

Behavior Change Techniques Improve Adherence to Physical Activity Recommendations for Adults with Metabolic Syndrome: A Systematic Review

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Background: Exercise and physical activity interventions improve short-term outcomes for people with metabolic syndrome, but long-term improvements are reliant on sustained adherence to lifestyle change for effective management of the syndrome. Effective ways of improving adherence to physical activity and exercise recommendations in this population are unknown. This systematic review aims to determine which interventions enhance adherence to physical activity and/or exercise recommendations for people with metabolic syndrome.

Methods: Electronic databases MEDLINE, PubMed, CINAHL, SPORTdiscuss and ProQuest were searched to July 2022. Risk of bias was assessed using the Cochrane risk of bias tool and overall certainty of evidence assessed using the Grading of Recommendation Assessment, Development and Evaluation approach.

Results: Four randomized controlled trials with 428 participants (mean age 49–61 years) were included. There was very low certainty evidence from two trials that goal setting interventions may improve adherence to physical activity recommendations over three to six months. There was low certainty evidence from two trials that self-monitoring and feedback interventions increased adherence to physical activity interventions over 12 months for people with metabolic syndrome.

Conclusion: Clinicians and researchers may consider using behavior change strategies such as goal setting, monitoring and feedback in interventions for people with metabolic syndrome to increase adherence to physical activity and exercise recommendations over 3 to 12 months, but high-quality evidence is lacking.

Keywords: metabolic syndrome, adherence, long-term condition, behavior change, physical activity, exercise

Introduction

Metabolic syndrome is defined by the International Diabetes Federation (IDF), National Heart, Lung, and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society, and International Association for the Study of Obesity as a cluster of three out of five risk factors: high waist circumference (central adiposity), high fasting blood glucose, low levels of high-density lipoprotein (HDL) cholesterol, high blood triglycerides and high blood pressure.¹ Having metabolic syndrome doubles an individual's risk of developing atherosclerotic cardiovascular disease and increases the risk five-fold for Type 2 Diabetes Mellitus.^{1,2} There is growing evidence that the inflammatory response to adipose tissue, through obesity and metabolic syndrome, is linked to an increased risk of developing cancer.^{3,4} Around a quarter of the world's population is now suspected to have metabolic syndrome, leading to higher healthcare utilisation and costs.^{5–7} Diagnosing metabolic syndrome brings an opportunity for early intervention to prevent the development of chronic disease.

Changing lifestyle behaviors through diet and increased physical activity is the first-line treatment for 26 chronic conditions, including metabolic syndrome.⁸ Physical activity improves the individual components that define metabolic syndrome, and ultimately, reduces the prevalence of the syndrome^{9–12} likely due to its impact on low-grade systemic

inflammation.¹³ Additionally, interventions combining physical activity and dietary changes reduce waist circumference, blood pressure, triglycerides and fasting glucose levels for people with metabolic syndrome.¹⁴

Although diet and physical activity interventions appear to improve metabolic outcomes for people with metabolic syndrome, maintenance of improvements are reliant on long-term adherence to recommendations for effective management of the syndrome.¹⁵ However, initiating and maintaining lifestyle changes can be difficult. It has been observed that only 10% of people at risk of metabolic syndrome were adherent to physical activity lifestyle recommendations.¹⁶ For people with metabolic syndrome who enrolled in exercise interventions, short-term attrition rates were as high as 50%.¹⁷ People with metabolic syndrome have been identified as having lower health literacy¹⁸ and, in turn, may struggle to execute healthy behaviors. The relationship observed between depression and metabolic syndrome may also limit long-term adherence to exercise interventions.¹⁹ Therefore, a significant challenge for health care professionals and people with metabolic syndrome, is sustaining long-term behavior change to prevent and manage chronic disease.

Adherence to physical activity has been identified as a therapeutic behavior that appears to be enhanced through behavior change strategies.²⁰ Considering the cost burden of metabolic syndrome,⁵ investments that improve adherence should be considered well spent through health benefits and savings in future healthcare utilisation. Previous reviews have investigated the effectiveness of interventions for reducing the risk of developing cardiovascular disease and diabetes for people with metabolic syndrome,²¹ lifestyle modification programmes for managing and reversing metabolic syndrome,^{14,22} and the impact of adherence to recommendations on outcomes,¹⁵ but none have focussed on the key issue of increasing adherence to recommendations to ensure the effect is optimised and maintained over time. Therefore, this review aims to determine which interventions enhance adherence to physical activity and/or exercise recommendations for people with metabolic syndrome.

Method

This systematic review was designed and reported following the Cochrane Handbook for Systematic Reviews of Interventions version 6.226²³ and is reported consistent with the PRISMA guidelines.²⁴ This review was registered prospectively with PROSPERO international register for systematic reviews (CRD42022267433).

Search Strategy

A search strategy was developed using medical subject headings (MeSH) and their synonyms for the concepts of metabolic syndrome, adherence, and exercise/physical activity ([Appendix/Supplement 1](#)). Electronic health databases (MEDLINE, PubMed, CINAHL, SPORTdiscuss and ProQuest) were searched from inception until July 2022. A manual search of reference lists of primary studies and citation tracking of included trials through Google Scholar were also completed. The results of each search were downloaded into an online platform, Covidence²⁵ and duplicates were removed. Initial screening of eligibility based on titles and abstracts to remove clearly ineligible trials was conducted by two reviewers (AG and CP) independently with discrepancies resolved by a third reviewer (SM). All papers not excluded were then reviewed in full-text independently by the two reviewers, with discrepancies resolved by consensus. The agreement of the reviewers was calculated using the Kappa statistic where, 0.21–0.4 represents fair agreement, 0.41–0.6 suggests moderate agreement, 0.61–0.8 is substantial and 0.81–0.99 suggests near perfect agreement.²⁶

Inclusion/Exclusion Criteria

Articles were included if they were randomized controlled trials published in English and investigated adults (18+) with metabolic syndrome as defined by the NCEP ATP III or the IDF¹ (or country specific adapted versions). Eligible interventions aimed to increase adherence to physical activity guidelines or prescribed physical activity or exercise that intended to improve metabolic syndrome, regardless of whether it was delivered by a healthcare professional (eg physiotherapist, nurse), trained lay representative (eg expert patient groups or arthritis self-management groups) or as part of a multi-disciplinary programme (which may have included other interventions eg diet). To be included, trials must have included a usual care or control group and used clearly defined and reproducible measures of adherence to exercise or physical activity or measures of physical activity where these had been used as a proxy measure of adherence. This includes patient-reported or clinician-reported measures, objective measures of physical activity or exercise diaries (if converted to an adherence measurement scale).

Trials were excluded if they aimed to increase adherence to medication or dietary intervention only or if they reported adherence or predictors of adherence but did not evaluate an intervention aimed at improving adherence.

Data Extraction

Data were extracted using the Data Collection Form for Cochrane Reviews: RCTs only form, completed by one reviewer (AG) and checked for accuracy by a second reviewer (CP). Data from included trials were extracted on population (number of participants, age, gender, and metabolic syndrome risk factors), intervention (type, duration, and frequency) and adherence outcomes (physical activity/exercise amount, physical activity/exercise frequency, numbers of participants meeting guidelines etc.). Study authors were approached for missing data when applicable.

Risk of Bias

The Cochrane updated risk of bias tool (RoB2)²⁷ was used to evaluate the risk of bias of each trial by two researchers independently (AG and NT). Using a fixed set of domains, the RoB2 considers aspects of bias such as the randomisation process, deviations from intended interventions, missing outcome data, bias through measurement of the study outcome and the selection of the reported result.²⁷ Assessment then produces an overall judgement for each selected trial as “low risk”, “high risk” or “some concerns” of bias. The agreement between reviewers was calculated using the Kappa statistic.

Data Analysis and Synthesis

Descriptive analyses were completed as data were unable to be pooled in meta-analyses due to heterogeneity of interventions, outcomes, and missing data.

The Grading of Recommendation, Assessment, Development, and Evaluation (GRADE) framework²⁸ was used to establish the overall certainty of the body of evidence for each intervention type based on guidelines for reviews without meta-analyses.²⁹ As all studies were randomized controlled trials, the grading began at “high” and was downgraded one place if: more than half of the studies had at least “some concern” regarding risk of bias (methodological limitations); the population, intervention or outcomes were dissimilar to our research question (indirectness); results were imprecise because of low sample size (<400) or wide confidence intervals within studies (imprecision); there was inconsistency in the direction and magnitude of results between studies (inconsistency); or if there was likelihood of reporting bias if there were only small positive studies.^{29,30} Initial grading was completed by two reviewers independently (AG, SM) and disagreements resolved by consensus through discussion with a third reviewer (CP).

Results

The initial database search recovered 1316 papers with 1131 remaining following removal of duplicates. The first screening process eliminated 1079 clearly irrelevant papers based on titles and abstracts and 22 papers went to full text review. There was slight agreement between reviewers (Kappa 0.16, 95% CI 0.07 to 0.25) when screening titles and abstracts due to uncertainty of one reviewer on the difference between determinants of adherence and interventions to enhance adherence. Following clarification of inclusion criteria, there was moderate agreement (Kappa 0.43, 95% CI 0.05 to 0.80) between reviewers on full-text review that four trials met inclusion criteria for the review (Figure 1).

Study Characteristics

Four randomized controlled trials^{31–34} were included with 428 participants, of whom, 203 (47%) were male and 258 participated in interventions to enhance their adherence to physical activity or exercise recommendations (Table 1).

Three of the four trials provided health education,^{32–34} which was accompanied by telemonitoring of physical activity and provision of written or telephone feedback in one trial,³² goal setting and monitoring via a mobile application in another trial,³⁴ and small group counselling sessions focussed on goal setting and behavior change in the third trial.³³ Participants in the final trial had individual face-to-face or telephone counselling sessions focussed on nutrition and physical activity goal setting and behavior change.³¹

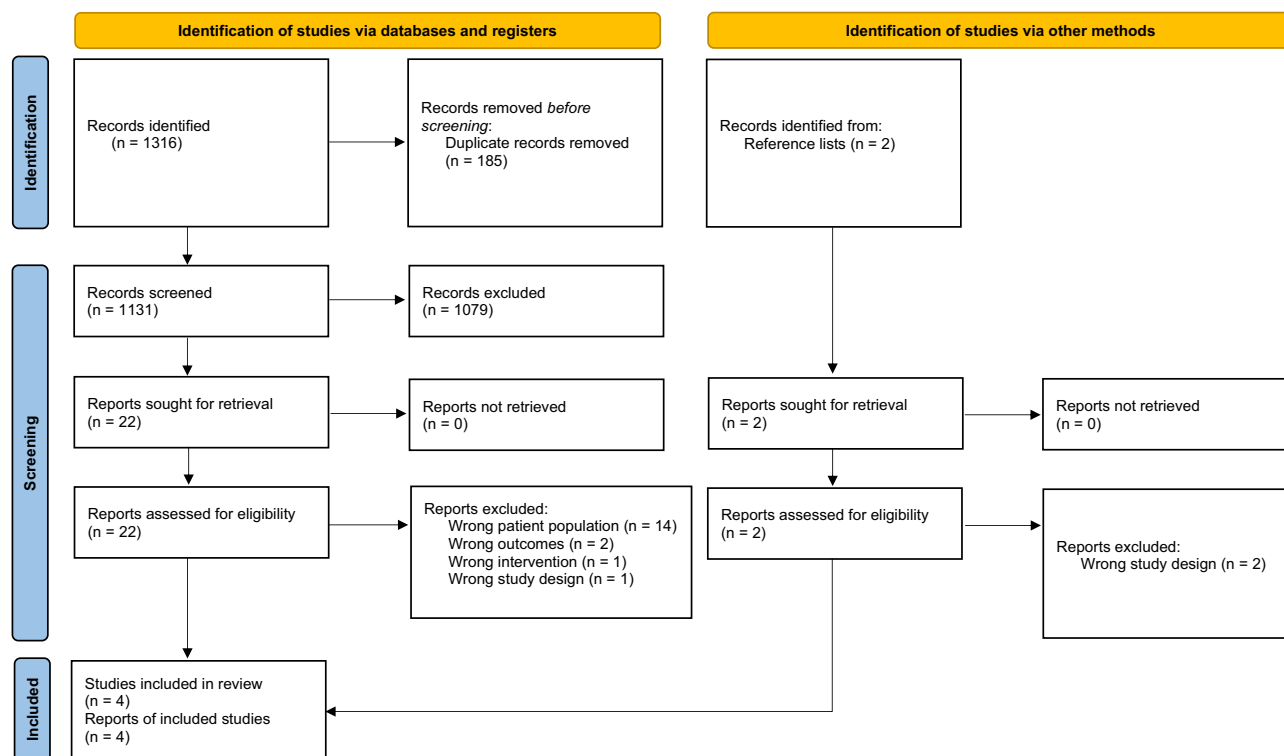


Figure 1 PRISMA flow of trials through the review.

The control group participants of all four trials received health education on metabolic syndrome from healthcare professionals, and control group participants in one trial³³ also received a take-home booklet surmising risk factors, goal setting techniques and emotional management strategies.

Risk of Bias Assessment

According to the RoB2, three of the included papers were considered of “some concern” and one of “high risk” in relation to perceived potential bias (Figure 2). Agreement between reviewers was fair (Kappa = 0.32, 95% CI. 0.50 to 0.60). Outcome assessors were unblinded in three of the four trials^{31–33} and all trials elicited some concern of bias due to lack of description of outcome measure selection, data analysis plan and reporting of results.

Outcomes

One trial³² objectively measured physical activity levels using accelerometer data. Self-reported measures of physical activity used in the other trials were the Greek adjusted physical activity questionnaire (HAPAQ),³¹ the Physical Activity Log,³³ and the Godin Shephard Leisure Time Physical Activity measure (GSLTPA)³⁴ (Table 1).

Two trials^{31,32} did not report outcome data for physical activity despite measuring it and were not able to provide data despite requests from the reviewers, therefore, data were not able to be included in meta-analyses.

At three to four months, the attrition rate across three studies was 6% in the experimental groups and 13% in the control groups.^{32–34} At longer-term follow-up in one of these studies, attrition rates were 18% in the experimental group and 35% in the control group at 12-months.³³ In the final study 41% of experimental group participants and 55% of control group participants were lost to follow-up at 6 months.³¹

Goal Setting

The interventions in two trials^{31,33} used goal setting counselling interventions delivered by dietitians to increase adherence to physical activity recommendations in 173 participants with metabolic syndrome. In one of the

Table 1 Trial Characteristics

Study and Setting	Participants	Intervention	Control	Outcomes
Fappa (2012) ³¹ Out-patient lipid clinic, Greece	n = 87 M:F = 49:38 Mean Age: 49	Duration: 6 months Type: Diet and physical activity goal setting and counselling. Frequency: Group 1: face to face, 1-hour, 1:1 sessions, fortnightly × 4, then monthly × 3 Group 2: telephone, 20-minute 1:1 sessions, fortnightly × 4, then monthly × 3 Delivered by: Dietitian	Duration: 6 months Type: Guidance and education for diet and physical activity goal setting during one baseline session. Frequency: Once. Delivered by: Dietitian	Harokopio Physical Activity Questionnaire (HAPAQ)
Luley (2014) ³² Community/home-based, Germany	n = 178 M:F= 105:73 Mean age: 52	Duration: 12 months Type: Health education and telemonitoring. Frequency: One 2-hour session followed by feedback via weekly letters or monthly phone calls Delivered by: specialist doctors and nurses	Duration: 12 months Type: Health education only. Frequency: one 2-hour session Delivered by: specialist doctors and nurses	Objectively assessed physical activity (accelerometer)
Suwankruhasn (2013) ³³ Unknown setting, Thailand	n = 86 M:F= 15:71 Mean age: 61	Duration: 3 months Type: Small-group education, counselling and goal-setting Frequency: Weekly × 4, then monthly × 2 Delivered by: Dietitian	Duration: 3 months Type: Usual care Frequency: unclear Delivered by: Registered Nurses	Self-reported physical activity using a logbook
Wong (2021) ³⁴ Community centre and Research centre, Hong Kong	n = 77 M:F= 34:43 Mean age: 57	Duration: 3 months Type: Health education plus mobile application for monitoring and goal setting Frequency: one 30-minute session on how to use application. Delivered by: researchers	Duration: 3 months Type: Health education only Frequency: one 30-minute session Delivered by: Registered Nurse	Godin-Shephard Leisure time physical activity questionnaire (GSLTPA)

studies, participants self-selected physical activity goals during 6 × 2-hour small-group counselling sessions delivered over three months and found experimental group participants had significantly higher objectively measured physical activity levels at three- (ie post-intervention) and six-months ($p < 0.001$).³³ In the other study, seven 1:1 nutritional counselling sessions (20 to 60 minutes each) delivered over six months focussed on nutritional goals (and one pre-determined physical activity goal) found significant improvements in diet but no significant differences in physical activity at 6-months (ie post-intervention).³¹ Therefore, there was very low certainty evidence that goal setting interventions may improve adherence to physical activity recommendations over three to six months for people with metabolic syndrome (Table 2).

Self-Monitoring and Feedback

Two trials^{32,34} used self-monitoring techniques and feedback to increase adherence to physical activity recommendations for 255 participants with metabolic syndrome. Telemonitoring plus regular feedback was reported to be effective at increasing adherence to physical activity recommendations over a 12-month period in one trial but raw data were not reported.³² Participants who used a mobile App with telemonitoring and feedback had moderate to large increases in exercise self-efficacy and moderate increases in physical activity compared to the control group at one ($p = 0.029$) and three ($p = 0.038$) months.³⁴ Therefore, there was low certainty evidence that self-monitoring and feedback interventions increased adherence to physical activity interventions over 12 months for people with metabolic syndrome (Table 2).

Study ID	D1	D2	D3	D4	D5	Overall
Fappa 2012						
Luley 2014						
Suwankruhasn 2013						
Wong 2021						

- D1 Randomisation process
- D2 Deviations from the intended interventions **Low risk**
- D3 Missing outcome data **Some concerns**
- D4 Measurement of the outcome
- D5 Selection of the reported result **High risk**

Figure 2 Risk of bias.

Discussion

This systematic review of four trials with 428 participants found low certainty evidence that interventions involving monitoring and feedback increased adherence to physical activity recommendations in people with metabolic syndrome. There was very low certainty evidence that interventions involving goal setting and counselling may increase adherence. Results are somewhat congruent with literature in people with musculoskeletal disorders where self-management programmes including goal setting, monitoring and feedback³⁵ and interventions aimed at increasing motivation^{36,37} have been found to increase adherence to exercise in people with musculoskeletal conditions while counselling and action coping plans did not improve adherence to long-term exercise and physical activity recommendations.^{36,37} With the exception of one study,³¹ attrition rates were lower in the included studies compared to what has previously been reported¹⁷ giving confidence that the behavior change interventions used were somewhat effective for maintenance.

This review focussed on adherence to exercise and physical activity, but all of the included trials also included a major focus on diet thus addressing pertinent lifestyle factors proven to have an impact on metabolic syndrome

Table 2 Summary of Findings

Intervention	Effect	Number of Participants (Trials)	Certainty of Evidence
Goal setting	One trial found increased adherence to physical activity recommendations at 3 and 6 months but the other reported no difference between groups.	n = 173 (2 trials)	VERY LOW* ^Λ ⊕⊕⊕○
Self-monitoring and feedback	Both trials reported small to moderate improvements in adherence to physical activity recommendations.	n = 255 (2 trials)	LOW* ^Λ ⊕⊕○○

Notes: *Downgraded one place as studies were all considered to have at least some concern regarding risk of bias; ^ΛDowngraded one place due to low sample sizes; [○]Downgraded one place due to inconsistency.

parameters. In one study³¹ participants increased their fruit consumption and their adherence to the Mediterranean diet while the remaining studies did not assess dietary intake³⁴ or reported no significant differences.^{32,33} However, all studies reported improvements in metabolic outcomes likely from the combined effect of small changes in diet and physical activity. Half of the intervention group participants in two studies no longer had metabolic syndrome by the end of the intervention.^{31,32} Participants had reduced waist circumference,^{31,32,34} systolic blood pressure,^{33,34} fasting blood glucose,^{31–34} and triglycerides,^{31–33} and increased HDL-cholesterol.³³ Therefore, with the addition of a dietary cointervention, the relatively small differences in physical activity adherence observed are likely to be clinically meaningful.

All of the included trials used strategies considered effective for behavior change. However, when used in isolation these may not address enough of the identified barriers. Previous research has identified that people with metabolic syndrome and low baseline levels of physical activity,³⁸ higher body mass index,^{38,39} and older age³⁸ were less likely to adhere to exercise and physical activity recommendations. On the other hand, people with access to walking routes and better self-rated health were more likely to adhere.⁴⁰ In a qualitative study people with metabolic syndrome identified low motivation, low self-efficacy and lack of social support as barriers to adhering to exercise and physical activity recommendations.⁴¹ Because of the complex and multifaceted barriers to adherence in people with metabolic syndrome, future interventions may need to be more holistic to increase adherence.

If we consider the COM-B model of behavior change,⁴² effective interventions should address Capability, Opportunity and Motivation. For those who are sedentary or have mobility impairments, physical capability may need to be addressed with supervised exercise sessions. Compared to unsupervised and group exercise respectively, supervised and individual exercise have both been found to enhance adherence in people with musculoskeletal conditions.³⁵ None of the included trials were delivered by exercise professionals (eg physiotherapists or exercise physiologists) and none included supervised exercise. Education and self-management strategies can enhance psychological capability and all included trials addressed this factor. Goal setting, monitoring and feedback were also features of all trials, which may have enhanced motivation. However, none of the included trials addressed opportunity by considering physical or social opportunities for physical activity. To enhance effectiveness, all components of the COM-B should be considered when designing interventions to address the multiple barriers that exist to ensure measurable improvements in lifestyle behaviors.

Limitations

This systematic review was conducted and reported following PRISMA guidelines and included independent screening and quality assessment. One limitation is the small number of randomized controlled trials identified and included and the lack of data reported within these trials which precluded meta-analysis. It is therefore difficult to draw strong conclusions from four randomized controlled trials.

Conclusion

This systematic review of four trials with 428 participants found that interventions involving goal setting, monitoring and feedback may have increased adherence to physical activity recommendations in adults with metabolic syndrome. Results should be interpreted with caution as there was low to very low certainty of evidence due to a lack of large, high-quality trials. Clinicians and researchers should consider using behavior change strategies such as goal setting, monitoring and feedback in interventions for people with metabolic syndrome to ensure short-term effects of lifestyle interventions on physical activity and exercise levels are maintained over time.

Disclosure

The authors report no conflicts of interest in this work.

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