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Review

Effectiveness of exercise snacks on physical function: a systematic reviews with meta-analysis of randomized controlled trials

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ABSTRACT

Background: The effects of exercise snacks interventions on physical function in healthy or sub-healthy adults remain unclear. Exercise snacks intervention is defined as breaking up daily physical activity into brief, frequent bouts performed intermittently throughout the day (e.g., 1–2 min of stair climbing or bodyweight training hourly). This study aims to evaluate the effectiveness of exercise snacks interventions in improving physical function in this population.

Methods: The systematic search covered the China National Knowledge Infrastructure (CNKI), China Science and Technology Journals (VIP), Wanfang, PubMed, Embase, CINAHL, Web of Science, Cochrane Library, and Scopus databases, screening relevant randomized controlled trials published up to July 31, 2025. The risk of bias in the included studies was assessed using the Cochrane risk of bias tool, and data analysis was performed with RevMan 5.3.

Results: This study included 11 eligible randomized controlled trials involving 472 participants. Meta-analysis results demonstrated that exercise snacks interventions significantly increased absolute peak power output [MD = 16.53, 95%CI (2.93, 29.77), $P = 0.02$], maximal oxygen uptake [MD = 0.19, 95%CI (0.02, 0.36), $P = 0.03$], the number of repetitions in the 60-second sit-to-stand test [MD = 4.38, 95%CI (1.00, 7.77), $P = 0.01$], while significantly reducing body fat percentage [MD = −3.12, 95%CI (−5.51, −0.73), $P = 0.01$]. However, no statistically significant differences were observed in improving fatigue levels or BMI.

Conclusion: Among healthy and sub-healthy adults, exercise snacks interventions enhance cardiorespiratory endurance by increasing Wpeak and VO_{2max}. Concurrently, they improve functional movement capacity by increasing the number of 60-second sit-to-stand repetitions and reducing body fat percentage. As a feasible, convenient, and easily integrated exercise method, exercise snacks demonstrate significant potential for health promotion.

1. Introduction

In the context of contemporary fast-paced lifestyles, sub-health has emerged as a pressing global public health challenge affecting adults, with its prevalence expanding and shifting toward younger demographics. It represents a gray zone between health and disease: while not meeting clinical diagnostic thresholds, it is characterized by persistent physiological decline and metabolic dysregulation [1]. Globally, approximately 31% of healthy adults fail to meet public health recommendations for physical activity [2]. Sedentary behavior and psychological stress are driving healthy individuals toward suboptimal health states, and chronic physical inactivity not only accelerates this transition but also is strongly associated with elevated risks of cardiovascular disease, obesity, type 2 diabetes, and all-cause mortality [3–5]. Thus, there is an urgent need for flexible, feasible, and effective physical activity strategies that address both the preventive needs of healthy adults and the rehabilitative needs of those in sub-health.

Traditional exercise guidelines recommend 150−300 min of moderate-intensity physical activity per week [6], yet widespread adoption remains constrained by time, environmental, and

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facility-related barriers [7]. As an innovative exercise intervention paradigm, "exercise snacks" have garnered increasing attention in recent years. First conceptualized by Harvard Medical School cardiologist Hartley in 2007 [8], the term "exercise snacks" was explicitly introduced by Francois et al. in 2014 [9]. The 2025 Expert Consensus [10] defines exercise snacks as brief, independent bouts of high-intensity activity (≤1 min per session) performed regularly throughout the day, fragmented into short, frequent segments (e.g., 1−2 min of stair climbing or bodyweight exercises hourly). Relative to traditional continuous exercise interventions, exercise snacks offer advantages of temporal flexibility and ease of implementation, rendering them particularly appealing to busy, sedentary adults in modern societies.

While existing studies have preliminarily examined the health impacts of exercise snacks, conclusions remain inconsistent. Some studies demonstrate significant improvements in cardiometabolic biomarkers, cardiorespiratory fitness, and muscular endurance, coupled with high adherence rates [11,12], whereas others report no significant effects on lower-limb motor function or body weight [13]. Current evidence regarding the effects of exercise snack interventions on physical function in healthy and sub-healthy adults remains limited, with a lack of systematic reviews with meta-analyses. This study synthesizes published randomized controlled trials (RCTs) to evaluate the effects of exercise snack interventions on cardiorespiratory endurance, exercise capacity, and body composition in healthy and sub-healthy adults, aiming to clarify their practical efficacy in improving adult physical function and inform their integration into daily life.

2. Materials and methods

This review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [14]. The study protocol has been registered in the International Prospective Systematic Reviews Register (PROSPERO), registration number: CRD420251166636.

2.1. Data sources and search strategy

Search the CNKI, VIP, Wanfang, PubMed, Embase, CINAHL, Web of Science, Cochrane Library, and Scopus databases to identify relevant randomized controlled trials. Develop the search strategy using a combination of subject headings and free-text terms. English search terms included: physical conditioning, physical fitness, physical health, body form, physical form, physical function, body function, muscle function, cardiopulmonary fitness, physical performance, physical functional performances, resting HR, lung capacity. The search timeframe spanned from each database's inception to July 31, 2025.

2.2. Literature inclusion criteria

2.2.1. Inclusion criteria

Inclusion criteria followed the PICOS framework [15]. Specifically: Population (P): Individuals aged >18 years in healthy or suboptimal health status, without comorbidities such as diabetes, hypertension, or cancer; Intervention (I): Exercise-based snack intervention in the experimental group; control group maintained routine daily habits or alternative exercise regimens; Outcome measures: cardiorespiratory endurance [VO_{2max}, absolute peak power output (Wpeak)], functional mobility (60-second sit-to-stand test), fatigue scores, and body composition indicators [body fat percentage (BF%), body mass index (BMI)]; Study design: randomized controlled trials; quantitative data from mixed-method studies meeting criteria may also be included.

2.2.2. Exclusion criteria

Full text unavailable; duplicate publications, conference proceedings, animal studies, observational studies (e.g. cross-sectional studies, case-control studies, cohort studies), reviews, case reports, government reports, and policy documents; data cannot be extracted.

2.3. Data selection and extraction

Two researchers trained in evidence-based methodology independently screened studies and extracted data according to inclusion and exclusion criteria, followed by cross-checking. Disagreements were resolved through mutual discussion or by consulting a third party. The following data were extracted from included studies: authors, publication year, sample size, intervention measures in the experimental group, frequency of intervention, duration of intervention, and outcome measures.

2.4. Risk of bias assessment

According to evidence-based medical research guidelines, the Cochrane Risk of Bias 2 (RoB 2) tool [16] was used to classify the risk of bias in RCTs as "low risk," "high risk," or "unclear," with corresponding risk assessment plots generated.

2.5. Statistical methods

Research data were analyzed and graphed using RevMan 5.4 software. Standardized mean difference (SMD) and mean difference (MD) were applied respectively for outcome measures with consistent or inconsistent measurement methodologies and units, with 95% confidence intervals (CI) used for estimation. When $I^2 \leq 50\%$, low heterogeneity was assumed, and a fixed-effect model was used. When $I^2 > 50\%$, high heterogeneity was assumed, and a random-effects model was employed. Sources of significant differences were investigated through sensitivity analysis or subgroup analysis. The significance level was set at $\alpha = 0.05$. All included randomized controlled trials reported results as mean ± standard deviation. Studies with incomplete data were excluded.

3. Results

3.1. Search results and overview

As shown in Fig. 1, the search yielded a total of 3,396 literature records, with an additional 1 study obtained through other channels. After removing duplicates, 2,408 records remained. Following review of titles and abstracts, 43 studies were assessed for eligibility, as the rest were excluded for irrelevance to the theme, review articles, conference papers, guidelines, or inappropriate study design types. Full-text screening resulted in 11 studies [17–27] that met the inclusion criteria and underwent data extraction and statistical analysis.

3.2. Study characteristics

The included studies were conducted in the United Kingdom (4 studies) [19–21,26], Canada (4 studies) [17,18,22,25], China (2 studies) [24,27], and Germany (1 study) [23]. All included studies were published in English. All 11 articles were randomized controlled trials (RCTs) involving a total of 472 participants, with sample sizes ranging from 20 to 90 individuals per study. One study [23] exclusively enrolled female participants, while the remaining studies included both male and female participants. Five studies [17,18,22,24,27] targeted young adults, while three studies each focused on middle-aged [23,25,26] and older adults [19–21]. Most studies included sedentary adults and healthy adults, with two studies also enrolling adults with specific health conditions or risks [18,21]. The basic characteristics of the literature are summarized in Table 1.

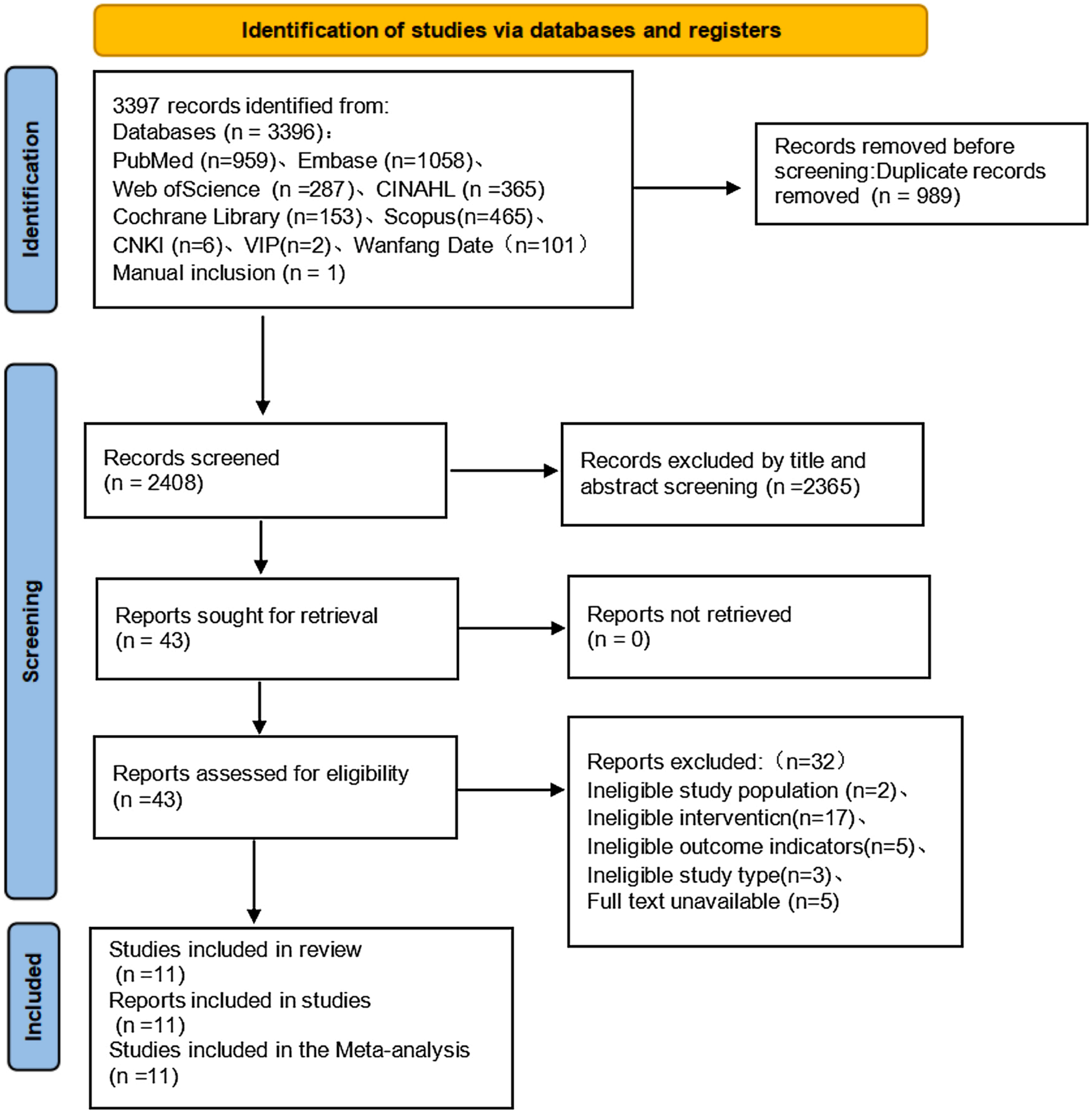

Fig. 1. Literature screening flowchart.

3.3. Interventions

All exercise snacks interventions were supervised by staff, including healthcare professionals, researchers, and certified trainers. The interventions lasted between 4 and 12 weeks, incorporating 1–7 training sessions per week, typically at a frequency of 3 sessions daily. Each exercise session generally lasted between 2 and 10 min. Different studies selected varying types of exercise. Four studies [17,22,24,27] employed stair sprint training as their intervention strategy, while two studies [20,21] combined strength training with Tai Chi movements. The remaining five studies [18,19,23,25,26] utilized interventions including bicycle sprint training, resistance training, bodyweight exercises, and sit-to-stand strength training (Fig. 2). The control group also exhibited heterogeneity in implemented interventions, including non-restricted stair sprints, habitual physical activity, low-intensity stretching, routine care, no exercise, and health guidance.

3.4. Risk of bias within studies

Among the 11 studies included, three employed block randomisation [17,20,25], two studies [18,22] employed randomised number grouping, one study [19] utilised minimisation randomisation, one study [24] employed coin tossing for allocation, one study [27] utilised randomised allocation via a secure web platform, one study [21] merely stated adherence to random allocation principles without specifying the method, and two studies [23,26] did not mention the allocation method. Regarding allocation concealment, one study [17] used opaque sealed envelopes. Three studies [22,25,27] mentioned that concealment was applied but did not describe the method. In two studies [19,20], allocation was performed by an independent person outside the research team. The remaining five studies [18,21,23,24,26] did not report any allocation concealment measures. Due to differing treatment interventions, blinding of patients proved challenging across all studies. Two studies [20,24] reported blinding of assessors. The remaining nine studies [17–19,21,22,23,25–27] made no mention of blinding for outcome evaluators.No dropouts were reported in any of the studies [17–27]. All studies [17–27] appeared to report outcomes without selective bias, and none mentioned other specific risks of bias (Fig. 3a,b).

Table 1
Characteristics of the included studies (n = 11).

Study	Country	Study design	Population characteristics	Sample Size		Age		Intervention methods	Duration and frequency	Outcome Indicator
				I	C	I	C			
Jenkins 2019 [17]	Canada	RCT	Healthy younger adults	12	12	20.0 ± 1.8	19.3 ± 1.6	Climb stairs, 3 times/day	3 times/week, 6 weeks	②③
Little 2019 [18]	Canada	RCT	Sub-healthy younger adults	12	16	22 ± 4	21 ± 4	Bicycle sprint (20 s/×3group) 3 times/day	9 times/week, 6 weeks	①②③
Perkin 2019 [19]	Britain	RCT	Healthy older adults	10	10	70 ± 4	74 ± 5	Strength Training (5 movements, 1 min each) twice/day	4w	①④⑤
Liang 2022 [20]	Britain	RCT	Sub-healthy older adults	13	16	73.3 ± 5.3	71.9 ± 4.7	Strength + Tai Chi Training (10 movements), once/day	7 times/week, 4 weeks	④
Liang 2024 [21]	Britain	RCT	Sub-healthy older adults	28	36	74.0 ± 5.5	74.2 ± 5.6	Strength + Tai Chi Training (10 movements), once/day	7 times/week, 12 weeks	④
Yin 2024 [22]	Canada	RCT	Sub-healthy younger adults	14	15	22.1 ± 2.1	20.9 ± 1.4	Climb stairs, (30 seconds/time, 126 steps in total) 3 times/day	3 times/week, 6 weeks	②③
Brandt2024 [23]	Germany	RCT	Healthy Middle-Aged adults	12	14	42.1 ± 11.1	49.9 ± 9.7	Resistance training (30–60 s/ time, 10 min in total)	5 times/week, 12 weeks	⑤
Zhou 2025 [24]	China	RCT	Sub-healthy younger adults	14	13	22.14 ± 1.88	21.08 ± 1.32	Climb stairs, (60 steps/time) 6 times/ day	4 times/week, 12 weeks	⑤
Babir 2025 [25]	Canada	RCT	Sub-healthy Middle-Aged adults	34	39	53 ± 6	54 ± 7	Body weight training (movement duration 60s→45s→30 s decreasing) ≥3 times/ day	≥3 times/ week, 12 weeks	①②③⑤
Daley 2025 [26]	Britain	RCT	Sub-healthy Middle-Aged adults	28	28	53.6 ± 12.5	55.1 ± 13.8	Moderate-to-vigorous intensity activity + resistance training (2–5 min/ session)	150 min ≥ w	⑥
Zhu 2025 [27]	China	RCT	Healthy younger adults	12	10	19.46 ± 0.71	19.74 ± 0.66	Stair sprint training (96 steps/time) 3 times/day	3 times/week, 6 weeks	③⑥

① Borg Rating of Perceived Exertion (RPE); ② Maximum Oxygen Uptake (VO_2max); ③ Absolute Peak Power Output (Wpeak); ④ 60-second Sit-to-Stand Test; ⑤ Body Fat Percentage (BF%); ⑥ Body Mass Index (BMI).

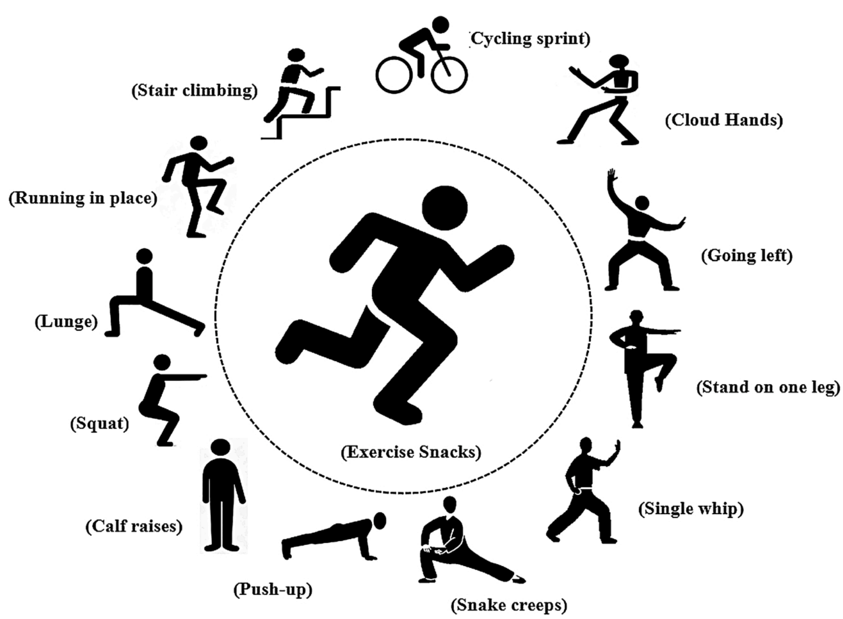

Fig. 2. Exercise methods.

3.5. Results of meta-analysis

3.5.1. Cardiorespiratory endurance

3.5.1.1. Wpeak. Wpeak reflects the combined level of muscular power and cardiorespiratory fitness. Among the included studies, five investigations [17,18,22,25,27] analyzed the effects of exercise snacks on adult Wpeak, involving a total of 176 participants. The studies exhibited low heterogeneity ($I^2 = 24\%$, $P = 0.26$). Analysis using a fixed-effects model revealed that the intervention group demonstrated statistically significant higher absolute peak power output than the control group post-intervention [MD = 16.53, 95% CI (2.93, 29.77), $P = 0.02$] (Table 1).

Subgroup analysis revealed that after progressive sprint training [17,22,25], the absolute peak power output in the experimental group was significantly higher than that in the control group [MD = 14.84, 95% CI (1.28, 28.39), $P = 0.03$]; following all-out sprint exercise [18,27], the comparison of absolute peak power output between the experimental and control groups showed no statistically significant difference [MD = 94.98, 95% CI (−2.66, 192.62), $P = 0.06$] (Fig. 4a).

3.5.1.2. VO_{2max}. Four studies [17,18,22,25] analyzed the effects of exercise snacks on VO_{2max}, involving 154 participants. The studies exhibited low heterogeneity ($I^2 = 0\%$, $P = 0.99$). Using a fixed-effects

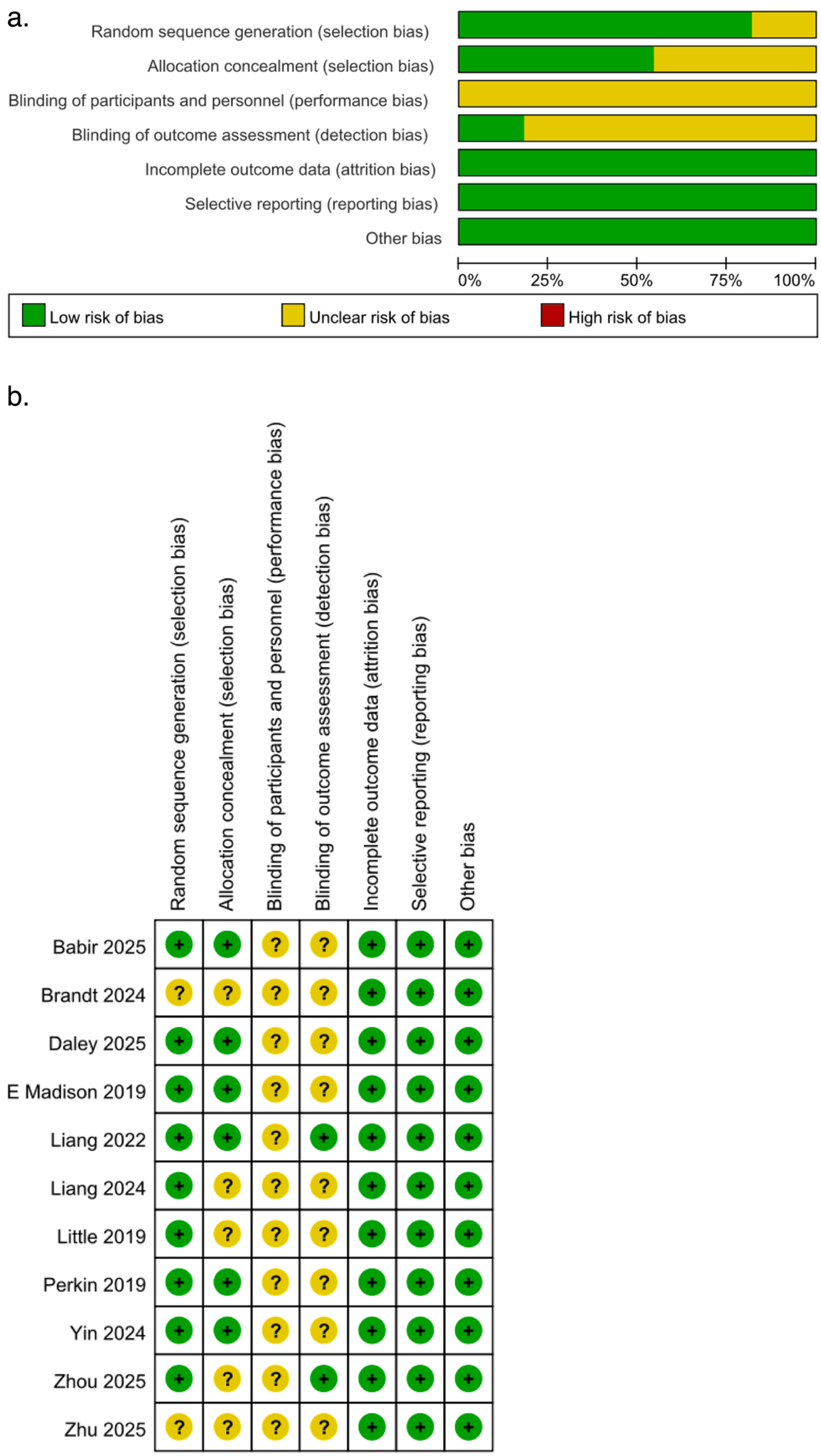

Fig. 3. (a) Risk of bias bar chart. (b) Risk of bias plot.

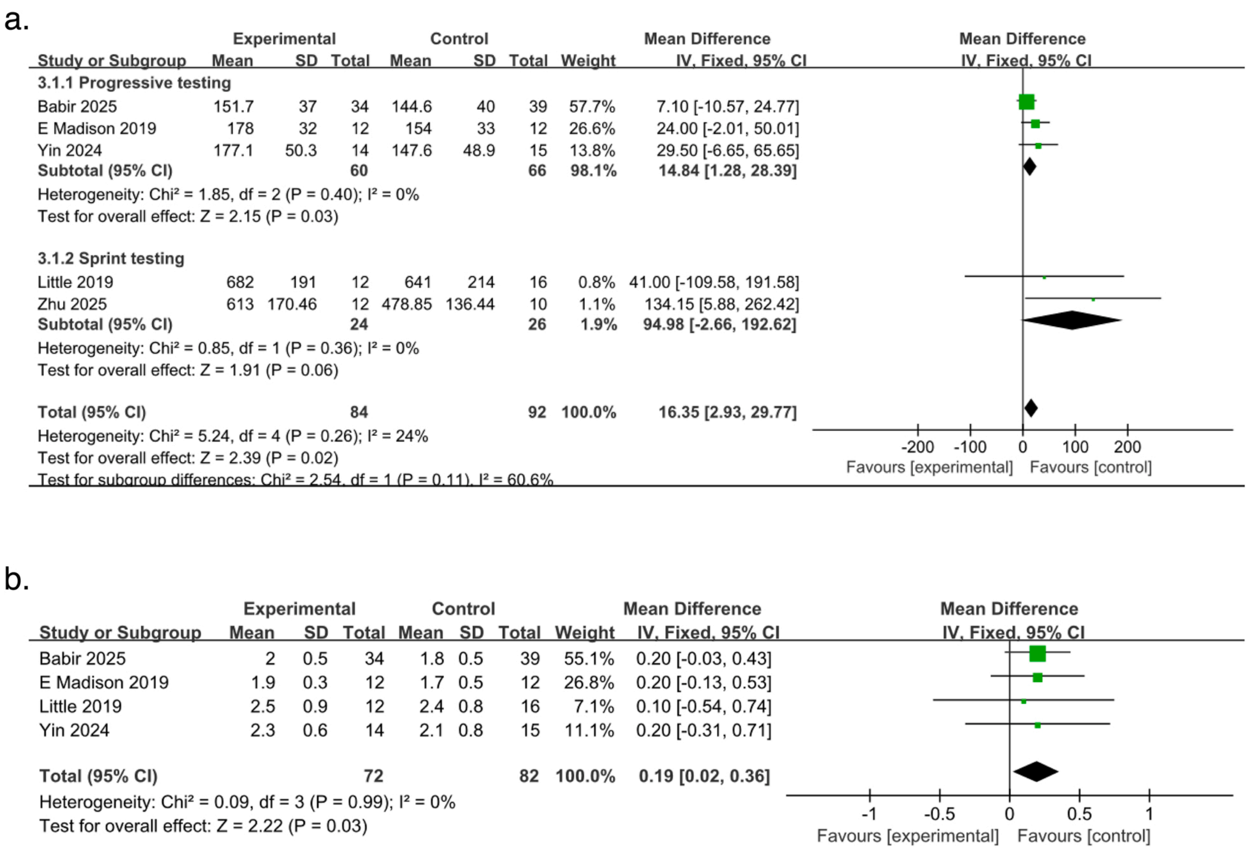

Fig. 4. (a) Subgroup analysis of different exercise test modes. (b) Forest plot of the meta-analysis for VO_{2max}.

model to analyze the four studies, the results showed that the absolute peak oxygen uptake in the intervention group was significantly higher than that in the control group after the intervention [MD = 0.19, 95%CI (0.02, 0.36), $P = 0.03$] (Fig. 4b).

3.5.2. Sit-to-stand test

Among the included studies, three evaluated the 60-second sit-to-stand test [19–21], involving a total of 116 participants. Heterogeneity among studies was low ($I^2 = 0\%$, $P = 0.56$), and a fixed-effect model was used to analyze the three studies. Results showed that compared with the control group, participants in the intervention group significantly increased the number of complete "sit-to-stand" movements performed within 60 seconds after the intervention, with a statistically significant difference [MD = 4.38, 95%CI (1.00,7.77), $P = 0.01$] (Fig. 5).

3.5.3. Fatigue degree

Three studies [18,19,25] reported the effects of exercise snacks on fatigue levels, involving a total of 121 participants. Due to inconsistent measurement tools (0–10 and 1–10 scales), the standardized mean difference(SMD) was selected. High inter-study heterogeneity ($I^2 = 88\%$, $P < 0.01$) prompted analysis using a random-effects model.Results indicated no significant difference in fatigue reduction between exercise snacks interventions [SMD = 0.34, 95%CI (−0.86, 1.53), $P = 0.58$] (Fig. 6).

3.5.4. Body composition

3.5.4.1. BF%. Four studies [19,23,24,27] reported the effects of exercise-snacking on body fat percentage (BF%) in adults, involving a total of 94 participants. Inter-study heterogeneity was low (I2 = 0%, $P = 0.76$). The fixed-effects model indicated that exercise snacks interventions significantly reduced body fat percentage [MD = −3.12,95% CI (−5.51, −0.73), $P = 0.01$]. Subgroup analysis by age revealed a decreasing trend in body fat percentage among the younger group [MD = −2.61, 95%CI (−5.69, 0.47), $P = 0.10$], while the middle-aged group showed a significant decrease [MD = −5.30,95%CI (−10.09, −0.51), $P = 0.03$]. No significant change was observed in the older group [MD = −1.50, 95%CI (−7.71, 4.71), $P = 0.64$]. No significant differences in effects were observed between subgroups ($P = 0.56$) (Fig. 7).

3.5.4.2. BMI. Three studies [25–27] reported BMI data involving 151 participants, with low inter-study heterogeneity ($I^2 = 0\%$, $P = 0.89$). A

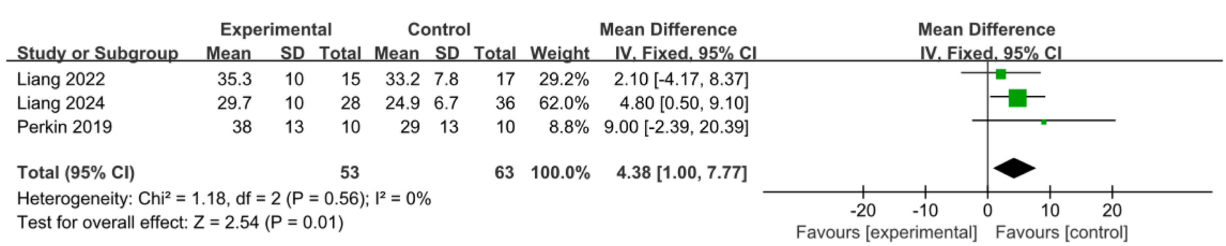

Fig. 5. Forest plot of the meta-analysis for 60s-STS.

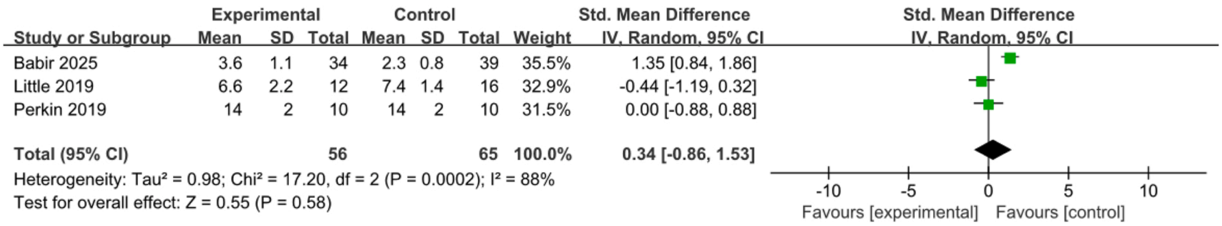

Fig. 6. Forest plot of the meta-analysis for RPE.

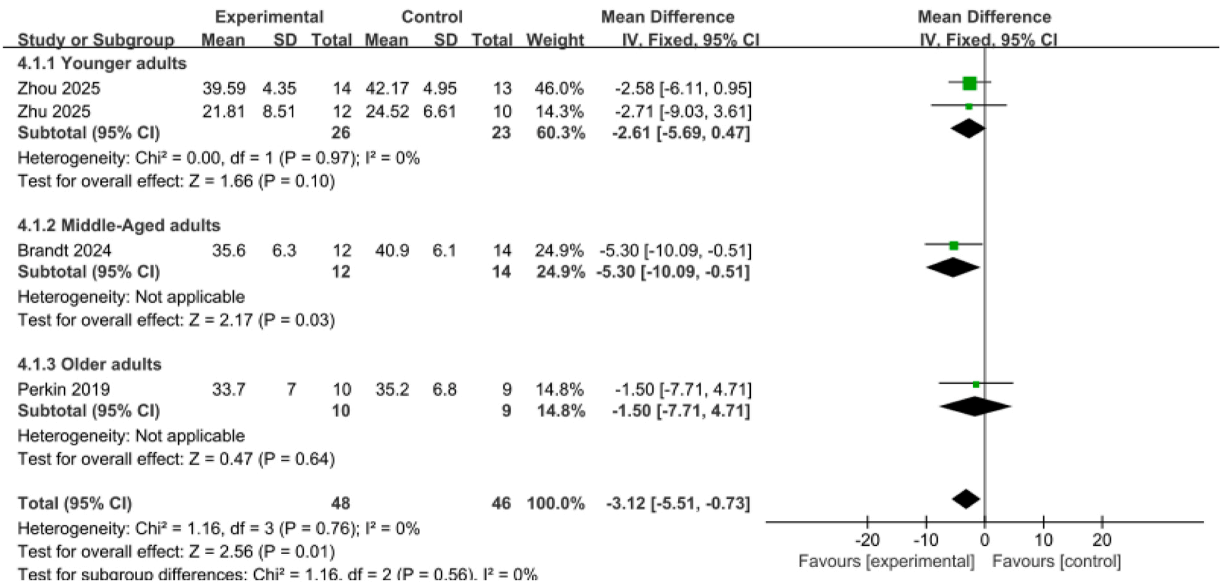

Fig. 7. Subgroup analysis of participants' age for body fat percentage.

fixed-effects model was used to analyze the three studies. Results showed no significant difference in BMI between the exercise and snacking interventions [MD = 0.56, 95% CI (−0.51, 1.63), P = 0.30] (Fig. 8).

4. Discussion

This study conducted a meta-analysis of 11 eligible randomized controlled trials to evaluate the effects of exercise snacks on physical function in sub-healthy individuals and adults of different age groups. The results showed that exercise snacks significantly increased VO_{2max} and Wpeak in adults, improved cardiorespiratory endurance, and enhanced lower limb function in older adults. Additionally, exercise snacks were found to reduce body fat percentage, although changes in BMI were not significant, and there were no notable changes in the subjectively reported RPE. These findings provide evidence that exercise snacks serve as an effective strategy for enhancing physical function in individuals with suboptimal health.

The primary finding of this study is that exercise snacks can significantly improve VO_{2max} and Wpeak in adults, and these results are highly consistent with those of previous meta-analyses [13]. However, this study has further improved the quality of the evidence by including high-quality randomized controlled trials. Additionally, from the perspective of age-related physiological changes, cardiopulmonary health gradually declines with age [28]. While traditional moderate-to-vigorous intensity continuous training is effective, it is often difficult to promote among the aging population due to high time costs and low adherence. Exercise snacks lower the barrier to participation through short, efficient sessions, offering a viable alternative for delaying age-related decline in cardiopulmonary function. Its mechanism of action may be associated with acute physiological responses and long-term adaptive remodeling. In the short term, high-intensity exercise rapidly elevates heart rate and cardiac output; increased venous return enhances cardiac preload, immediately boosting myocardial contractility and pumping efficiency [29]. Simultaneously, high shear stress stimulates phosphorylation of endothelial nitric oxide synthase [30], increasing vascular NO levels [31] and providing acute signaling for subsequent cardiovascular remodeling. Animal studies [32] have also confirmed that intermittent exercise has cumulative benefits in aging rats.

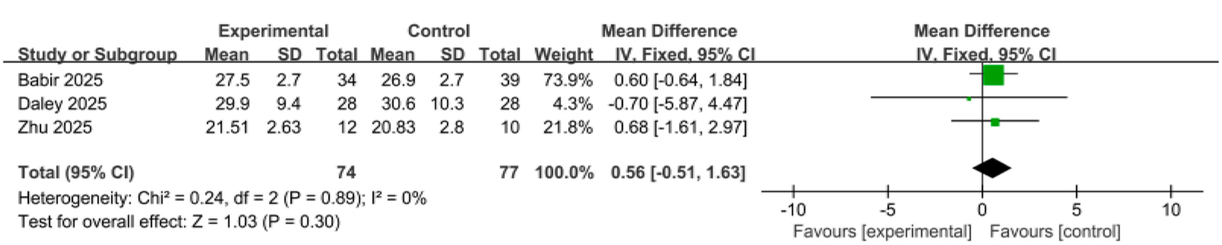

Fig. 8. Forest plot of the meta-analysis for body mass index.

In the analysis of motor function-related outcome measures, this study incorporated the 60-second sit-to-stand test into the meta-analysis and found that exercise snacks significantly increased the 60-second sit-to-stand test scores in older adults. This finding is supported by Perkin's [19] study. Using peripheral quantitative computed tomography and dual-energy X-ray absorptiometry, the study found that exercise snacks can increase the cross-sectional area of thigh muscles by 2% and lean mass in the legs by 1% in older adults. Given that declining lower-body muscle strength is a key precursor to loss of mobility in older adults, the frequent sitting, standing, and knee-bending movements involved in exercise-based activities effectively integrate functional training into daily life. By specifically targeting the thigh muscle groups (such as the quadriceps and hamstrings), these activities help improve older adults' ability to perform activities of daily living [33]. However, this conclusion applies only to older adults and has clear limitations. Younger individuals possess relatively robust muscle function, and their daily activities (such as walking and climbing stairs) already meet their basic strength requirements. Consequently, existing studies rarely use the 60-second sit-to-stand test to assess their motor function, and the impact of exercise snacks on muscle strength in younger adults remains unclear at present.

Regarding body composition, this study found that exercise snacks significantly reduced body fat percentage, but the effect on BMI did not reach statistical significance. This finding is of particular concern in the elderly population. The elderly are often at risk of obese sarcopenia, in which elevated body fat and muscle loss coexist [34], but a single BMI cannot reflect such complex changes in body composition. The improvement in body fat percentage observed in this study suggests that exercise-based interventions may hold promise for maintaining cardiovascular and metabolic health in older adults; although BMI did not decrease significantly, these findings are consistent with existing evidence regarding high-intensity interval training interventions. This result aligns with Liang's [35] meta-analysis conclusion that high-intensity interval training (HIIT) showed no significant difference in BMI compared to non-exercise controls. The Wewege study [36] further confirmed that although exercise snacks showed no significant difference in body composition improvement compared to moderate-intensity continuous exercise, they required only 40% of the time investment, significantly reducing exercise duration. Subgroup analysis further revealed age-related differences in the effects of exercise snacks. When stratified by age, it was found that the effect of exercise snacks on reducing body fat percentage varied by age: body fat percentage decreased significantly in the middle-aged group, showed a downward trend in the young group, and did not change significantly in the elderly group. This finding has important implications for health management across different age groups. It is noteworthy that existing evidence indicates disease risks are not solely associated with high weight. Both high BMI [37], high BF% [38], and low BMI [39] increase cardiovascular disease risk. Therefore, for older adults, effectively managing BMI and appropriately reducing body fat percentage are crucial. The improvement in BF% observed with exercise snacks in this study aligns precisely with this need. The mechanism may involve fragmented exercise improving postprandial plasma triglyceride and total non-esterified fatty acid levels, promoting fat oxidation, and thereby controlling body weight [40]. Meanwhile, the lack of significant BMI changes may stem from improvements in body composition being influenced by multiple factors including age, gender, dietary habits, and overall lifestyle [41]. Single exercise interventions struggle to rapidly alter baseline weight, necessitating comprehensive measures such as daily dietary adjustments.

The lack of significant changes in RPE and the high heterogeneity may be attributed to both physiological and methodological factors. Physiologically, exercise snacks is a high-intensity intermittent activity that reduces oxygen and nutrient supply to muscles. This shifts energy production toward anaerobic pathways [42] and accelerates the accumulation of metabolic byproducts, such as hydrogen ions and inorganic phosphate. Local hypoxia and metabolic buildup strongly stimulate fatigue receptors and afferent nerve fibers within muscles, efficiently transmitting fatigue signals to the central nervous system and amplifying perceived subjective fatigue [43]. Despite the aforementioned physiological basis, exercise bouts are typically brief, and the accumulation of metabolic byproducts may not reach the threshold for "subjective fatigue perception." Furthermore, accelerated blood circulation during rest periods facilitates the clearance of some metabolic byproducts, hastening muscle fatigue recovery [44]. This ultimately results in no significant change in RPE scores. In terms of heterogeneity, as a subjective measure of fatigue, RPE results are highly dependent on subjective factors such as individual mood, sleep quality, and pain tolerance. Additionally, the scoring criteria for the RPE scales used in different studies are not entirely consistent, and some controlled studies did not even assess fatigue levels, further exacerbating the heterogeneity of the results. [SMD = 0.34, 95%CI (−0.86, 1.53), $P = 0.58$]. In addition, as people age, their pain thresholds tend to increase [45]. Combined with factors such as declining sensory function, this may make their perception of high-intensity exercise more complex. Even if RPE does not show a significant increase during high-intensity exercise, exercise snacks may still improve cardiopulmonary and muscular function, which is beneficial for encouraging older adults to participate in high-intensity interval training and enhancing exercise adherence.

In general, this study systematically reviewed the multiple effects of exercise snacks on the physical function of sub-healthy people. The core feature of exercise snacks is that they integrate short-term, moderate-to-vigorous physical activity into daily life scenes such as workplace, recess, and home scenes, aiming to achieve a total amount of exercise by piecemeal accumulation. However, existing programs exhibit significant variations. Regarding intervention design, studies incorporate diverse exercise types—ranging from bodyweight training to simple equipment-assisted movements—with no standardization in session duration or daily total activity time. Regarding assessment methods, inconsistencies exist in the RPE measurement tools used across studies (e.g. variations in RPE scale versions). Regarding population applicability, existing studies predominantly focus on healthy adults, lacking tailored designs for specific groups such as the elderly or working populations. To address these limitations, future research should prioritize standardizing exercise snacks prescriptions by clearly defining intensity, dosage, and frequency, while also harmonizing measurement tools for core outcome indicators. Additionally, optimal application parameters across diverse populations should be explored, and mobile health technologies should be leveraged to enhance implementation feasibility and adherence.

5. Limitations

This study has several limitations. First, the number of included studies was relatively small. Although participants were primarily non-disease-state adults, significant heterogeneity existed in age stratification (e.g. young working adults, older adults), potentially introducing selection bias. This may limit the generalizability and reliability of the findings. Secondly, existing intervention measures for exercise snacks (frequency, intensity, type, duration) lack unified quantitative standards. They lack objective definitions based on metrics such as heart rate thresholds and oxygen consumption ratios, and fail to specify the "minimum effective dose" and "optimal cumulative duration." This hinders the development of personalized plans in clinical practice. Third, most studies included were short-term interventions (4–12 weeks) lacking long-term follow-up data. This prevents verification of the sustained improvement in physical function from exercise snacks and hinders assessment of their long-term impact on chronic disease risk. Additionally, the majority of studies were small-scale pilot or feasibility trials with limited sample sizes, resulting in insufficient statistical power that may mask potential effects of exercise snacks on certain outcome measures (BMI, RPE). Finally, due to the limited research on metabolic indicators such as improved insulin sensitivity and inflammatory factor regulation, we were unable to analyze these aspects. Given the low quality of evidence in current meta-analyses, future studies require greater rigor to confirm the efficacy of exercise-based interventions in enhancing physical function across diverse populations. Additional research should focus on mental health and sleep quality outcomes, while interventions tailored to specific clinical populations will provide more reliable evidence for clinical application.

6. Conclusion

Exercise snacks help improve physical function in healthy and sub-healthy adults. Specifically, this exercise regimen significantly enhances individuals' Wpeak and VO_{2max}, thereby effectively boosting cardiorespiratory endurance. Simultaneously, it improves muscle function and body composition by increasing the number of repetitions in the 60-second sit-to-stand test and reducing body fat percentage. However, no significant effects were observed in fatigue improvement or BMI. This finding may be related to the intervention methods and the heterogeneity of current studies. High-quality clinical trials are needed in the future to clarify the benefits of exercise in specific clinical populations, thereby providing evidence for healthcare providers to promote exercise education among patients in the recovery phase.

Authors' contributions

Duo Zhang: Writing-original draft, Methodology, Investigation; Shu Sun and Yujiao Ding: Methodology, Investigation; Le Chen: Supervision; Xiaotu Zhang and Jiawei Yin: Investigation; Hongshi Zhang: Visualization, Writing review & editing.

Consent to publish declaration

Confirmation that all authors have approved the manuscript for submission.

Ethics approval and consent to participate

Not applicable.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used DeepSeek in order to improve the readability and language of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Availability of data and materials

All relevant data are included in this manuscript.

Declaration of competing interest

None.

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Appendix A. Supplementary data

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