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Application of behaviour change techniques to motor-skill development and health promotion in young adults: A narrative review

Ping Huang[1], Jamalsafri Bin Saibon[1*], Aswati Binti Hamzah[1], Yangguang Xue[2]
[1]Universiti Sains Malaysia, School of Educational Studies, Minden, Penang 11800, Malaysia; emilyhuangping@student.usm.my (P.H.) jamalsafri@usm.my (J.B.S.).
[2]Sports Group, RDFZ Sanya School, Sanya, China.

Abstract: This narrative review explores how Behavior Change Techniques (BCTs) have been applied to promote physical activity, motor skills, and health-related fitness in young adults aged 18–35, and maps their mechanisms onto the COM-B model. Following PRISMA guidelines, studies from 2011–2025 were retrieved from PubMed and Web of Science. After deduplication and screening via EndNote and Zotero, 29 studies were included: 17 experiments, 9 observational studies, 2 reviews, and 1 mixed-methods study. A core triad of goal setting with action planning, self-monitoring with immediate feedback, and social support or comparison appeared in over 60% of studies. This combination increased daily steps or moderate-to-vigorous physical activity within 8–12 weeks and prevented weight gain in interventions lasting 16 weeks or more. Only two studies reported objective motor skill outcomes. Effectiveness was influenced by intervention duration, adherence, gender, and motivational type. Digital tools improved access but required personalization for sustained impact. The multicomponent approach—goal setting, self-monitoring with feedback, and social support—is the most robust pathway to increase activity and maintain weight in young adults. Future research should extend follow-up periods, use objective measures of fitness and skills, and apply adaptive delivery strategies. Trials in cross-cultural settings are also needed to assess real-world scalability and cost-effectiveness.

Keywords: *Behaviour-change techniques, Digital interventions, Health-related physical fitness, Motor-skill development, Narrative review, Young adults.*

1. Introduction

As the participation rate of physical exercise among adolescents and college students worldwide decreases, health problems such as deteriorating physical fitness, rising obesity rates, and increased sedentary behavior are becoming increasingly serious. As emphasized by the World Health Organization in the Global Physical Activity Action Plan 2018–2030, the world is working to reduce the public health threat of insufficient physical activity through policy interventions [1]. Especially in China, despite the government's promotion of the "Healthy China" and "National Fitness" strategies, the motor skills and physical activity of college students have not reached the ideal state, and "fragile college students" have emerged. The lack of long-term, continuous, and systematic physical exercise has become one of the constraints on the physical health of adolescents. The physical activity level of a large number of young people is still below the recommended standard [2] which will affect the long-term health trajectory. Coupled with academic, occupational, and social pressures, this phenomenon will continue into middle age, increasing the risk of chronic diseases.

In addition, health-related fitness (such as cardiorespiratory endurance, muscle strength and body composition) is not only an important outcome indicator of physical activity, but also an independent factor in predicting long-term health outcomes [3]. However, existing studies have mostly focused on the frequency and duration of physical activity, while relatively insufficient attention has been paid to

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* Correspondence: jamalsafri@usm.my

health-related fitness, resulting in an incomplete evaluation of the effectiveness of intervention measures. Therefore, exploring how to effectively improve young people's motor skills and health-related fitness through behavior change techniques (BCTs) has important theoretical and practical significance.

Current research on the application of BCTs in physical exercise behavior still has many limitations and urgently needs further integration and expansion. First, most studies focus on specific groups, such as adolescents [4] pregnant women [5, 6] patients with chronic diseases or mental disorders [7, 8] and the elderly [9]. There are relatively few studies on the application of BCTs in ordinary healthy populations such as college students, which limits its generalizability to a wider population [10, 11]. Secondly, the effects of single BCTs are studied [12, 13]. There is still a lack of systematic understanding of which BCTs or BCTs combinations are most effective in preventing weight gain and stimulating lasting exercise motivation [14]. In addition, most of the existing reviews on the effects of BCTs on PA are systematic reviews, with most of them involving app interventions [15]. Therefore, the discussion on the mechanism of action is not in-depth enough [16, 17]. Most scholars use qualitative interviews or self-report questionnaires for evaluation [8, 18] with less reliance on objective indicators. Self-reports are easily affected by social desirability bias, which often leads to over-reporting of physical activity levels [19, 20].

Therefore, this paper adopts a narrative review method to integrate relevant empirical research and theoretical models from 2011 to May 2025, systematically and flexibly integrates and sorts out how behavior change technology promotes the development of motor skills and health promotion in young people, summarizes its action path, intervention model, practical value and future research direction, aiming to provide feasible suggestions and theoretical support for health promotion practitioners and college physical education educators.

2. Materials and Methods

2.1. Review Type and Selection Reason

This study adopts the narrative review method, aiming to flexibly integrate empirical research and theoretical models on behavior change techniques (BCTs) to promote sports skills and health-related physical fitness in youth groups from 2011 to June 2025. Behavior change interventions are proposed by Michie, et al. [21]. Compared with systematic reviews, narrative reviews are more suitable for areas where there is no unified theoretical framework or research design heterogeneity, and are convenient for analyzing intervention strategies, mechanisms of action and theoretical foundations from multiple perspectives [22].

2.2. Review Design Summary

Table 1 summarizes the process of this study from retrieval to analysis, including review type, retrieval strategy, exclusion criteria, data extraction dimensions and thematic synthesis methods.

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Table 1.
Methodology Framework for the Narrative Review.

Component	Content	Description
Review Type	Narrative review (non-systematic)	Flexibly integrate diverse evidence and theories Green, et al. [22].
Search Strategy	("behavior change techniques" OR "behavioral intervention" OR "behavior change intervention" OR "Goals and Planning" OR "Feedback and Monitoring" OR "Social Support" OR "Shaping Knowledge" OR "Natural Consequences" OR "Comparison of Behavior" OR "Associations" OR "Repetition and Substitution" OR "Comparison of Outcomes" OR "Rewards and Threats" OR "Regulation" OR "Antecedents" OR "Identity" OR "Scheduled Consequences" OR "Self-belief" OR "Covert Learning") AND ("university students" OR "college students" OR "young adults")AND ("motor skills" OR "physical literacy" OR "health-related fitness" OR "health promotion" OR "physical competence" OR "physical activity") AND ("intervention" OR "training" OR "program" OR "promotion") Time：2011-2025	Asterisk wildcards (*) and Boolean operators (AND/OR) were used in the keyword search. The Web of Science search, limited to the SCI-EXPANDED and SSCI indices, produced 882 records, while PubMed returned 1,119 records; 552 duplicates were identified across the two databases.
Inclusion Criteria	1. Participants: young adults aged 18–35 years 2. Language: English 3.Intervention: incorporates ≥ 1 Behaviour Change Technique (BCTs) as classified in Michie et al.'s 2013 taxonomy 4.Outcomes: physical activity and/or health-related fitness indicators (e.g., VO_2 max, muscular strength) 5.Publication type: peer-reviewed empirical study or theoretical review	Ensure alignment with the research question.
Exclusion Criteria	(1) Non-human studies (e.g., animal experiments) (2) Studies that do not include any behavioural intervention strategy or identifiable BCT component (3) Studies that do not clearly report motor-skill or health-related outcomes (4) Conference abstracts, theses/dissertations, commentaries, preprints, or duplicate publications (5) Studies unrelated to the exercise/physical-activity field	Exclude irrelevant evidence.
Data Extraction	Data extraction items: BCTs employed (coded using the Michie et al. taxonomy) Intervention format/delivery mode Outcome measures (primary and/or objective assessments) Key findings on underlying mechanisms	Enable standardized comparisons across studies
Synthesis Approach	Thematic analysis focuses: Effective BCT combinations Mediating mechanisms (e.g., self-efficacy) Contextual factors (e.g., digital tools)	Identify common patterns spanning multiple studies

2.3. Literature-Screening Procedure

A total of 2,001 records were identified from Web of Science and PubMed. After removing duplicates and excluding irrelevant articles based on predefined criteria, 29 studies were included in the final review. The screening process was conducted independently by two reviewers and followed the PRISMA 2020 guidelines (Figure 1).

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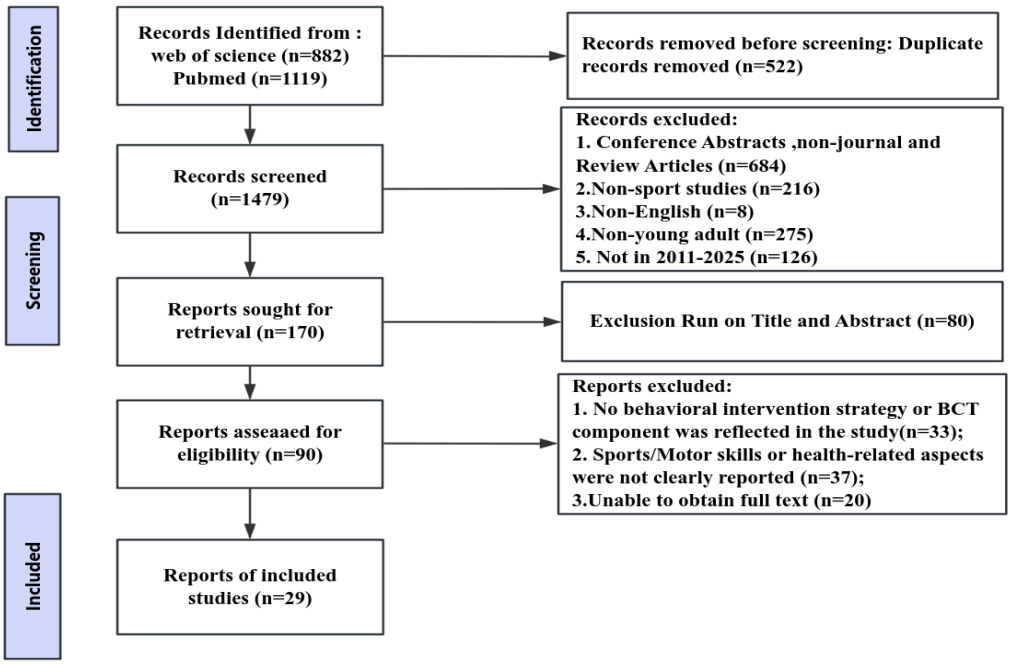

Figure 1.
PRISMA flow-diagram.

2.4. Data Extraction and Integration Method

The retrieved data were first imported into EndNote 20 in batches, and its "Find Duplicates" function was used to automatically remove duplicates by DOI and title; then the deduplicated literature was exported, and in order to prevent bias, it was imported into Zotero 7.0. One researcher screened the articles in Zotero, and another researcher performed the same operation in EndNote20. Finally, the part containing key information was exported and integrated into the Excel extraction table, realizing the pipeline management of retrieval, deduplication, indexing, and extraction. 18 RCT/experimental studies (one of which was mixed), 9 cross-sectional or longitudinal observations, and 2 systematic reviews/meta-analyses.

3. Results and Analysis

3.1. Basic Characteristics of the Literature

This study screened literature related to the topic from 2011 to 2025, and finally included 29 studies, all of which focused on young adults aged 18–35 years (Table 2). The research design was mainly randomized controlled trials or experiments (17, accounting for 58.6%), 1 experiment combined with qualitative research, and the rest were 9 cross-sectional or longitudinal observations and 2 systematic reviews/meta-analyses. The sample size span was large (14-1445 people, with a median of about 220), of which 4 trials had samples ≥ 400. The intervention carriers were diverse: 12 wearable or smartphone apps, 6 multi-platform integration (App + SNS + email), 5 offline group courses, and 4 pure web/social media projects; observational studies mainly used questionnaires and device monitoring. The most common BCT clusters were "goal setting-action plan", "self-monitoring + feedback" and "social support/comparison", of which 11 trials packaged ≥ 3 technologies into a composite intervention. Outcome measures focused on physical activity (steps, MVPA) and weight management (approximately two-thirds of the studies); seven also assessed diet or sleep, and three focused on motor skills or attention performance.

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Table 2.
Basic characteristics and main findings of the 29 included studies.

No.	Author (year)	Study design	Participants	BCTs applied	Intervention mode	Duration	Outcomes	Key findings
1	Al-Nawaiseh, et al. [23]	RCT	130 university students, 18–30 y (IG = 65, CG = 65)	Goal-setting (10 000 steps/day), self-monitoring (step-count feedback), action planning	Smartphone app + weekly reminders	12 weeks	Steps, exercise frequency, body-weight, BMI	Steps and exercise frequency increased in IG; no sig. change in BMI or body-fat %
2	Annesi, et al. [24]	RCT	98 students (56 % women, mean 20.7 y)	15 SCT-based techniques (goal & feedback, cognitive restructuring, relapse prevention, behaviour contract, self-monitoring, etc.)	Small-group sessions (15–20 per class; 8–10/class) vs usual course	15 weeks (2×75 min/week)	Exercise freq., fruit/veg, BMI; self-regulation, exercise self-efficacy, mood, body satisfaction	"Coach approach" class improved exercise, BMI & psychosocial metrics; self-regulation strongest predictor
3	Benau, et al. [25]	Cross-sectional	117 U.S. female students	SDT constructs (diet goals, exercise motives)	No intervention—surveys	–	Exercise freq., goals & motives, self-report BMI	Weight-loss dieters exercise for extrinsic/aesthetic motives; maintenance dieters report intrinsic motives; emphasising health-oriented goals may foster long-term behaviour
4	Epton, et al. [26]	RCT	1 445 UK first-year students	TPB + implementation intentions, self-affirmation	Web & mobile platform	Baseline (–2 week) to 6-monh follow-up	6-mo smoking, FV intake, PA (MET-min), alcohol; EQ-5D, drug use, BMI, cognition variables	TPB-based multi-behaviour programme designed; adherence low, effect modest
5	Farmanbar, et al. [27]	Cross-sectional	418 Iranian students, 18–30 y	Integrated TTM + SDT (stages, processes, SE, decisional balance, motivation forms, needs)	Survey	–	PA level (LTEQ); SEM fit	Model explained 82 % variance in PA; processes, SE & autonomy strongest predictors
6	Farren, et al. [28]	Cross-sectional	Active students 18–20 y	Self-efficacy, outcome expectancies, social support	Observational; gender-tailored plan suggested	–	Meeting U.S. PAGs	Psychosocial factors increased odds of meeting PAGs; males higher adherence; need SCT-based multidimensional programmes
7	She, et al. [29]	Cross-sectional	Chinese students 17–21 y	Self-esteem, physical literacy, PA pathway	–	–	Physical literacy, self-esteem, PA freq.	Physical literacy partially mediates self-esteem–PA link
8	Heeren, et al. [30]	RCT	176 South-African sophomores	SCT: behavioural capability, SE, motivation	Interactive games, role-play, video, group discussion	4 weeks (8 sessions) + 12-month follow-up	PA guideline adherence, FV & fried-food intake	IG 3.35× more likely to meet PA guideline; aero days increased; fried-food decreased; FV no change
9	Napolitano, et al. [31]	RCT + cohort	456 U.S. students	RPA framework: risk perception × SE	Social media, personalised texts, advice	6 months weekly then tapered 12	MVPA (self + device)	Personalised arm most effective; "responsive" quadrant increased PA, "indifferent" decreased

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						months		
10	Hayes, et al. [32]	RCT	599 young adults	Self-monitoring, goal-setting, small- vs large-change strategy	Small- vs large-change groups	4 months (10 F2F sessions)	Perceived efficacy, difficulty, satisfaction, weight, diet/PA change	Majority prefer small changes (esp. higher BMI); viewed as more sustainable
11	Stodden, et al. [33]	Cross-sectional	187 students & young adults 18–25 y	–	Observational	–	Motor skill index, health-related fitness	Motor skills moderately correlated with CRF & strength; low-skill linked to poor fitness
12	Quinn, et al. [34]	Longitudinal cohort	CARDIA subset 18–30 y	–	13-year follow-up GXT	13 years	VO_2 max (GXT time)	Leisure PA positively, occupational PA negatively related to CRF
13	Valle and Tate [35]	RCT	86 young adult cancer survivors 21–39 y	Goal-setting, social support, feedback	Facebook PA support group	12 weeks	PA level, engagement, behaviour change	Higher interaction linked to PA gains; peer-driven posts potentially > expert
14	Watson-Mackie, et al. [36]	Systematic review	Females 13–24 y	Prompts, feedback, self-monitoring, social influence	Wearables, apps, social media	–	PA freq., physical literacy, motivation	Tech-supported PA beneficial but evidence base limited
15	Pope, et al. [37]	RCT	38 U.S. students	SCT + SDT BCTs (SE, social support, intrinsic motivation)	Polar M400 + FB education 2×/week	12 weeks	Feasibility, MVPA, body comp., CRF, psychosocial, diet	IG showed healthier PA & diet; feedback & goal-setting effective
16	Su and Zeng [38]	Cross-sectional	403 U.S. students	Health consideration, exercise intent, entertainment motive, perceived monitoring	Online questionnaire (SEM)	–	Leisure PA, exergaming, health motives	Health consideration exergaming but not leisure PA
17	West, et al. [39]	RCT	58 U.S. students 18–35 y	SCT: self-monitoring (Fitbit, scale), goal (10 000 steps), modelling (FB norms), self-reg	Multi-tech platform	9 weeks	Weight, weight-control strategies, diet, PA	IG used +2.1 healthy strategies, weight stable; device use > 90 %
18	Kerr, et al. [40]	RCT	220 AUS young adults 18–30 y	SDT + MI: diet feedback, goal-setting	Mobile diet record + personalised SMS	6 months	FV & "junk-food" servings, intention, diet change	FV increased, junk-food decreased in IG; SMS amplified feedback effect
19	Xu, et al. [41]	Field experiment	261 Chinese students	Self-monitoring, social norms info, feedback, gender-tailoring	Pedometer + peer-step feedback	3 weeks	Mean steps/day	Both BCTs increased steps; males respond more to norms, females to self-monitoring
20	Kruger, et al. [42]	Cost-effectiveness + RCT secondary	1 445 AUS first-years	Goal-setting, feedback, reinforcement, self-monitoring, planning, info	6-module e-course + personalised email	6 months	QALY, BMI, ICER	Online programme cost-effective vs control
21	Wing, et al. [43]	RCT	600 U.S. adults 18–35 y, BMI 21–30	Self-monitoring, self-reg, goal, small vs large change, feedback, support	Three-arm (control, small, large change)	4 months + 3-year follow-up	Weight (primary), diet/PA, psychosocial, CVD risk	Both interventions decreased weight gain over 3 y; large change best
22	Merchant,	RCT (qual.	38 SMART	Goal-setting, self-monitoring,	Multi-modality	2 years	Weight-control	Social networks increased motivation;

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	et al. [44]	sub-study)	participants	social support, accountability, comparison, prompts	(FB, SMS, 3 apps, blog, coach)		behaviour, network use, experience	FB interaction moderate; contamination risk noted
23	McDonough, et al. [45]	RCT	64 U.S. adults (mean 22.8 y, BMI 23.1)	SDT: intrinsic motivation, self-monitoring, goal, barrier reduction, autonomy support, modelling	Weekly YouTube exercise (IG) vs health-edu videos	12 weeks	MVPA, light PA, sedentary, sleep, strength freq., motivation, barriers	IG increased MVPA, sleep efficiency, strength freq., intrinsic/identified motivation
24	Jakicic, et al. [46]	RCT	470 U.S. adults 18–35 y, BMI 25–40	Self-monitoring, feedback, goal, support	Standard lifestyle vs wearables + online support	24 months	Weight (main); fat %, PA, diet, psychosocial	Wearable group −3.5 kg vs −5.9 kg standard; tech ≠ superior
25	Zurita-Ortega, et al. [3]	Cross-sectional	597 Spanish students (mean 20.98 y, 57.3 % women)	Med-diet education, habit ID	Questionnaires (KIDMED, PAQ-A, AF-5)	–	Med-diet adherence, PA level, self-concept	Med-diet adherence correlated with higher PA & positive self-concept
26	Fedele, et al. [47]	Systematic review & meta	≈ 6 000 youths ≤18 y	mHealth BCTs via SMS, apps, wearables	15 mHealth studies	4 week–6 month	BMI, glycaemic control, SE, behaviour change	Moderate overall effect; multi-component mHealth promising
27	Su, et al. [48]	Lab experiment	14 elite female footballers vs 20 non-athlete students	Video-based MOT attention training	Real-match MOT with 4/6/8 targets	Single 50-min	MOT accuracy	Athletes > non-athletes; more targets decreased accuracy
28	Mullen [49]	Longitudinal survey	196 students (mean 20.2 y) & 250 adults	Perceived motor competence (PMC), physiological change (PPC), exercise identity	Online survey	4 months & 4 weeks waves	Exercise freq., identity, strength/flex	Perceived progress correlated with higher exercise & identity certainty
29	Sañudo, et al. [50]	RCT	107 adults 19–28 y	Goal-setting, real-time feedback, social support, comparison	LevantApp + Mi Band 6	8 weeks	Steps, MVPA, sleep, sedentary, SF-36	Social-comparison gamification increased moderate PA & emotional role; sleep & MVPA ns

Note: (Abbreviations: RCT = randomized controlled trial; IG = intervention group; CG = control group; SCT = Social Cognitive Theory; SDT = Self-Determination Theory; TPB = Theory of Planned Behavior; TTM = Transtheoretical Model; RPA = risk perception–attitude framework; SE = self-efficacy; BCT = behaviour change technique; PA = physical activity; BMI = body-mass index; MET=Metabolic Equivalent of Task; EQ-5D=EuroQol Five-Dimension Health Questionnaire; LTEQ=Leisure-Time Exercise Questionnaire; SEM=Structural Equation Modelling; FB=Facebook;CVD=Cardiovascular Disease; KIDMED=Mediterranean Diet Quality Index for Children and Adolescents; AF-5=Autoconcepto Forma-5 (Five-Factor Self-Concept Questionnaire); SMS=Short Message Service (text messaging); PAGs = Physical Activity Guidelines; PAGs = Physical Activity Guidelines; FV= fruit and vegetables; GXT = graded exercise test; CRF = cardiorespiratory fitness; QALY = quality-adjusted life year; ICER = incremental cost-effectiveness ratio; mHealth = mobile health; MVPA = moderate-to-vigorous physical activity; MOT = multiple-object tracking; ns = not significant; MI = motivational interviewing.).

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3.2. Theory And BCTS Application

3.2.1. Theory Drive

Theoretical frameworks varied across studies, with Social Cognitive Theory (SCT), Self-Determination Theory (SDT), and the Theory of Planned Behavior (TPB) being the most frequently applied. Table 3 summarizes the distribution, representative studies, and design features of each theoretical approach.

Table 3. Theoretical frameworks underpinning included interventions.

Theory	Representative Studies	Frequency (N)	Key Constructs / Design Highlights
Social Cognitive Theory (SCT)	Annesi, et al. [24]	7	Emphasises self-efficacy, outcome expectations and social support; frequent use of self-monitoring and feedback to strengthen personal–environment coupling within Bandura's triadic reciprocity.
Self-Determination Theory (SDT)	Benau, et al. [25]	6	Seeks to satisfy autonomy, competence and relatedness to foster intrinsic motivation; often combined with goal-setting and social-support BCTs.
Theory of Planned Behavior (TPB)	Epton, et al. [26]	4	Tailors messages and implementation intentions on the basis of attitude, subjective norm and perceived behavioural control.
Transtheoretical Model (TTM)	Farmanbar, et al. [27]	3	Integrates stage of change with SDT regulation types; explained 82 % of variance in exercise behaviour in the cited study.
Risk-Perception–Attitude Framework (RPA)	Napolitano, et al. [31]	1	Digital prompts personalised to the four risks × efficacy quadrants, matching message tone to user profile.
Supplementary mechanism: Implementation Intention & Self-affirmation	—	2	Uses self-affirmation to lower defensiveness, then "if–then" plans to close the intention–behaviour gap.

Notably, digital interventions, such as mobile apps, wearable devices, and social network services, tended to adopt SCT or SDT to facilitate real-time feedback and social interaction. In contrast, classroom-based or group interventions more often employed TTM or TPB to guide stage-wise progression. However, there was a clear gradient in the depth of theoretical integration: approximately one-third of studies merely cited a theory in the introduction without applying it to design, and fewer than 30% translated theoretical constructs into measurable variables. This suggests a potential mismatch between theory, technology, and evaluation, which warrants cautious interpretation.

3.2.2. Overview of the Application of Behavior Change Techniques (BCTs)

Based on the 93-item classification of behavior change techniques (BCTTv1) by Michie, et al. [21] 17 intervention trials were coded one by one, with an average of 4.2 ± 1.5 BCTs per intervention; clusters with an occurrence rate of ≥ 50% are shown in Table 4 below.

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Table 4.
High-frequency BCT clusters identified in the 17 intervention trials.

High-frequency BCT cluster	BCTTv1 code	Frequency (n = 17)	Representative studies & highlights
Goal setting + Action planning	1.1 / 1.4	14	"10 000 steps per day" or "150 min MVPA per week" targets common in Al-Nawaiseh, et al. [23]; Kerr, et al. [40] and Wing, et al. [43] raised step count markedly (ES = 0.82).
Self-monitoring + Immediate feedback	2.3 / 2.2	13	Wearable or log-based feedback: Sañudo, et al. [50](Mi Band + leaderboard), West, et al. [39] (Fitbit + Wi-Fi scale).
Social support / Social comparison	3.1 / 6.2	11	Facebook groups Pope, et al. [37] and Valle and Tate [35] tiered leaderboards .
Feedback–Reward–Gamification	10.1 / 10.4 / 10.9	8	Sañudo, et al. [50] and Merchant, et al. [44] app-based task badges and peer "likes".
Problem solving / Relapse prevention	1.2 / 8.2	7	Wing, et al. [43] "traffic-light weight zones" triggering self-selected responses; Hayes 2021 "small- vs large-change" coping strategy.
Prompts / Cues	7.1	7	Al-Nawaiseh, et al. [23] weekly SMS; Napolitano, et al. [31] personalised push notifications.

The coding results of 17 intervention trials show that health interventions for young adults generally build a basic closed loop around "goal setting/action plan-self-monitoring-immediate feedback": the occurrence rates are as high as 82%, 76% and 76% respectively. More than 80% of the trials integrate at least 3 BCTs, and the effects of this "composite package" on step count, MVPA or weight control are significantly better than single technology (such as Al-Nawaiseh, et al. [23]) and Wing, et al. [43]. However, "technology stacking" is not the more the better: Jakicic, et al. [46] found that the wearable group lost less weight due to the lack of individualized strategies, suggesting that the dose-response curve may be an inverted U-shaped [46]. Looking further, social support/comparison and gamification rewards can strengthen motivation through peer interaction or point badges, but their effectiveness depends on the push frequency and feedback timeliness; insufficient prompts will weaken the intensity of intervention. In general, the most effective projects all reflect the fit of "theory-technology-context": one type uses SDT/SCT as a framework to improve self-efficacy and intrinsic motivation through goal setting + self-monitoring + social support; the other type follows the TPB/implementation intention idea, combining action plans, push reminders and instant feedback to bridge the intention-behavior gap. Both paths use high-frequency BCTs to form a positive cycle in the ability, opportunity and motivation links of the COM-B model to achieve continuous improvement in exercise and health behaviors of young adults.

3.3. Intervention Effects on Motor Skill Development

Although all 29 studies focused on physical activity or health outcomes in young adults, there is still very limited evidence that truly uses "sports skills" as the primary or objective endpoint. Only two cross-sectional/laboratory studies directly quantified skill performance: Stodden, et al. [33] combined college students' throwing speed, standing long jump, etc. into a "sports skill index" and found that the index was moderately correlated with cardiopulmonary endurance and muscle strength ($r \approx 0.40–0.55$), revealing that low-skilled people often lack physical fitness Stodden, et al. [33] used a video multi-target tracking task based on real football games to confirm that elite athletes had significantly higher accuracy than non-athletes under high-load visual tracking ($p < .001$), suggesting that long-term sports experience can be transferred to high-level perception-decision-making abilities [48]. These two results show that skill level may be both a prerequisite for physical fitness and a manifestation of cognitive-motor integration, but there is still a lack of randomized controlled designs to verify the intervention causal chain.

In randomized controlled trials (RCTs) and field experiments, "skills" appear more as indirect indicators. McDonough, et al. [45] pushed strength and core training videos on YouTube every week, combined with goal setting and self-monitoring, which increased the frequency of strength training in the intervention group by about 30% McDonough, et al. [45] and West, et al. [39] combined Fitbit

monitoring, Facebook exercise demonstration posts and daily weigh-in feedback, and participants reported an increase in movement proficiency and a decrease in improper weight management behavior [38] found that "health motivation" was positively correlated with Exergaming complex movement exercises, indicating that digital games can build a low-threshold entry for skill practice [38]. Although these projects do not have objective skill assessments, the chain of "demonstration-practice-feedback" provides an operational framework for future skill-oriented interventions.

"I feel more skilled" is also a key psychological driver to maintain exercise. Mullen [49] found in a 4-month follow-up that college students who perceived their skills or physiological "progress" had a simultaneous increase in the number of days they exercised per week and their "sense of identity as an athlete"Mullen [49] took "skill mastery-self-regulation" as the core theme of a group course, and found that self-regulation became the strongest predictor of exercise frequency and BMI improvement [24]. These studies confirm the "sense of competence" emphasized by self-determination theory. Even in the absence of objective measurement, improving subjective skill mastery can stabilize behavioral stickiness.

In summary, the existing literature shows that: (1) objective skill evidence is scarce and is mainly limited to cross-sectional or laboratory comparisons; (2) demonstration and feedback in digital media can indirectly improve skill-related behaviors, but there is a lack of post-test verification; (3) subjective skill mastery is positively correlated with sports persistence and identity. Future interventions should systematically introduce standardized skill tests (such as skill-related fitness or sports visual assessment) in RCTs, and use wearable or computer vision technology to achieve real-time action quality feedback to verify the results of sports skill practice.

3.4. Intervention Effects on Health-Related Fitness

Of the 17 trials that included interventions, 14 reported health-related fitness indicators, with intervention periods ranging from 3 weeks to 24 months, and digital solutions (wearable devices, apps, or social media) accounted for the majority. Most studies observed significant improvements in step counts or MVPA within 8–12 weeks. For example, Al-Nawaiseh, et al. [23] achieved a daily step count effect size of 0.82 in the intervention group through "10,000 steps per day + weekly SMS reminders"[50] 8-week gamified leaderboard did not significantly increase the total MVPA, but increased moderate-intensity activity time and improved emotional role function [50]. Long-term follow-up evidence is relatively scarce, but [34] 13-year cohort analysis showed that leisure-type physical activity was positively correlated with VO_2 max, while high-physical labor occupational activities had limited benefits for cardiorespiratory fitness[34].

Weight and body composition are the most frequently reported physical fitness endpoints (8 trials). found in an average 3-year follow-up that both the "small change" strategy of daily small energy deficit (-100 kcal/+2000 steps) and the "big change" strategy of annual buffered weight loss can significantly inhibit weight gain, and the latter is more effective [43] in contrast, Jakicic, et al. [46] 24-month study showed that the wearable group lost less weight (-3.5 kg) than the traditional lifestyle group (-5.9 kg), suggesting that technology stacking cannot replace personalization and high-frequency feedback [26]. 9-week multi-platform program also did not significantly reduce weight[39] but significantly increased the number of healthy weight control strategies (+2.1 vs -1.1), indicating that the path of changing behavior first and then seeing weight results is still feasible.

Multi-factor combination interventions often bring richer physical fitness benefits. Kerr, et al. [40] significantly increased fruit and vegetable intake and reduced "junk food" intake through 6 months of personalized text messages and dietary feedback [37] combined Polar watch monitoring with Facebook health education for 12 weeks, and the intervention group's MVPA, body composition and self-efficacy improved simultaneously [37] used YouTube video push to simultaneously improve MVPA, sleep efficiency and strength training frequency within 12 weeks, highlighting the potential of online videos to lower the threshold for skill learning and thus improve physical fitness [45]. Studies on special populations also show the advantages of customization [35]. Facebook support group for young cancer survivors significantly increased PA within 12 weeks, and the frequency of interaction was positively

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correlated with the increment [35] found that men were more sensitive to peer step feedback, while women were more driven by self-monitoring, suggesting that gender factors should be incorporated into the design of algorithm push and reminder frequency [41].

In general, digital intervention can significantly improve daily activity and healthy weight behavior in the short term, but there is still little evidence for follow-up of more than 1 year; "hard indicators" such as cardiopulmonary endurance are not measured enough, and most trials still use steps or MVPA as alternative indicators. Future research urgently needs to combine multi-sensor technology and machine learning to dynamically monitor energy budget and cardiopulmonary load, and verify the complete causal chain of "physical activity → physical fitness → metabolic health" through stratified and phased intervention, while clarifying the minimum effective dose of technology intervention and the possible "overdose" threshold.

Based on the COM-B model (Capability-Opportunity-Motivation → Behaviour) proposed by West and Michie [51] 29 literatures revealed three common "technology-construction" pathways for health intervention in young adults, and presented a structure that can be circulated and amplified: self-monitoring generates data → data sharing or instant feedback expands opportunities → sense of achievement/social comparison enhances motivation → re-performs behavior and accumulates new data. The following explains how each component is triggered by high-frequency BCT.

3.5. COM-B Mapping of Action Mechanism

Self-monitoring and immediate feedback (BCT 2.3/2.2) enable participants to quickly correct technical movements and recognize physical boundaries by quantifying steps, weight or training progress. Al-Nawaiseh, et al. [23] "10,000 steps per day + weekly text messages" significantly increased the number of steps, and the subjects reported that they "better understood their own exercise rhythm" [33] further showed that skill level was moderately correlated with cardiopulmonary endurance and muscle strength, suggesting that ability improvement has a transfer effect [33] pushed action demonstrations on YouTube, and the frequency of strength training and sleep efficiency improved simultaneously[33] indicating that video-based skill teaching is also an effective means to expand mental/physical abilities.

Social support and social comparison (BCT 3.1/6.2) provide external opportunities for young people: [33] found that after the Polar watch data was made public in the Facebook group, the number of interactions was positively correlated with the increase in Stodden, et al. [33] showed a similar trend in the support group for cancer survivors[35]. In addition, Xu, et al. [41] gender-tailored intervention showed that peer step rankings were particularly motivating for men, while women relied more on self-monitoring, emphasizing that the opportunity structure needs to be aligned with demographic characteristics [35]. Digital platforms and wearable devices superimpose "physical opportunities" (recording at any time, exercising anywhere) and "social opportunities" (instant sharing, group norms), forming a double push.

Goal setting-action plan (BCT 1.1/1.4) and rewards (BCT 10) jointly drive motivation. Xu, et al. [41] used leaderboards and points badges to activate social comparison and external rewards, increasing the time of moderate-intensity activities in the short term [24] incorporated "skill mastery-positive self-talk" into group courses, and self-regulation became the strongest predictor of BMI and exercise frequency improvement, reflecting the intrinsic motivation effect of increased competence [24] pushed personalized text messages based on the risk perception-self-efficacy quadrant, and the activity volume of high-risk/high-efficiency people increased the most, indicating that accurate matching can shorten the "intention-behavior" gap [31].

The above elements are not arranged linearly, but form a closed loop of "recording → feedback → motivation improvement → re-recording": psychological ability is improved through self-monitoring, and after obtaining feedback, emotional rewards are triggered through external opportunities (likes, leaderboards), thereby stimulating reactive motivation. After motivation is increased, higher-quality

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behavioral output is promoted, thereby strengthening reflective motivation and physical ability, and generating new data again. This cycle demonstrates the elements of COM-B and the functions of BCW [42], and also explains why composite packages (≥3 BCTs) perform better than single technologies. Conversely, when feedback is delayed or insufficiently personalized (e.g., the Jakicic, et al. [46] wearable group lost less weight than the control group [31] the closed loop will fail due to motivational decay.

3.6. Key Factors Affecting Intervention Effectiveness

The "dose" of intervention, that is, duration and frequency of contact, first determines the upper limit of health benefits. Programs shorter than six weeks can only produce slight fluctuations in behavior; Al-Nawaiseh, et al. [23] significantly increased the number of steps through the "10,000-step goal + weekly text messages" within 12 weeks Al-Nawaiseh, et al. [23] failed to increase the total MVPA in just eight weeks, suggesting that insufficient intensity makes it difficult to penetrate daily inertia [50]. Designs that last more than four months and are accompanied by phased reinforcement are more likely to translate into changes in weight or body composition [50] proved in a three-year follow-up that the dual strategies of "small changes" and "annual buffering" can suppress weight gain in the long term, emphasizing the need to embed intervention into the annual rhythm of life[50].

The delivery vehicle is equally important. A single wearable or a single social platform can often only cover a certain link in the behavior chain; Kerr, et al. [40] "diet record-text message-personalized feedback" triple solution and Kerr, et al. [40] "Fitbit-Facebook-email" hybrid model both increase fruit and vegetable intake and healthy weight control strategies due to multi-channel touchpoints[40]. On the contrary, found that the 24-month group that relied only on wearable devices lost less weight than the traditional face-to-face group, indicating that the effect of technology stacking will be discounted if there is no interpersonal or situational support. Whether the intervention is effective also depends on participation and compliance recorded that the number of Facebook interactions was significantly positively correlated with the increase in MVPA Kerr, et al. [40] also observed that the more posts and likes from peers, the greater the increase in physical activity among cancer survivors. A negative example comes from Epton, et al. [26]. Although the intervention content was carefully designed based on TPB, the webpage click rate was less than 20%, resulting in no significant increase in physical activity at 6 months. It can be seen that "high-quality content + high usage stickiness" are indispensable.

Individual differences further regulate intervention sensitivity. Epton, et al. [26] confirmed that gender modulated the information path: men were most sensitive to the ranking of "peer steps", while women relied more on self-monitoring feedback [31] pointed out in the four quadrants of risk perception-attitude (RPA) that "high-risk-high-performance" youth had the largest increase in physical activity after receiving personalized text messages, while the "indifferent" group decreased [31]. Different health states also require differentiated designs-among young cancer survivors, emotional support and a small number of structured goals can maintain participation better than high-intensity competitions [31].

Situation and incentive structure is the fourth dimension. Annesi, et al. [24] combined "self-regulation skills training" with positive feedback through face-to-face teaching in small groups, and self-regulation became the strongest predictor of BMI improvement; on the contrary, Jakicic, et al. [46] showed that after the motivation of the wearable group declined, there was not enough social or material rewards to fill the gap in the long period, and the weight loss eventually fell behind [31]. Gamification design should also be cautious leaderboard enhanced moderate-intensity activities, but did not touch on sedentary and sleep-implying that the point badge has limitations on specific behaviors [31].

In summary, the five dimensions of dose, carrier, participation, individual differences, and situational incentives jointly determine the "height" and "steepness" of the intervention curve. If future programs want to achieve sustainable effects in young adults, they should: (1) combine a core period of at least 12 weeks with a low-dose maintenance period of more than half a year; (2) adopt a hybrid delivery method

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of "technology + people" and use social or face-to-face components to maintain emotional bonds; (3) monitor usage data in real time and set dynamic reminder thresholds; (4) push notifications by gender, motivation baseline or health risk; and (5) embed visual progress and diversified rewards at behavioral touchpoints to prevent motivation from fading.

3.7. Study Heterogeneity and Quality Assessment

The 29 papers included in this review had significant differences in design and reporting quality: 17 RCTs/experimental studies, one mixed, 9 cross-sectional or longitudinal observations, and 2 systematic reviews/meta-analyses, with follow-up spans ranging from 3 weeks to 24 months. Although most RCTs described the randomization process, only about half described allocation concealment or intervention implementation in detail, and digital interventions generally face low compliance rates - for example, the web page click rate of Epton, et al. [26] was less than 20%, which may underestimate the intervention effect. The choice of indicators is also highly heterogeneous: most trials use subjective steps or MVPA as endpoints, and less than one-third of them actually measure VO_2 max, body composition or sleep quality; objective motor skill tests are only seen in individual laboratory studies. Cultural and sample structure differences further amplify the discreteness of the results (the proportion of women is 0–73%, covering four continents: America, Europe, Asia and Africa). Based on the above limitations, the findings of this review should be regarded as trend evidence rather than precise effect size; future studies need to be further strengthened in terms of extending follow-up, adding objective physical fitness measurements, and improving bias control using CONSORT-eHEALTH or ROB-2 tools.

4. Conclusion and Future Study

4.1. Conclusion

This narrative review screened 29 studies targeting young adults aged 18-35 years from 2011 to June 2025 and found that: a high-frequency BCT combination consisting of "goal setting/action planning, self-monitoring with immediate feedback, and social support/social comparison" can significantly increase daily steps and MVPA in 8-12 weeks, and lead to weight maintenance, body composition optimization, and mood improvement in some studies; digital carriers (wearable devices, smartphone apps, social media) amplify the intensity of intervention through real-time data and peer interaction, but their effectiveness depends on personalized push and emotional ties; the intervention effect shows a dose-response feature, and a core period of ≥12 weeks plus a low-dose maintenance period is most conducive to behavior consolidation; gender, baseline motivation, and health risks have a moderating effect on intervention sensitivity, and although objective motor skills are associated with healthy physical fitness, there is little randomized controlled evidence to directly verify the complete chain of "skills-physical fitness-health".

4.2. Future Study

This review is limited by the heterogeneity of the original studies and incomplete reporting: only half of the RCTs described randomization and bias control in detail, there were very few follow-up data for more than 12 months, objective indicators (VO_2 max, sleep, motor skills) were seriously insufficient, and digital interventions generally had problems of low compliance and poor stickiness; cultural sample differences (region, gender ratio) also magnified the effect dispersion. Future studies should extend follow-up and introduce a maintenance phase, use unified and objective physical fitness and skill measurements, use hierarchical algorithms to accurately push to improve individualized effects, and verify the economy and scalability of interventions in multi-center, cross-cultural settings, especially to explore the implementation and cost-effectiveness of the "skills-first" model and hybrid delivery model in the real world.

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Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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