effective behavioural interventions supported by theory and evidence, as they have less pre-existing PA, a greater sense of helplessness, less social support and more perceived barriers.[5]

Complex behavioural interventions with multiple components are gaining traction as a promising and important public health approach for encouraging these people to develop healthy eating habits and actively participate in sports. Their explosion has resulted in a plethora of categorical frameworks for aggregating intervention components. The Behaviour Change Technique Taxonomy version 1 (BCTTv1) is one of the

most complete and systematic frameworks. It consists of an 'extensive, consensually agreed upon, hierarchically structured' set of 93 techniques aimed at changing health behaviours.[6] BCTTv1 is of great value in synthesising and analysing complex behavioural interventions.

One effective behaviour change technique (BCT) popularised in PA or DB improvement is 'action planning'. It is defined as 'prompt detailed planning of behaviour performance, including context, frequency, duration and intensity'.[6] A plan that specifies situational cues and sufficient action detail, such as 'I intend to go jogging in the park on Monday at 11:00' qualifies as an action plan. Several meta-analyses have confirmed the effectiveness of planning in improving PA[7–9] and DB,[7 9–11] and they identified that reinforcement,[12] barrier management[8] and monitoring[11] were significant moderators. However, it is likely that some potential moderators have not yet been identified due to the absence of a theoretical and comprehensive synthesis of planning intervention components from the perspective of BCTs.

Theoretically, planning has been incorporated as one of the theoretical constructs into the Health Action Process Approach (HAPA) model. The model indicates that the process of health behaviour change involves two phases: motivational and volitional. Self-efficacy, outcome expectancy and risk perception are considered critical to promote intention formation (eg, 'I intended to do more exercise.') in the motivational phase, and planning is regarded as the watershed in intention conversion to action in the volitional phase, with self-efficacy moderating the effect.[13] However, the contradictory results of previous studies regarding the predictability of planning suggest that there may be unspecified mechanisms in the health behaviour change process.[14–17] For example, self-regulation[13 18] and social support[16 19] are frequently included as volitional constructs, and past habits were found to impair the intention–action association.[20 21]

To improve the theoretical understanding of the planning intervention, intervention reverse coding was conducted to identify the mechanisms contributing to the planning effect. It is identifying mechanisms of action (MoAs, the theoretical approach through which behaviour change occurs) that link to the BCTs used in an intervention through the theory and technique tool.[22] The tool is based on an expert consensus[22] and literature review[23] that summarises existing connections between BCT and MoA. A previous study applied it to determine the most frequently used MoAs in a PA intervention programme.[24] However, there is no review research that synthesises MoAs that occurred in the planning of interventions, which would advance the theoretical understanding of intervention effectiveness. By deconstructing the planning interventions into BCT combinations and MoA scores, this review aimed to (1) summarise the characteristics of BCT distribution and critical BCTs in PA and DB planning interventions targeting community-dwelling patients; and (2) enhance comprehension of the theoretical mechanisms

underlying the efficacy of planning interventions based on the HAPA model.

METHOD

Patient and public involvement
No patients were involved.

Search strategy and study selection
The review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines,[25] with the checklist available in online supplemental file 1. The protocol was registered in the International Prospective Register of Systematic Reviews (CRD42021241227). Seven electronic databases were searched, including PubMed, Web of Science, CINAHL (EBSCO), PsycINFO (EBSCO), Psychology and Behavioural Sciences Collection (EBSCO), psyARTICLES and Medline, for English-language studies published from January 1990 to September 2021. Online supplemental file 2 contains detailed information about the search strategy. Furthermore, manual searching was carried out via Google Scholar and the reference lists from previous meta-analyses.[8 10–12]

Inclusion and exclusion criteria
This review included both randomised controlled trials (RCTs) and non-RCTs. The inclusion criteria were presented according to 'PICO'. Participants were adults who lived in the community and had at least one chronic condition (Participation). They received PA and/or DB planning intervention. Specifically, they were asked to create detailed action plans specifying when, where, and how to do things or to use an 'if–then' form to create specific behavioural plans to improve PA or DB (Intervention). There should be no planning intervention in the control group (Comparison). Physiological or behavioural outcomes (as measured by self-report questionnaires or wearable devices) were considered (Outcome). The exclusion criteria were as follows: (1) participants' plans did not qualify as action or coping plans; and (2) the intervention provider (eg, nurses, healthcare professionals, etc), rather than patients, was the research object.

Study selection and data extraction
The title, abstract, and full text were reviewed independently and concurrently by HL and DX. Disagreements were discussed and resolved with the assistance of a third reviewer (ND). HL extracted the following data from each included study: sample size, participant health status, intervention target (either PA or DB, or both), intervention delivery, rehabilitation, key outcome indicator and measuring method, follow-up time, and statistical power of outcome difference between planning intervention group and control. In studies with multiple outcome indicators, the behavioural outcome (eg, pedometer) was selected first, followed by the physiological outcome and

finally the self-reported outcome. In the case of DB, the physiological outcome came first, followed by the self-reported behavioural outcome.

Risk of bias and fidelity assessment

RCT study quality was assessed using the Cochrane risk of bias assessment tool,[26] which included the following domains: (1) random sequence generation, (2) allocation bias, (3) performance bias related to participant and intervention provider blinding, (4) attrition bias due to missing data, (5) detection bias and (6) reporting bias. In the final three domains, non-RCTs were also evaluated. Additionally, they were assessed for risk of baseline confounding due to one or more prognostic variables that predicted the intervention effect, selection bias due to participant inclusion/exclusion based on their characteristics and performance bias due to deviation from intended interventions using the Risk of Bias in Nonrandomized Studies–of Interventions assessment tools.[27] Each item's risk level was classified as 'low risk', 'high risk' or 'uncertain'. Fidelity was assessed using modified Bellg *et al*[28] criteria and a dichotomised assessment in terms of study design, provider training, treatment delivery and treatment receipt. Cohen's kappa was used to assess interrater agreement in risk of bias and fidelity assessments.

Intervention coding and reverse coding

Two reviewers (HL and DX) completed the tutorial (http://www.bct-taxonomy.com, accessed on 23 January 2021) to qualify them of capacity for BCT coding. In addition, prior to formal coding, DX and HL independently coded 5% of the studies to ensure consistency. Inter-rater agreement in coding was determined by Cohen's kappa value. Two coders were retrained and coded again if the kappa value was less than 80%. The remaining differences were resolved through discussion with a third reviewer (ND).

The coding result was vectorised, with '1' indicating the presence of the BCT and '0' indicating its absence. Inactive or undefined control groups were not coded. Following coding, the BCTs were mapped to MoAs using the theory and technique tool (an online interactive heatmap matrix retrieved on 23 January 2021, from https://theoryandtechniquetool.humanbehaviourchange.org/tool). Each MoA score was determined by the number of BCTs associated with that MoA, indicating the variety of BCTs used to modify behaviour according to this theoretical mechanism. This process was repeated for each intervention group, resulting in a matrix of MoA scores, with the row representing the score of a certain MoA for all groups and the column representing the scores of all MoAs within a certain group.

Intervention effectiveness coding

Because the outcome measurement and follow-up time were highly inconsistent, it was anticipated that quantitative estimation of planning intervention effectiveness would have low evidence power and a low reference value.

Hence, intervention effectiveness was classified as 'effective', 'ineffective' or 'inconclusive' based on the effect size (ES) and statistical significance of the key indicator. Cohen's d was used to calculate the magnitude of the ES by dividing the mean difference between the intervention and control groups by the SD.[29] The rules for coding intervention effectiveness were as follows: if statistical power was significant ($p > 0.05$), the ES of an 'effective' intervention should at least reach a small level ($d > 0.2$) for physiological measurement or device-based measurements, or a medium level ($d > 0.5$) for self-reported indicators, or it was coded as 'ineffective'. If there was no information on the statistical power or ES, it was classified as 'inconclusive'.

Data synthesis

Only the planning intervention groups from the included studies were included in the analysis. The occurrence rate of each BCT was calculated by dividing the number of groups that used this BCT by the total number of groups and was classified based on target behaviour, health condition and mode of delivery. The success rate of each BCT was calculated by dividing the number of effective groups that used this BCT by the total number of groups that used this BCT and was classified as long-term (ie, the follow-up period was longer than 3 months) and short-term (ie, the follow-up period was not longer than 3 months). Notably, only BCTs involved in more than 10% of studies were included in subsequent analyses.

The MoA scores for all planning intervention groups were displayed using the R software (V.3.6.1) heatmap drawing tool.[30] MoA with an average score greater than 1 indicates that, on average, at least one specific BCT was used to improve health behaviour change via this mechanism. These MoAs were further conceptualised with the HAPA model. Descriptive analyses were then performed on the difference in MoA score between effective intervention groups and ineffective intervention groups for PA and DB outcomes.

RESULTS

Study selection and study characteristics

A total of 52 studies were included in the analysis (figure 1). As shown in table 1, there were 45 RCTs[31–75] and 7 quasi-experiments.[76–82] Thirty-nine studies included PA planning interventions, and 37 included DB planning interventions. Ten trials included a rehabilitation period prior to action planning, eight of which occurred outside the hospital.[41 47 50 51 56 58 62 78] Thirty-seven per cent of the studies targeted obese patients without metabolic syndrome (MS). The majority of studies administered the intervention via face-to-face sessions that were either individual based (58%) or individual and group based (29%). Nine studies provided merely online sessions.[31 36 38 41 48 64 65 70 78] Three studies incorporated both individual sessions and online sessions based on computers[37 68] or smartphone applications.[72]
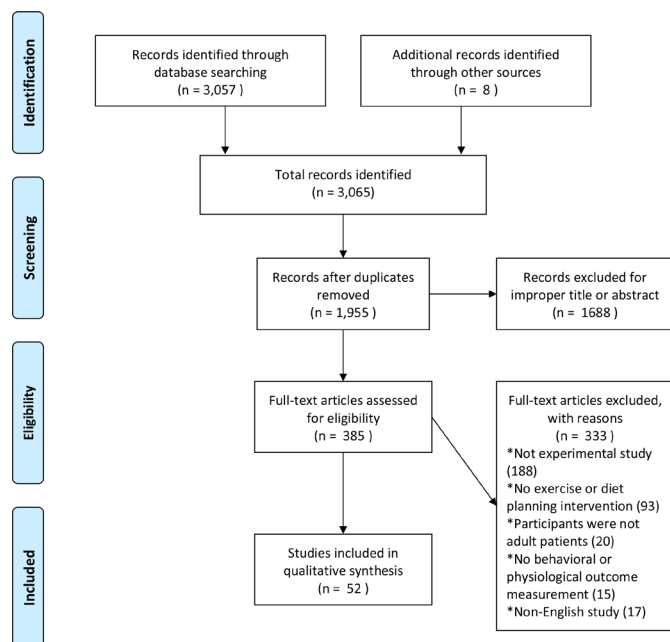
Figure 1 PRISMA flow diagram. From Moher *et al.*[25] PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Risk of bias and fidelity assessment

A substantial proportion of studies were evaluated with a high/unclear risk of performance bias (58%) and reporting bias (58%). Attrition bias and detection bias were high for 33% and 58% of the included studies, respectively. Seven RCTs were assessed with insufficient random sequence generation, and 18 showed insufficient concealment of allocations. Five non-RCTs had a high risk of baseline confounding, and three had significant selection bias. Only five trials were evaluated as having low risk in every domain.[56 64 65]

According to the fidelity assessment, 81% of studies had descriptions of standardised procedures for planning intervention, and 67% provided supplementary resources to aid participants in developing action plans. Less than half (44%) measured participants' action plans. The quality of action plans was guaranteed in 54% of trials. Only 10 (19%) studies described planning intervention provider training. Online supplemental files 3 and 4 contain detailed information on the risk of bias and fidelity assessment within individual studies. The kappa values for risk of bias and fidelity were 0.87 and 0.95, respectively.

BCT coding

To improve coding consistency, a systematic review of 20 rehabilitation studies[83] was used to summarise the common BCTs used in rehabilitation studies. The coding consistency kappa was 0.89. A total of 46 BCTs were identified from 52 studies (see online supplemental files 5 and 6 for details). In addition to action planning, the BCTs occurring in more than 10% of all groups and their occurrence rates were: (1) information about health consequences (78%); (2) behavioural goal setting (71%); (3)

unspecified social support (69%); (4) problem solving (68%); (5) adding objects to the environment (56%); (6) instruction on how to perform the behaviour (53%); (7) self-monitoring of behaviour (52%); (8) feedback on behaviour (40%); (9) practical social support (37%); (10) self-monitoring of outcomes of behaviour (32%); (11) reduce negative emotions (31%); (12) pharmacological support (28%); (13) credible source (28%); (14) prompt/cues (28%); etc. These BCTs were referred to by serial numbers for ease of reference, for example, '(2)' refers to 'behavioural goal setting' below.

The planning interventions for patients with MS included an average of 12 BCTs, which was higher than the number of BCTs used in groups for obese patients without MS (7 BCTs on average, see figure 2). The top eight BCTs in terms of occurrence in patients with MS were (1), (2), (3), (5), (6), (4), (7) and (9). In terms of the occurrence in obese patients without MS, the top eight most popular BCTs in order were (4), (1), (2), (3), (7), (8), (5) and (6). 'Practical social support' was merely popular in patients with MS (52%), while 'feedback on behaviour' was only popular in obese patients without MS (38%).

Individual session intervention, group plus individual session intervention, and online session intervention all identified averages of 9, 12, and 11 BCTs, respectively. As shown in figure 3, the top eight popular BCTs in group plus individual session interventions were (1), (2), (3), (5), (7), (4), (6) and (8) in order. The top eight common BCTs in individual session interventions were (2), (4), (1), (3), (5), (7), (6) and (11) in order. The top eight popular BCTs in order were (1), (4), (3), (2), (6), (8), (14) and (5). 'Reduce negative emotions' was simply common in individual session interventions (37%), and 'prompts/cues' was uniquely popular in online session interventions (50%).

Intervention effectiveness coding

In summary, 47 groups contained PA planning interventions, of which 42 were available for effectiveness coding, while 43 groups contained DB planning interventions. Among the 46 BCTs identified, 24 occurred in more than 10% of the PA groups, and 21 occurred in more than 10% of the DB groups. The PA intervention group had an average of 11 BCTs, whereas the DB intervention group had an average of 8 BCTs. Janssen *et al*[47] designed an intervention involving the maximum number of BCTs (N=25).

As shown in figure 4A, the top eight popular BCTs in the PA intervention groups were (1), (3), (2), (4), (6), (7), (5) and (9) in order. Except for (1), all popular BCTs had a success rate of more than 50% for long-term PA outcomes. However, only (4) and (5) had success rates above 50% for short-term PA outcomes. For the DB intervention groups, the top eight popular BCTs were (1), (2), (4), (3), (5), (7), (6) and (8). All of them had a success rate above 50% for short-term DB outcomes. However, only (4), (7), (6) and (5) had success rates

Table 1 Study characteristics

Author	Published year	Study type	Intervention target	Health status	Intervention delivery	Rehabilitation
Almeida et al[31]	2015	RCT	PA & DB	CVD	Computer session	None
Armitage et al[32]	2014	RCT	DB	OB	Individual session	None
Armitage et al[33]	2017	RCT	DB	OB	Individual session	None
Ayre et al[34]	2020	RCT	DB	OB, DM	Individual session	None
Bélanger-Gravel et al[35]	2013	RCT	PA	OB	Individual session	None
Breslin et al[36]	2019	RCT	PA & DB	OB	Group session plus individual session	None
Broekhuizen et al[37]	2012	RCT	PA & DB	FH	Computer session plus individual session	None
Cheung et al[38]	2017	RCT	PA & DB	OB	Computer session	None
Christiansen et al[39]	2010	RCT	PA	CBP	Individual session	None
de Freitas Agondi et al[40]	2014	RCT	DB	HP	Individual session	None
Duan et al[41]	2018	RCT	PA & DB	CVD	Computer session	Out-of-hospital
Gagnon-Girouard et al[42]	2010	RCT	DB	OB with depression or eating disorder	Group session plus individual session	None
Groeneveld et al[43]	2011	RCT	PA & DB	CVD	Individual session	None
Hayes et al[44]	2020	RCT	DB	OB	Individual session	None
Igelström et al[45]	2014	RCT	PA & DB	OB, OSAS	Individual session	None
Jackson et al[46]	2005	RCT	DB	CVD	Individual session	None
Janssen et al[47]	2014	RCT	PA & DB	CVD	Group session plus individual session	Out-of-hospital
Kim and Utz[48]	2019	RCT	PA & DB	DM	Smartphone application	None
Kwasnicka et al[49]	2020	RCT	PA &DB	OB	Group session plus individual session	None
Luszczynska[50]	2006	RCT	PA	Post-MI	Individual session	Out-of-hospital
Luszczynska et al[51]	2007	RCT	DB	Post-MI	Individual session	Out-of-hospital
Luszczynska et al[52]	2007	RCT	PA & DB	OB	Individual session	None
Miller et al[53]	2016	RCT	PA & DB	DB	Group session plus individual session	None
Obara-Golebiowska and Brycz[54]	2015	RCT	DB	OB	Group session plus individual session	None
Osborn et al[55]	2018	RCT	PA & DB	SMI	Individual session	None
Rodgers et al[56]	2014	RCT	PA	CLD	Individual session	Out-of-hospital
Rodrigues et al[57]	2013	RCT	PA	CVD	Individual session	None
Scholz et al[58]	2007	RCT	PA	CVD	Individual session	Out-of-hospital
Scholz et al[59]	2013	RCT	DB	OB	Individual session	None
Silva et al[60]	2020	RCT	PA	DM	Individual session	None
Sniehotta et al[61]	2005	RCT	PA	CVD	Individual session	Hospital
Sniehotta et al[62]	2006	RCT	PA	CVD	Individual session	Out-of-hospital
Sniehotta et al[63]	2011	RCT	PA & DB	NCD	Individual session	None
Soureti et al[64]	2011 a	RCT	DB	OB	Computer session	None
Soureti et al[65]	2011b	RCT	DB	OB	Computer session	None
Stevens et al[66]	2001	RCT	PA & DB	OB	Individual session	None
Ströbl et al[67]	2013	RCT	PA & DB	NCD	Group session plus individual session	Hospital
Svetkey et al[68]	2008	RCT	PA & DB	OB, HP, DLP	Computer session or individual session	None
Thoolen et al[69]	2009	RCT	PA & DB	DM	Individual session	None
van Genugten et al[70]	2014	RCT	PA & DB	OB	Computer session	None

Table 1 Continued

Author	Published year	Study type	Intervention target	Health status	Intervention delivery	Rehabilitation
Vinkers et al[71]	2014	RCT	PA & DB	OB	Group session plus individual session	None
Wilczynska et al[72]	2019	RCT	PA	OB, DM	Smartphone application plus individual session	None
Wooldridge et al[73]	2019	RCT	PA	DM	Group session plus individual session	None
Zakrisson et al[74]	2019	RCT	PA	COPD, CHF	Group session plus individual session	None
Zandstra et al[75]	2010	RCT	DB	OB	Individual session	None
Dombrowski et al[76]	2016	QE	PA & DB	OB	Individual session	None
Boekhout et al[77]	2018	QE	PA	NCD	Computer session	None
Fleig et al[78]	2011	QE	PA & DB	CVD	Computer session	Out-of-hospital
Göhner et al[79]	2012	QE	PA & DB	OB	Group session plus individual session	None
Kivelä et al[80]	2020	QE	PA & DB	NCD	Individual session	None
Leung et al[81]	2019	QE	PA	DM, HP	Group session plus individual session	None
Richardson et al[82]	2012	QE	PA	NCD	Group session plus individual session	None

CBP, chronic back pain; CHF, chronic heart failure; CLD, chronic lung disease; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; DB, diet behaviour; DLP, dyslipidaemia; DM, diabetes mellitus; FH, familial hypercholesterolemia; HP, hypertension; NCD, non-communicable chronic disease; OB, obesity; OSAS, obstructive sleep apnoea syndrome; PA, physical activity; post-MI, post-myocardial infarction; QE, quasi-experiment; RCT, randomised controlled trial; SMI, severe mental illness.

above 50% for long-term DB outcomes. Overall, 'self-monitoring of behaviour', 'problem solving', 'instruction on how to perform the behaviour' and 'adding objects to the environment' were BCTs that were favoured by the planning interventions for both PA and DB long-term improvements.

Mapping BCT to MoA
BCTs in the planning intervention groups corresponded to 21 MoAs, 11 of which scored higher than 1. In addition to 'behavioural cueing' (which corresponded to action planning), the top three MoAs in terms of occurrence were 'intention' (89%), 'behavioural regulation' (88%) and 'beliefs about capabilities' (87%). 'Behavioural regulation' was the highest scoring MoA, which was associated with an average of 1.6 BCTs. 'Beliefs about capabilities', 'knowledge' and 'intention' tied for second place, each with an average of 1.5 BCTs. A PA planning intervention involved an average of 8 MoAs, while a DB planning intervention involved an average of 11 MoAs. However, all MoAs in the PA planning
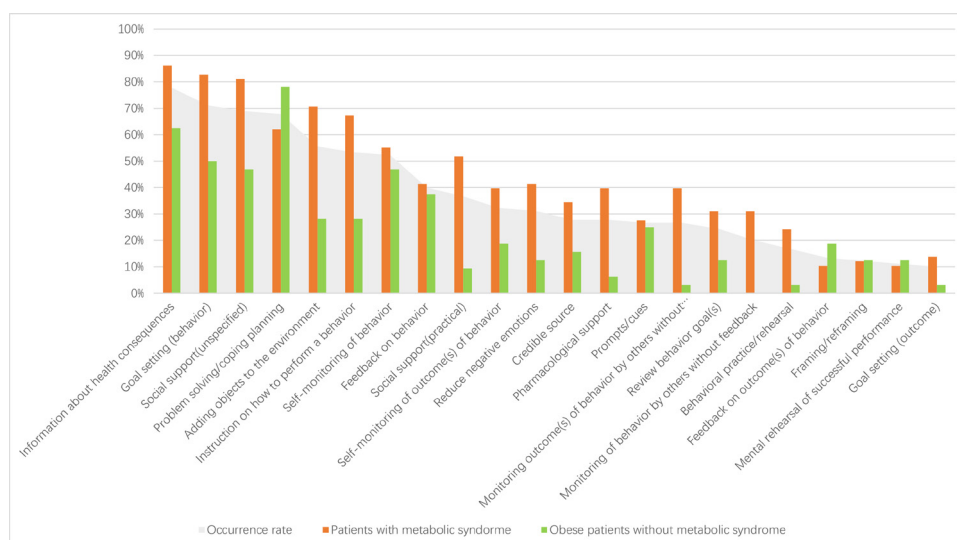

Figure 2 Distribution of BCTs for different health conditions. BCTs, behaviour change techniques.
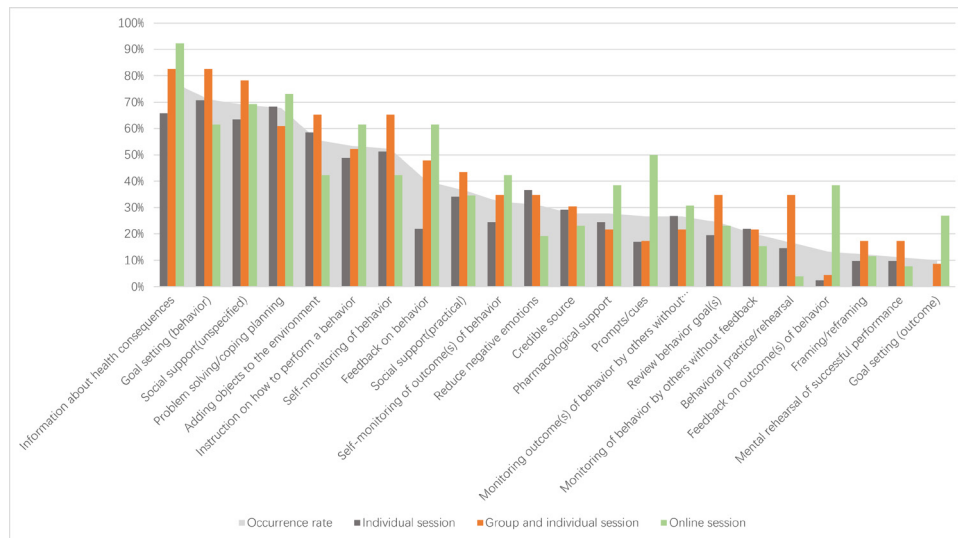
Figure 3 Distribution of BCTs for different intervention deliveries. BCTs, behaviour change techniques.
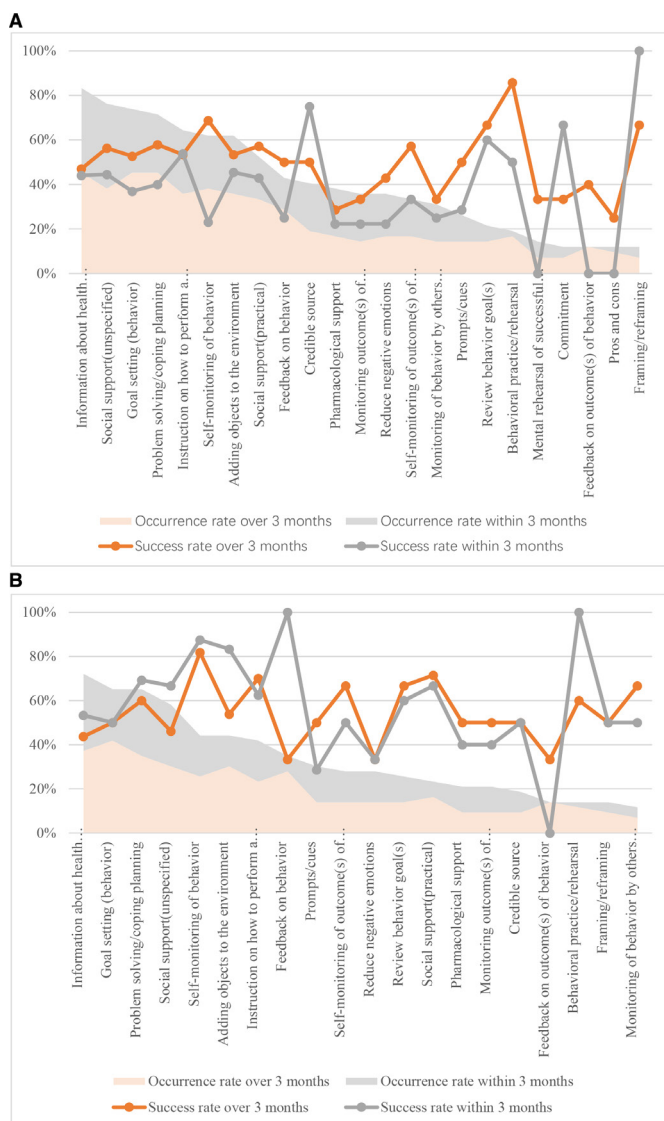

Figure 4 Occurrence and success rates of BCT in (A) physical activity and (B) diet behaviour planning intervention. BCTs, behaviour change techniques.

interventions scored higher than those in the DB planning interventions.

The results are displayed as heatmaps presenting the distribution of MoA scores (see figures 5 and 6). Table 2 displays the conceptualisation of the 11 MoAs that scored greater than 1 according to the HAPA model (columns 1 and 2), as well as their average scores for effective and ineffective planning interventions, distinguished by PA and DB outcomes (columns 4–7). Both effective and ineffective interventions covered both phases and all of the HAPA model's constructs. In the motivational phase, however, effective interventions exhibited higher scores in MoAs corresponding to self-efficacy (ie, 'beliefs about capabilities') and intention (ie, 'goals') than ineffective interventions. In the volitional phase, all effective intervention MoAs scored higher than ineffective intervention MoAs.

DISCUSSION

This study synthesised the BCT distributions and theoretical mechanisms in PA and/or DB planning interventions for community residents with chronic conditions. Overall, a total of 46 BCTs were identified from 52 included studies. There were 47 PA intervention groups and 43 DB intervention groups. 'Self-monitoring of behaviour', 'problem solving', 'instruction on how to perform the behaviour' and 'adding objects to the environment' were identified as critical BCTs. 'Behavioural regulation', 'beliefs about capabilities' and 'intention' were considered key MoAs. The following sections will elaborate on the results from the perspective of BCT distribution, intervention effectiveness and MoA.

Features of BCT distribution in planning intervention

We found that a planning intervention contains an average of eight BCTs in addition to action planning. This number is greater for PA planning interventions compared with DB planning interventions, for patients with MS versus obese patients without MS, and for group
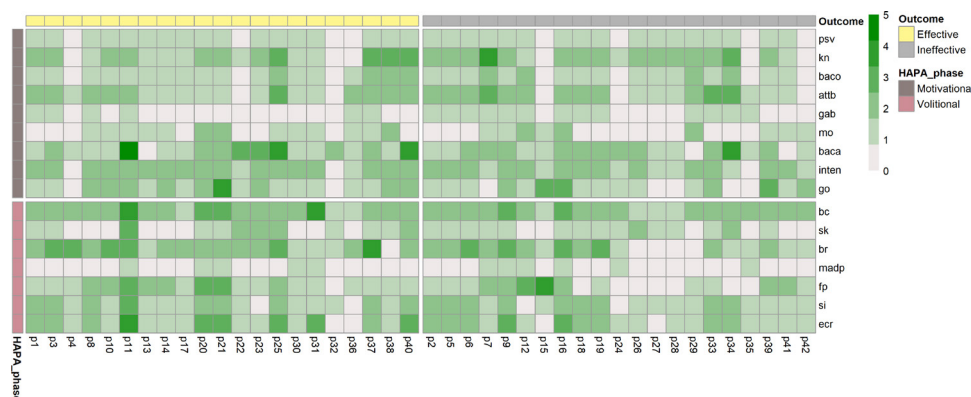
Figure 5 MoA score heatmap of physical activity planning intervention. HAPA, Health Action Process Approach; MoA, mechanism of action; psv, perceived susceptibility/vulnerability; kn, knowledge; baco, beliefs about concequences; attb, attitudes towards the behaviour; gab, general attitudes/beliefs; mo, motivations; baca, beliefs about capabilities; inten, intention; go, goals; bc, behaviour cueing; sk, skill; bc, behavioural regulation; madp, memory, attention and decision processes; fp, feedback processes; si, social influences; ecr, environmental context and resources.

and individual session interventions compared with other delivery modes.

The top eight most popular BCTs in general were information about health consequences, behavioural goal setting, unspecified social support, problem solving, adding objects to the environment, instruction on how to perform the behaviour, self-monitoring of behaviour and feedback on behaviour. However, differences were detected in the most popular BCTs for different target behaviours, disease populations and delivery modes. 'Practical social support' was only popular in PA planning interventions and interventions for patients with MS, and it was also identified as one of the key BCTs in previous reviews that synthesised the critical BCTs in PA interventions.[84–86] 'Feedback on behaviour' was simply common in DB planning interventions and interventions aimed at obese patients without MS. Consistently, Cradock *et al* regarded it as one of the critical BCTs in DB interventions for patients with T2DM.[87] In addition, we found that face-to-face sessions frequently use 'reduce negative emotions', and online sessions often use 'prompts/cues'. The latter was also detected in a past

review targeting mobile health application users. However, several previously identified BCTs failed to be captured in this review, for example, demonstration of behaviour,[7 85] social comparison,[87] information about others' approval,[85] credible source,[84] etc. This may be due to different interventions and populations of interest. However, it is insufficient to merely know what BCTs are popular because they are not always the most effective ones.

Considering intervention effectiveness, 'self-monitoring of behaviour', 'problem solving', 'instruction on how to perform the behaviour' and 'adding objects to the environment' are long-term universal facilitators for planning intervention. 'Goal setting (behaviour)', 'social support (unspecified)' and 'social support (practical)' are specific facilitators of PA planning. This is the first review to identify the critical BCTs based on the popularity and intervention's efficacy by target behaviour and follow-up period, thereby enhancing the practical and reference value. Nevertheless, it is essential to comprehend the underlying mechanisms to design an effective planning intervention with a credible theoretical foundation.
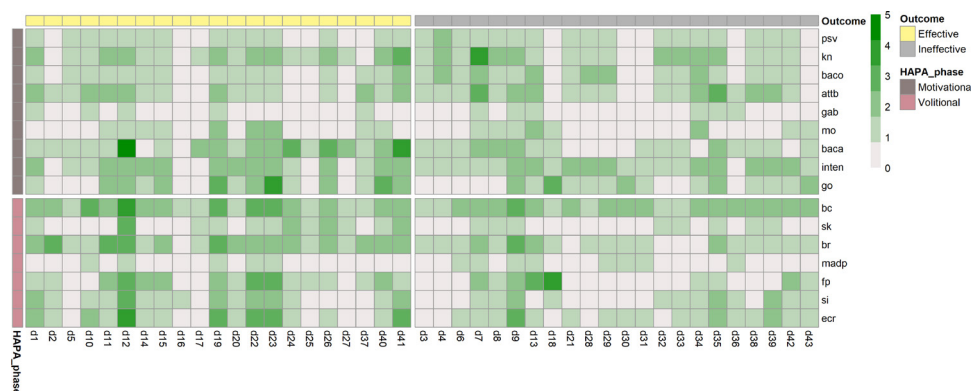

Figure 6 MoA score heatmap of diet behaviour planning intervention. HAPA, Health Action Process Approach; MoA, mechanism of action; psv, perceived susceptibility/vulnerability; kn, knowledge; baco, beliefs about concequences; attb, attitudes towards the behaviour; gab, general attitudes/beliefs; mo, motivations; baca, beliefs about capabilities; inten, intention; go, goals; bc, behaviour cueing; sk, skill; bc, behavioural regulation; madp, memory, attention and decision processes; fp, feedback processes; si, social influences; ecr, environmental context and resources.

Table 2 Average mechanism of action scores for effective or ineffective planning intervention groups

HAPA framework			Mechanism of action score			
			Physical activity		Diet behaviour	
Motivation phase (goal setting)	Volitional phase (goal pursuit)	Mechanism of action	Effective (n=21)	Ineffective (n=21)	Effective (n=21)	Ineffective (n=22)
Risk perception		Knowledge	1.6	1.7	1.3	1.2
Outcome expectation		Beliefs about consequences	1.0	1.0	0.8	1.0
		Attitude towards the behaviour	1.4	1.6	1.1	1.2
Self-efficacy		Beliefs about capabilities	1.9	1.5	1.7	0.9
Intention		Intention	1.7	1.6	1.3	1.4
		Goals	1.4	1.2	1.3	0.9
	Planning	Behavioural cueing	2.1	1.9	2.0	1.8
	Action control	Behavioural regulation	2.0	1.5	1.8	1.0
	Self-efficacy	Feedback processes	1.5	1.1	1.3	0.8
	External support	Environmental context & resources	1.7	1.4	1.3	1.0
		Social influence	1.4	1.3	1.0	0.7

HAPA, Health Action Process Approach.

Interpretation of MoAs in planning intervention based on the HAPA model

The BCTs identified through planning interventions were primarily associated with 11 MoAs. They were conceptualised based on the HAPA model. We discovered that PA planning interventions are more diverse in BCT selection but less complex in potential theoretical mechanisms than DB planning interventions. The three mechanisms with the highest scores were 'intention', 'behavioural regulation' and 'beliefs about capabilities', which were also the three most prevalent. This indicates that they are the most frequently considered factors when designing PA or DB interventions for community-dwelling patients. A prior study also found that 'beliefs about capabilities' was the most frequently targeted theoretical domain in a PA intervention programme for patients with diabetes.[24] Furthermore, effective intervention groups had higher MoA scores for action self-efficacy, maintenance self-efficacy and all other volitional constructs, which appear to be able to account for intervention effectiveness. This finding is also consistent with the connotation of the HAPA model. Schwarzer proposed that the integrity and interpretability of the HAPA model with regard to varying situations of behaviour change remain to be perfected.[88] The findings of this review would be useful for enhancing the theoretical understanding and development of HAPA research, as well as for planning interventions to improve PA and DB in community-dwelling patients with chronic conditions.

Strengths and limitations

To the best of our knowledge, this is the first review identifying BCTs and MoAs in planning interventions aimed at improving PA and DB for community-dwelling patients with chronic conditions. The summary of the characteristics of BCTs in terms of various target behaviours, chronic conditions and intervention deliveries has practical significance. The conceptualisation of identified MoAs according to the HAPA model further improves the theoretical understanding of the intervention of interest.

Several limitations exist in this review. First, the MoA score was unable to reflect the actual impact of the interventions, and data on social cognitive indicators were not collected. Second, population and language restrictions in the inclusion criteria limit the generalisability of the findings. Third, the validity of intergroup comparisons of intervention components was compromised by the fact that the coding of intervention content only accounted for the variety, but not the intensity, of each BCT. Fourth, the inclusion of non-RCT studies and dichotomous coding of intervention effectiveness diminished the evidence power. Fifth, both the overall quality of the included studies and fidelity of the planning interventions were inadequate. Due to the dichotomous approach, the fidelity assessment failed to capture the degree of each fidelity item.

Implications for future research

To design an effective PA or DB planning intervention, intervention designers should apply the prevalent BCTs identified with long-term effects in this review and consider the target population and intervention delivery. In addition, we also encourage future intervention studies on phase-based planning interventions, structuring as BCTs, and elaborating processes in a structured form (eg, intensity, frequency and delivery), as well as measuring implementation fidelity. When analysing complex behavioural interventions in the future, it is advised that implementation factors be considered. In addition, it was

suggested that data be collected on social cognitive indicators to determine the actual impact of BCTs on them.

CONCLUSIONS

In conclusion, the prevalent BCTs for planning interventions vary by target behaviour, chronic condition and intervention delivery. However, the most widely used BCTs are not always the most effective. To increase the success rate of exercise or diet planning interventions, it is best to employ BCTs that promote self-efficacy and volitional constructs of the HAPA model. The findings of this review may serve as an important reference for future research aimed at developing a rational and effective PA or DB intervention for individuals living in the community with chronic conditions.

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