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REVIEW

Determinants of Non-Adherence to Exercise or Physical Activity in People with Metabolic Syndrome: A Mixed Methods Review

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Background: Long-term adherence to exercise or physical activity (EPA) is necessary for effective first-line management of metabolic syndrome (MetS). Little is known about the determinants of adherence in this population. This systematic review aims to identify the determinants of adherence to EPA in people with MetS.

Methods: Six databases (MEDLINE, CINAHL Complete, PubMed, PsycINFO, SPORTDiscus, and Cochrane Central Register of Controlled Trials (CENTRAL)) were searched for studies published before April 26, 2021. Primary research studies investigating factors affecting EPA adherence in adults with MetS in outpatient settings were included. Risk of bias was assessed using the QUIPS (Quality in Prognostic Factor Studies) and CASP (Critical Appraisal Skills Program) tools, for quantitative and qualitative methodologies, respectively.

Results: Four quantitative studies (n = 766) and one qualitative (n = 21) study were included in the review, evaluating 34 determinants of adherence to EPA in MetS. Limited evidence was found for an association between ten determinants and non-adherence to EPA: lower self-rated health, lower baseline EPA, lower high-density lipoprotein cholesterol (HDL-C), fewer walk-friendly routes within 1 km, less consciousness raising, lower self-re-evaluation, lower self-liberation, reporting more arguments against EPA (cons), lower social support, and fewer positive psychological constructs. There was limited evidence of no association or conflicting evidence for the remaining 24 determinants.

Conclusion: A small number of included studies, most of low methodological quality, resulted in limited confidence in the findings for all determinants. The identified determinants associated with non-adherence are all potentially modifiable, thus further high-quality studies are required to increase confidence in the determinants of EPA in people with MetS, and test interventions.

Keywords: adherence, long-term condition, behavior change

Introduction

Metabolic Syndrome (MetS) is characterized by a cluster of five risk factors; raised triglycerides, lowered high-density lipoprotein cholesterol (HDL-C), abdominal obesity, hypertension, and impaired glucose tolerance.[1] According to the International Diabetes Foundation (IDF), abdominal obesity plus any two risk factors constitute MetS, while the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria define MetS as any three of the five risk factors.[2] The global prevalence of MetS is increasing as a likely consequence of rising levels of obesity and sedentary lifestyles,[1] with an estimated 25% of adults affected worldwide. MetS results in a doubling of the risk of atherosclerotic cardiovascular disease and a five-fold increase in the risk of type 2 diabetes mellitus.[2,3]

Lifestyle modification is the first-line management strategy for MetS, with pharmacology used as a second-line intervention or to supplement lifestyle changes.[4,5] Physical inactivity, obesity, and an atherogenic diet are targeted with exercise and a reduced calorie and saturated and trans-fat diet, using principles of behavior change.[2] Exercise has acknowledged benefits on cardiovascular health,[6] and on MetS parameters. Both resistance and endurance training can

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reduce blood pressure in MetS populations,[7,8] while moderate-intensity aerobic exercise may improve HDL-C, triglyceride levels, and glucose tolerance/insulin sensitivity, in people with MetS.[9,10] A systematic review of supervised exercise coupled with dietary interventions found they significantly reduced waist circumference, blood pressure, fasting blood glucose, and triglycerides in adults with MetS.[11] However, a systematic review of unsupervised exercise coupled with dietary intervention found smaller reductions in waist circumference and blood pressure and no significant improvements in other components of MetS.[12]

Poor adherence is one possible explanation for the difference in effect of supervised versus unsupervised exercise.[12] In studies investigating exercise alone in MetS populations, there is a consistent lack of reporting of adherence to exercise interventions.[9,10] However, poor adherence to exercise recommendations is a common problem in many health conditions,[13–16] which may diminish the effectiveness of EPA interventions. It seems likely that improvements in MetS are only achieved and maintained if lifestyle modifications such as exercise are maintained in the long term.[17] Adherence is defined by the World Health Organization as the extent to which a person's behavior corresponds with agreed recommendations from a health care professional.[18] Increased adherence to EPA recommendations is associated with better outcomes in chronic conditions including those with musculoskeletal conditions and MetS.[17,19] However, adherence is reported to be low in populations with chronic conditions.[20,21] Bullard et al[21] found that across cancer, cardiovascular disease and type 2 diabetes mellitus populations, the average adherence rate to prescribed exercise was 77%. In another study, 90% of individuals at risk of MetS were non-adherent to lifestyle changes,[20] highlighting the need to consider adherence in this population.

To identify individuals at risk of non-adherence and design appropriate interventions to target this, we should first be able to identify the determinants of adherence.[14] A mixed methods review investigating determinants of adherence to EPA in patients with musculoskeletal disorders identified strong or moderate evidence for 38 determinants under seven overarching themes: individual internal characteristics; individual's knowledge and experience of health problem; social influences; therapeutic relationship; characteristics of exercise program; support for exercise, and effect of exercise programme.[22] Sociodemographic factors and socioeconomic status (SES) may also affect exercise adherence during cancer treatment[23] and among older people.[24] For people with obesity, healthier eating and physical activity behaviors, higher initial weight loss, and older age predict greater adherence to lifestyle interventions.[13,14] For the MetS population, who have high rates of obesity and sedentary behavior,[25] the determinants of adherence to EPA recommendations are likely to be equally multi-dimensional and therefore complex to manage.

To the best of our knowledge, no previous systematic review has investigated the determinants of adherence to EPA in people with MetS. The aim of this review is to identify the determinants of adherence to home, outpatient, or community-based EPA in adults with MetS. Understanding determinants will help healthcare professionals identify individuals at risk of non-adherence and thus those most likely to benefit from targeted behavior change interventions, with the goal of improving health outcomes in this population.

Methods

This mixed methods systematic review was designed in accordance with the Cochrane Prognosis Methods Group guidelines,[26] the Cochrane Qualitative and Implementation Methods Group (CQIMG) Guidance Series[27] and PRISMA reporting guidelines recommended for use in mixed-method reviews.[28] The inclusion of a qualitative evidence synthesis can provide insight into how the environments in which people live and experience healthcare, and their attitudes and beliefs, may impact their behavior.[29] This is of particular importance when investigating adherence to EPA, a concept with the behavior of individuals at its core.

Data Sources and Search Strategy

Six electronic databases, MEDLINE, CINAHL Complete, PubMed, PsycINFO, SPORTDiscus, and Cochrane Central Register of Controlled Trials (CENTRAL), were searched from their inception to April 26, 2021. Search terms synonymous with determinants, exercise/physical activity, adherence, and metabolic syndrome, along with MeSH terms, were used to search for relevant studies (Supplementary Table 1).

Eligibility Criteria

We included studies that (1) were peer-reviewed primary quantitative, qualitative or mixed methods studies published in the English language; (2) investigated adult populations with MetS as defined by either the IDF or NCEP-ATP III criteria or by other closely aligned criteria, i.e. presence of 3 out of the 5 risk factors associated with MetS: impaired glucose tolerance, hypertension, raised triglycerides, low high-density lipoprotein, and abdominal obesity; (3) investigated factors that affect adherence, related to participants (eg, age, gender, self-efficacy), healthcare providers (eg, aspects of therapeutic relationship such as communication), or healthcare organizations (eg, facilities, reputation); (4) investigated programs of EPA delivered for therapeutic benefit, by a healthcare professional, trained lay representative, or as part of a multi-disciplinary package of management, performed in any outpatient setting; and (5) investigated adherence to EPA or physical activity levels.

We excluded studies if they investigated determinants of adherence to diet and/or medication only, if adherence to diet and exercise was reported as combined data, or if adherence was measured by attendance to appointments or clinics only.

Screening

Covidence, a web-based software program for systematic review management (covidence.org), was used to import references from searches, remove duplicates, complete the screening process, and generate the PRISMA flowchart of study selection. Title and abstracts were independently screened by two authors, with LE reviewing all entries and the remaining three authors reviewing a third each. The same process was followed for screening of full-text articles remaining for review. Conflicts were resolved through discussion between all four reviewers. Agreement between reviewers was assessed using Cohen's kappa statistic. A kappa value between 0.00 and 0.20 represents slight agreement, 0.21–0.40 represents fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial agreement, and 0.81–1.00 almost perfect agreement.[30] Reference lists of included full-text articles were screened for additional relevant studies.

Assessment of Study Quality

The methodological quality of quantitative studies was assessed using the QUIPS (Quality In Prognostic factor Studies) checklist, which assesses risk of bias over six domains: study participation, study attrition, prognostic factor management, outcome measurement, study confounding, statistical analysis, and reporting.[31] Each domain was rated as having "high", "moderate", or "low" risk of bias based on responses to a list of prompts, then an overall risk of bias was determined based on all domains.[31]

Methodological quality of qualitative studies was assessed using the modified Critical Appraisal Skills Program.[32] This tool consists of 10 items which assess three aspects of the study: quality of reporting of the rationale, aims and context of the study; rigor of the methods used; and credibility of the methods used. Studies were assessed for the fulfilment of each criterion ('yes', "no" or "unclear"), and a judgement was made on the overall assessment of limitations, as calculating total quality scores is not recommended.[27] Methodological quality assessment was conducted independently by two reviewers (LE and NT) and consensus was reached through discussion. Agreement between the two reviewers was assessed using Cohen's kappa statistic.

Data Extraction

The CHARMS-PF checklist (checklist for critical appraisal and data extraction for systematic reviews of prediction modelling studies-prognostic factors) was used to guide extraction of key data items across 11 domains from each quantitative study included in the review.[26] Data extraction from qualitative studies was completed based on a template designed by the National Institute for Health and Care and Excellence (NICE),[33] recommended by the CQIMG.[27] Information was extracted about themes that were evaluated by included studies. This process was completed by one reviewer (LE) and checked for accuracy by a second reviewer (CP), with full extraction tables available (Supplementary Tables 2 and 3).

Certainty of Evidence

Assessing the certainty of evidence from quantitative studies was completed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach for prognostic factor studies.[34] Six domains were taken into consideration: phase of investigation, study limitations, inconsistency, indirectness, imprecision, and publication bias, which determined if the certainty rating was downgraded.[34] An initial rating of "moderate" was given to each determinant, as studies were Phase I explanatory studies. Where the majority (≥75%) of studies evaluating a determinant were of low methodological quality, the rating was downgraded.[22] If only one study evaluated a determinant, it was not possible to assess inconsistency, thus the score was downgraded. Imprecision is difficult to evaluate in the absence of a meta-analysis, but the presence of rationale for sample sizes and sample sizes themselves were considered.[34] Huguet et al[34] recommend downgrading for publication bias unless a determinant has been investigated in a large number of cohort studies, thus all determinants were downgraded for publication bias. Moderate or large effect sizes, and an exposure-response gradient were reasons for upgrading. This process was conducted by one reviewer (LE) and checked by a second reviewer (SMc).

Assessment of certainty of evidence from qualitative studies was done using the GRADE-CERQual (Confidence in the Evidence from Reviews of Qualitative Research) method.[27] This approach evaluates four domains: methodological limitations, coherence, adequacy of data, and relevance. An initial rating of "very high" was given to each determinant, as advised by the protocol.[35] Both approaches produce a certainty rating of high, moderate, low, or very low.[34,35]

Data Synthesis

A triangulation protocol described by Farmer et al[36] was used to synthesise data from quantitative and qualitative studies and to evaluate the extent of alignment or non-alignment between determinants of EPA adherence. It followed four stages as described below. Triangulation was completed by one reviewer (LE) with a second reviewer (CP) involved for cross-checking, to increase reliability.

1. Sorting. Findings from each data set (quantitative and qualitative) were sorted into categories based on identified determinants or themes.
2. Certainty of evidence for qualitative and quantitative data sets. This information was obtained through the GRADE and GRADE-CERQual protocols.
3. Convergence coding. Determinants or themes from each data set were compared to assess the degree of convergence, using the coding scheme in Table 1.
4. Evaluating overall strength of evidence. Assessing overall certainty of evidence for the combined qualitative and quantitative data sets for each determinant based on risk of bias, quantity of studies, consistency of findings across the studies, and impact, using pre-determined criteria according to the Dietary Guidelines Advisory Committee in Table 2.[37] All determinants were evaluated in relation to non-adherence.

Results

Study Selection

Database and reference list searches yielded 1952 results. Following removal of duplicates, 1272 titles and abstracts were screened. Of these, 1243 were excluded and the remaining 29 full-text articles were assessed for eligibility. Five studies met the inclusion criteria, one qualitative and four quantitative studies, and were included in the review (Figure 1). There was

Table 1 Convergence Coding scheme

Congruence	There is agreement between both sets of results. (ie, factors emerging as significantly related to adherence outcomes in quantitative studies are considered important and relevant in qualitative studies OR agreed that there is no relationship between the determinant and adherence).
Silence	One set of results covers the theme or determinant whereas the other set of results is silent on the same.
Dissonance	There is disagreement between the sets of results on either the relevance or direction of the determinant under consideration.

Table 2 Criteria for Assessing Overall Strength of evidence

Elements	Grade I: Strong	Grade II: Moderate	Grade III: Limited	Grade IV: Not Assignable
Risk of bias	Studies of strong design free from design flaws, bias, and execution problems	Studies of strong design with minor methodological concerns OR only studies of weaker study design for question	Studies of weak design for answering the question OR inconclusive findings due to design flaws, bias, or execution problems	Serious design flaws, bias, or execution problems across the body of evidence
Quantity - Number of studies - Number of subjects	Two or more good quality studies; Large number of subjects studied Studies have sufficiently large sample size for adequate statistical power	Two or more studies by independent investigators; Doubts about adequacy of sample size to avoid Type I and Type II error	At least one study irrespective of quality; Low number of subjects studied and/or inadequate sample size within studies	Available studies do not directly answer the question OR no studies available
Consistency of findings across studies	Findings generally consistent in direction and size of effect or degree of association with very minor exceptions	Some inconsistency in results across studies in direction and size of effect	Unexplained inconsistency among results from different studies	Independent variables and/or outcomes are too disparate to synthesize OR single small study unconfirmed by other studies
Impact - Directness of studied outcomes	Studied outcome relates directly to the question	Some study outcomes relate to the question indirectly	Most studied outcomes relate to the question indirectly	Studied outcomes relate to the question indirectly

moderate agreement between reviewers when evaluating titles and abstracts (kappa = 0.41, 95% CI 0.28 to 0.56) and substantial agreement between reviewers when evaluating full-text articles for inclusion (kappa = 0.70, 95% CI 0.38 to 1).

Quality Assessment

QUIPS assessment found that three quantitative studies had a high risk of bias, and the remaining quantitative study had a low risk of bias (Figure 2). Each of the three studies with a high risk of bias scored "high" for the domain of study attrition, due to inadequate response rates,[38] inadequate reasons provided for participant drop-out,[39] reported differences in participant characteristics between those who completed the study and those who did not,[38] or a lack of reporting on potential differences between those who completed the study and those who did not.[39,40] In assessing methodological quality, agreement between the two reviewers was fair (kappa = 0.29, 95% CI −0.07 to 0.65), with independent ratings and final consensus by domain recorded.

The qualitative study[43] adequately described nine out of ten items in the CASP tool, but the relationship between researcher and participants was deemed to have not been adequately considered (Figure 3). In line with use of the CASP tool in a Cochrane mixed methods systematic review,[41] an answer of "no" to any of the ten items in the tool is interpreted as the study having major limitations. Agreement between the two reviewers was perfect.

Study Characteristics

The five included studies evaluated determinants of adherence in 787 adults diagnosed with MetS. Two of the quantitative studies were cross-sectional studies, and two were longitudinal studies (Table 3). The qualitative study used general qualitative methods with directed content analysis and inductive and deductive coding methods (Table 4).

The four quantitative studies used self-report measures to record either adherence to EPA recommendations or overall physical activity levels, and one study[39] also measured physical activity using an accelerometer (Table 3).

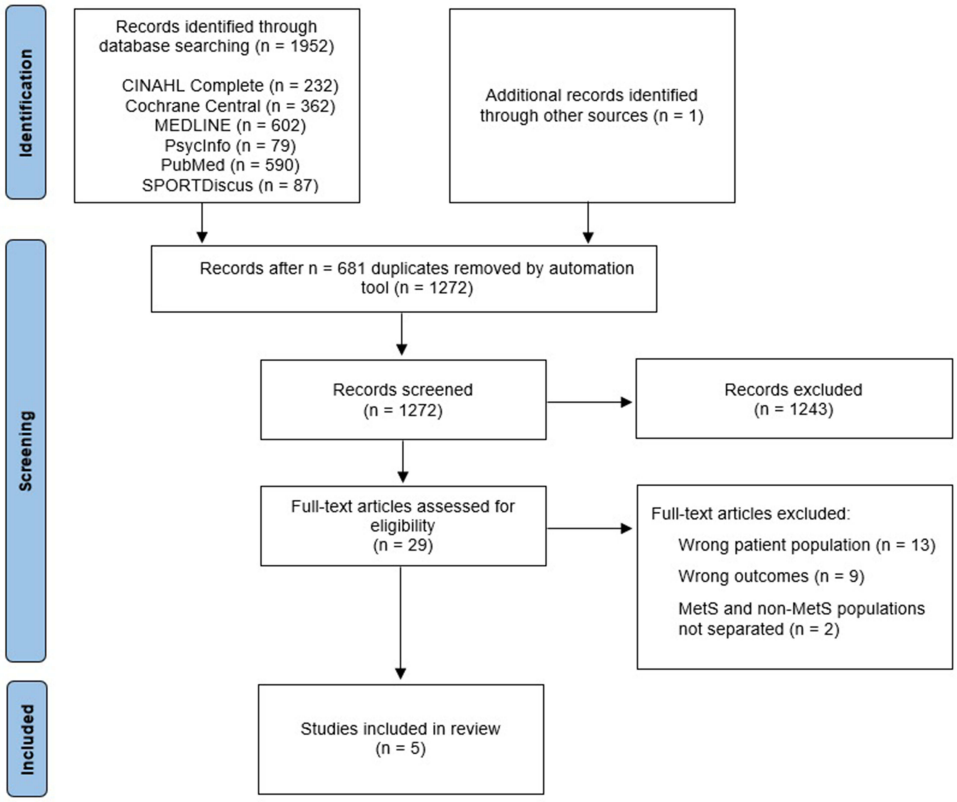

Figure 1 PRISMA flow chart of screening and study selection.
Notes: Adapted from Page MJ, McKenzie JE, Bossuyt PM et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;(372):n160.[28]

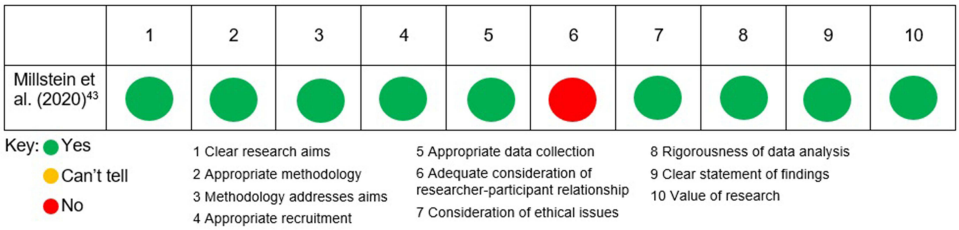

Figure 2 Quality assessment of quantitative studies.

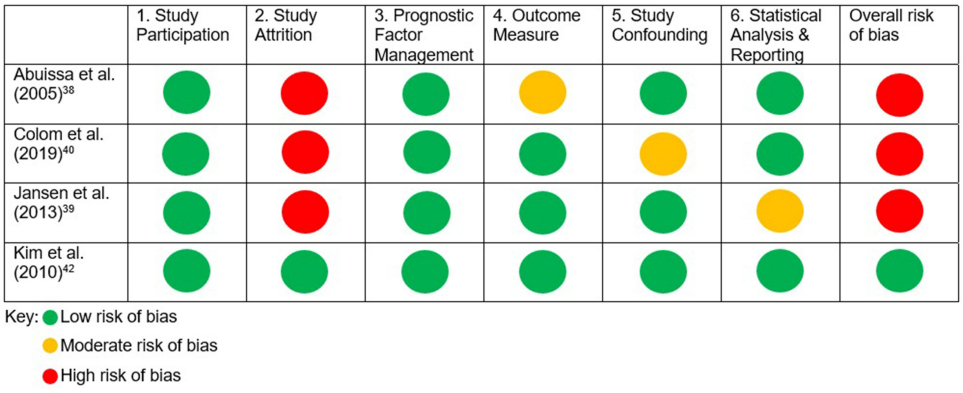

Figure 3 Quality assessment of qualitative studies.

Table 3 Summary of Quantitative Results

Study (Country)	Study Population /MetS Criteria Used	Participant Baseline Characteristics	Outcomes / Physical Activity Measures	Prognostic Factors Evaluated	Timing of Outcomes	Key Results
Abuissa et al (2005)[38] (USA)	Adults with MetS from an acute coronary syndrome registry at two hospitals NCEP-ATP-III	n = 273 / 170 (baseline / follow-up) Male 97 (57%) Female 73 (43%) Age 60 ± 12	Self-reported physical activity "Moderate physical activity pursued for 30 min at least three times weekly"	• Age • Gender • Race • BMI • Exercise at baseline	Baseline 1 year	Routine exercise at baseline (OR = 2.6, 95% CI = 1.1–6.4), younger age (OR = 0.67 per 10-year increase, 95% CI = 0.45–0.99), and lower BMI (OR = 0.4 per 10-unit increase, 95% CI = 0.17–0.91) predicted exercise.
Colom et al (2019)[40] (Spain)	Adults with MetS enrolled from primary care facilities that were part of the PREDIMED-Plus trial IDF	n = 218 Female 112 (51%) Male 106 (49%) >65y: 102 (47%) ≤65y: 116 (53%)	Self-reported (REGICOR) and objectively measured (accelerometer) physical activity	• Age • Gender • Education level • Self-rated health Plus 12 geographical factors	Baseline	Poorer self-rated health associated with lower PA level ($p < 0.001$). Women had lower objectively measured physical activity than men ($p < 0.001$). Closer walk-friendly routes associated with higher objectively measured physical activity (p = 0.028).
Jansen et al (2013)[39] (The Netherlands)	Adults with MetS, identified after population-based screening in the Ijsselstein Screening for Central Obesity to Detect Metabolic Syndrome study NCEP-ATP-III	n = 473 / 168 Female 239 (51%) Male 234 (49%) Age 49 ± 10	Self-reported physical activity (SQUASH physical activity questionnaire) Dutch physical activity guidelines	• Age • Gender • Ethnicity • Education level • Weight • BMI Plus 6 MetS-specific factors	Baseline 3 years	Female gender (OR = 3.67, 95% CI 1.34–10.03, $p = 0.01$), weight (OR = 0.96, 95% CI 0.93–0.99, $p = 0.02$) and BMI (OR = 0.80, 95% CI 0.67–0.96, $p = 0.02$) were associated with an increase in PA.
Kim et al (2010)[42] (South Korea)	Adults with MetS from a convenience sample from one university hospital NCEP-ATP-III	n = 210 Female 70 (33%) Male 140 (67%) Age 53 ± 11	Regular / non-regular exerciser based on TTM-related questionnaires	• Smoking • High blood pressure • HDL-C Plus 10 TTM-related factors	Baseline	HDL-C (OR = 1.075; 95% CI 1.016–1.137; P = 0.012), Consciousness raising (OR = 1.271, CI 1.042–1.551, $p = 0.018$), Self-re-evaluation (OR = 1.480, CI 1.068–2.051, $p = 0.019$), Self-liberation (OR = 2.310, CI 1.737–3.071, $p = 0.000$) were associated with exercise.

Abbreviations: MetS, metabolic syndrome; NCEP-ATP-III, National Cholesterol Education Program Adult Treatment Panel III; IDF, International Diabetes Foundation; REGICOR, Girona Heart Registry Short Physical Activity Questionnaire; SQUASH, Short Questionnaire to Assess Health-enhancing; TTM, Transtheoretical Model; BMI, body mass index; HDL-C, high density lipoprotein cholesterol; OR odds ratio; CI, confidence interval.

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Table 4 Summary of Qualitative Results

Study (Country)	Study Population / MetS Criteria Used	Participant Baseline Characteristics	Data Collection /Data Analysis	Key Themes
Millstein et al (2020)[43] (USA)	Adults with MetS from purposive sampling of patients from a primary care clinic IDF	n = 21 Female 13 (62%) Male 8 (38%) Age 63 ± 10	1-hour semi-structured telephone interviews conducted by clinical psychologist Directed content analysis using predetermined coding framework	Physical activity leads to positive psychological constructs including determination, optimism, connectedness. Motivators for physical activity were health benefits, physical independence with respect to aging, relaxation, spousal / social support. Barriers to physical activity were perceived lack of willpower, low motivation, low self-efficacy, lack of social support, stress.

Abbreviations: MetS, metabolic syndrome; IDF, International Diabetes Foundation.

Determinants of Adherence to EPA

During the triangulation process, 34 determinants were identified and evaluated for their relationship with adherence to EPA. The adapted GRADE approach, as described by Huguet et al,[34] was used to evaluate strength of the quantitative evidence for each determinant (Supplementary Table 4). As only Kim et al[42] was of high methodological quality, most determinants were downgraded. Twenty-nine of 34 determinants were only evaluated in one quantitative study, therefore these were downgraded for inconsistency. Where there was an absence of rationale for sample sizes,[38–40] sample sizes were considered adequate; thus, no determinants were downgraded for imprecision.[34] No determinants were upgraded as there was no evidence of moderate or large effect sizes or exposure-response gradients.

The GRADE-CERQual approach was applied to evaluate the strength of the qualitative evidence (Supplementary Table 5).[35] As the only qualitative study[43] involved had major methodological limitations, there were serious concerns in the methodological limitations and adequacy domains.[44,45] There were no concerns in the domain of coherence, with clear and cogent study findings, and minor concerns in the relevance domain due to very limited ethnic diversity in the study population.[46,47] Given the serious concerns in two out of four domains, and minor concerns in another, the confidence in the findings was rated as "low" for each of the 6 determinants identified in this study.

Table 5 shows the summary of the triangulation process with quantitative and qualitative results combined, convergence level, and the overall certainty of evidence (strong, moderate, limited, unassignable) for each determinant. The full breakdown of results from all quantitative and qualitative studies can be found in Supplementary Table 6. Determinants were categorised into five themes: Demographic Characteristics, General Health Parameters, MetS-specific Characteristics, Geographical Factors, and Psychosocial Factors.

Demographic Characteristics

There is limited conflicting evidence that older age and male gender are associated with lower adherence to EPA. Neither ethnicity nor educational level is associated with non-adherence (limited evidence).

General Health Parameters

Lower self-rated health and lower baseline EPA are associated with lower adherence (limited evidence). There is limited but conflicting evidence that body mass index is associated with lower adherence to EPA.

MetS-Specific Characteristics

There is limited evidence for an association between lower HDL-C and non-adherence to EPA. No association was found between waist circumference, systolic or diastolic blood pressure and non-adherence (limited evidence).

Table 5 Summary of Triangulation for Determinants of Adherence to PA

	Quant				Qual			Convergence Level	Overall Strength	Summary Statement
	Sig. +ve	No Sig.	Sig. -ve	GRADE	+ve Rel.	-ve Rel.	GRADE CERQual			
Demographic Characteristics										
Older age	1	2	0	Very low	-	-	-	Silent	Limited	There is limited conflicting evidence for an association between older age and non-adherence
Male gender	1	2	1	Very low	-	-	-	Silent	Limited	There is limited conflicting evidence for an association between male gender and non-adherence
Ethnicity	0	2	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between ethnicity and non-adherence
Education	0	2	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between education and non-adherence
General Health Parameters										
Body mass index	1	0	1	Very low	-	-	-	Silent	Limited	There is limited conflicting evidence for an association between BMI and non-adherence
Self-rated health	0	0	1	Very low	-	-	-	Silent	Limited	There is limited evidence for an association between lower self-rated health and non-adherence
Exercise at baseline	0	0	1	Very low	-	-	-	Silent	Limited	There is limited evidence for an association between lower exercise at baseline and non-adherence

(*Continued*)

Table 5 (Continued).

	Quant				Qual			Convergence Level	Overall Strength	Summary Statement
	Sig. +ve	**No Sig.**	**Sig. -ve**	**GRADE**	**+ve Rel.**	**-ve Rel.**	**GRADE CERQual**			
Smoking	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between smoking and non-adherence
MetS-specific Characteristics										
Waist circumference	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between waist circumference and non-adherence
Systolic blood pressure	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between systolic BP and non-adherence
Diastolic blood pressure	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between diastolic BP and non-adherence
High density lipoprotein cholesterol	0	0	1	Very low	-	-	-	Silent	Limited	There is limited evidence for an association between lower HDL-C and non-adherence
Geographical Factors										
Precipitation	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between precipitation and non-adherence
Distance to coast	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between distance to coast and non-adherence

(*Continued*)

Table 5 (Continued).

	Quant				Qual			Convergence Level	Overall Strength	Summary Statement
	Sig. +ve	No Sig.	Sig. -ve	GRADE	+ve Rel.	-ve Rel.	GRADE CERQual			
Healthy routes contained or intersected by buffer	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between healthy routes contained or intersected by buffer and non-adherence
Distance to nearest sports facility	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between distance to nearest sports facility and non-adherence
Distance to nearest beach	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between distance to nearest beach and non-adherence
Distance to nearest park	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between distance to nearest park and non-adherence
Walk-friendly routes contained or intersected by buffer	0	0	1	Very low	-	-	-	Silent	Limited	There is limited evidence for an association between fewer walk friendly routes within a certain distance and non-adherence
Number of sports facilities contained or intersected by buffer	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between number of sports facilities within a certain distance and non-adherence

(*Continued*)

Table 5 (Continued).

	Quant				Qual			Convergence Level	Overall Strength	Summary Statement
	Sig. +ve	No Sig.	Sig. -ve	GRADE	+ve Rel.	-ve Rel.	GRADE CERQual			
Number of parks contained or intersected by buffer	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between number of parks within a certain distance and non-adherence
Areas of parks contained or intersected by buffer	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between areas of parks within a certain distance and non-adherence
Number of Public Open Spaces (POS) contained or intersected by buffer	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between number of POS within a certain distance and non-adherence
Areas of POS contained or intersected by buffer	0	1	0	Very low	-	-	-	Silent	Limited	There is limited evidence for no association between areas of POS within a certain distance and non-adherence
Psychosocial Factors										
Consciousness raising (undertaking to find out more about exercise behavior)	0	0	1	Very low	-	-	-	Silent	Limited	There is limited evidence for an association between lower consciousness raising and non-adherence
Dramatic relief (caring about the consequences of inactivity or nonexercise)	0	1	0	Very low	0	1	Low	Dissonant	Limited	There is limited conflicting evidence for an association between dramatic relief and non-adherence

(*Continued*)

Table 5 (Continued).

	Quant				Qual			Convergence Level	Overall Strength	Summary Statement
	Sig. +ve	No Sig.	Sig. -ve	GRADE	+ve Rel.	-ve Rel.	GRADE CERQual			
Self-re-evaluation (seeing oneself as an active person)	0	0	1	Very low	-	-	-	Silent	Limited	There is limited evidence for an association between lower self-re-evaluation and non-adherence
Self-liberation (choosing and making commitment to change)	0	0	1	Very low	0	1	Low	Convergent	Limited	There is limited evidence for an association between lower self-liberation and non-adherence
Stimulus control (avoiding or controlling stimuli or other causes that support inactivity or nonexercise)	0	1	0	Very low	0	1	Low	Dissonant	Limited	There is limited conflicting evidence for an association between stimulus control and non-adherence
Reporting of positives of adopting or maintaining exercise behavior	1	0	0	Very low	0	1	Low	Dissonant	Limited	There is limited conflicting evidence for an association between reporting of positives and non-adherence
Reporting of arguments against adopting or maintaining exercise behavior	1	0	0	Very low	1	0	Low	Convergent	Limited	There is limited evidence for an association between reporting of arguments and non-adherence
Self-efficacy	0	1	0	Very low	0	1	Low	Dissonant	Limited	There is limited conflicting evidence for an association between low self-efficacy and non-adherence
Social support	-	-	-	-	0	1	Low	Silent	Limited	There is limited evidence for a relationship between reduced social support and non-adherence

(*Continued*)

Table 5 (Continued).

	Quant				Qual			Convergence Level	Overall Strength	Summary Statement
	Sig. +ve	No Sig.	Sig. -ve	GRADE	+ve Rel.	-ve Rel.	GRADE CERQual			
Positive psychological constructs	-	-	-	-	0	1	Low	Silent	Limited	There is limited evidence for a relationship between reduced positive psychological constructs and non-adherence

Abbreviations: Sig. +ve, positive significance; no sig., no significance; Sig. -ve, negative significance; +ve rel, positive relationship; -ve rel., negative relationship.

Geographical Factors

There is limited evidence for an association between fewer walk-friendly routes within a 1 km distance and non-adherence to EPA. No associations were found between the other 11 geographical factors and non-adherence (Table 5) (limited evidence).

Psychosocial Factors

There is limited evidence for an association between the following psychosocial factors and non-adherence to EPA: lower consciousness raising (reduced undertaking to find out more about exercise behavior), lower self-re-evaluation (seeing oneself as a less active person), lower self-liberation (lesser ability to choose and make a commitment to change), reporting more arguments against adopting or maintaining exercise behavior, lower social support, and lower positive psychological constructs.

There is limited conflicting evidence for an association between the following psychosocial factors and non-adherence to EPA: dramatic relief (caring about the consequences of inactivity or non-exercise), stimulus control (avoiding or controlling stimuli or other causes that support inactivity or non-exercise), reporting more positives of adopting or maintaining exercise behavior, and self-efficacy.

Discussion

To the best of our knowledge, this systematic review is the first to investigate the determinants of adherence to EPA in people with MetS. Based on one high quality and four low quality studies, this review identified 34 potential determinants and found limited evidence of an association between ten determinants and non-adherence to EPA: lower self-rated health, lower baseline EPA, lower high-density lipoprotein cholesterol (HDL-C), fewer walk-friendly routes within 1km, lower consciousness raising, lower self-re-evaluation, lower self-liberation, reporting more arguments against EPA, lower social support, and fewer positive psychological constructs. There was limited evidence of no association or conflicting evidence for the remaining 24 determinants, potentially due to the lack of high-quality studies available for this review.

The existing literature supports our finding that lower self-rated health is associated with non-adherence to EPA. Studies in populations at risk of MetS and a systematic review in populations of older adults found associations, or results to suggest associations, between better self-rated health and greater adherence to EPA.[20,24,48] Self-rated health is an individual's perception of their biological, psychological, and social health. Some evidence suggests a link between low self-rated health and psychological distress.[49] Evidence in MetS populations and in older people suggests that those who experience psychological distress show reduced adherence to healthy behaviors, including physical activity.[24,50] Therefore, those with greater self-rated health may suffer less psychological distress, which may contribute to better adherence to EPA in these groups.

Our finding that higher baseline physical activity is associated with greater adherence to EPA is reflected by studies in those at risk of MetS, in people with type 2 diabetes mellitus, and in people with cancer.[23,51–53] Considering the transtheoretical model of behavior change, individuals with higher baseline physical activity are in the "action" or "maintenance" stages of change. Here, individuals may perceive more benefits of physical activity than costs.[42] Enjoyment of exercise and previous positive adherence behavior are positively associated with adherence in musculoskeletal populations.[22] Compared to those who enjoy exercise, those who do not may lack intrinsic motivation and therefore have no intention to initiate or continue EPA.[54] Enjoyment has been shown to predict physical activity more than cognitive intentions to engage in physical activity.[55]

We found conflicting evidence for an association between self-efficacy and adherence in people with MetS. However, existing evidence points towards an association between greater self-efficacy and better adherence in those at risk of MetS,[48,56] in type 2 diabetes mellitus populations,[52,57] in people with Parkinson's disease,[58] people with cancer,[23] and in older people.[59] However, Susin et al[53] found no association between self-efficacy and adherence to a diet and exercise intervention for people with MetS, although the data for diet and exercise was combined. Although Kim et al[42] did not find self-efficacy to be a significant predictor of exercise behavior in people with MetS, levels of self-efficacy did increase as individuals progressed through stages of change, equating to increasing levels of exercise behavior. Self-efficacy is an individual's confidence in their ability to achieve a set goal,[60] and is the central construct of Bandura's social cognitive theory, which hypothesises that health behaviors are driven by personal, behavioral, and environmental factors.[52] Self-efficacy is thought to increase as individuals progress through an exercise or physical activity intervention.[42] EPA adherence requires skills related to self-regulation, such as goal setting, self-monitoring, time management, and relapse prevention.[59]

Social and spousal support were identified as facilitators to physical activity in this review. Existing qualitative research supports this finding, with social support, often including healthcare professionals, regular follow-ups, and exercising in groups, required for EPA adherence in populations similar to MetS,[61–63] in sedentary women,[64] and in people with cancer.[23] Social support, therapeutic support, and regular follow-ups are associated with greater exercise adherence in musculoskeletal populations,[22] and supervised exercise appears more effective than unsupervised exercise to improve metabolic risk factors in people with MetS.[12] Social support is thought to enhance EPA adherence by increasing self-efficacy, or by increasing positive emotions experienced while participating in physical activity, leading to enjoyment.[60] Group exercise is often cited as a preference by participants.[61–63] This could be driven by the opportunity to share experiences with other people going through similar health and behavior challenges.[22] Providing, as well as receiving, social support may have beneficial effects on health,[65] another possible driver of the desire for group exercise. Out of four effective interventions for increasing EPA adherence in older adults, three involved some form of feedback and/or monitoring from programme leaders.[66] Regular follow-ups from healthcare professionals also increased adherence to exercise in a type 2 diabetes mellitus population.[67] This supports the notion that support from a healthcare professional, or perhaps from anyone perceived as knowledgeable and able to offer guidance, feedback, and motivation, such as the leader of an exercise programme, is important in EPA adherence.

Limitations

This review was designed and conducted in accordance with current guidelines produced by the Cochrane Prognosis Methods Group, the CQIMG, and PRISMA. Multiple databases were used, and multiple reviewers were involved throughout the review, and any conflicts were resolved through discussion. These processes are considered gold standard for increasing the rigour of systematic reviews.[68,69]

One limitation of this review is that only studies in the English language were included, and search methods were limited to database searching and reference list searching of the eligible studies. Additional supplementary search methods, such as hand searching and citation tracking, may have led to the inclusion of additional studies.[70] Additionally, publication bias cannot be excluded and may lead to the exclusion of unpublished data, leading to overestimation of the importance of each determinant.[71] However, this is a potential bias in all systematic reviews.

A further limitation relates to using physical activity measures as proxy markers of adherence. Each included quantitative study reported physical activity levels, an increase of which was interpreted as adherence to the purpose of this review. Application of a measure for a purpose other than for which it was designed may affect the validity of the

results.[72] In patient populations, EPA is often prescribed in accordance with physical activity guidelines in order to increase overall physical activity levels and improve self-management of the health condition, therefore any significant difference in physical activity might be considered an acceptable indicator of adherence to a prescribed therapeutic recommendation.

One final limitation of this review is the lack of high-quality literature, leading to a low number of included studies. This leads to a low level of confidence that the findings in this review are associated with non-adherence to EPA. However, multiple other reviews support the idea that a wide range of factors are likely to be associated with non-adherence in various patient populations,[22–24] and therefore there is a need to undertake further research that strengthens our understanding of these factors for people with MetS.

Clinical Implications

Physiotherapists and other healthcare professionals must consider a broad, complex range of factors affecting patients' adherence to EPA, and help patients seek solutions to overcome these barriers using an individualized and holistic approach.

Patients with poorer self-rated health may need more support to initiate and maintain EPA.[50] For those with low baseline EPA, identifying enjoyable ways to engage in EPA may facilitate greater uptake and continuation of EPA in patients with MetS.[54] For patients with low self-efficacy, physiotherapists may need to help patients identify potential EPA strategies that would fit with the patient's lifestyle, support goal setting, and discuss relapse management until the patient has sufficiently increased their ability to engage with EPA independently.[60] For patients with smaller social support systems, increased guidance, feedback and motivation may be provided by physiotherapists or other professionals.[66,67]

Implications for Research

The small number of eligible studies and very low certainty of evidence in this review suggests that the existing research into the determinants of EPA in MetS is limited and that further high-quality quantitative, qualitative or mixed-methods research in this area is warranted. Identification of determinants also creates the opportunity to begin identifying behaviour change interventions that might be used to increase EPA adherence and to begin testing the effectiveness of these behaviour change techniques in populations with MetS.

Finally, existing research in other health populations, such as those at risk of MetS, and those with musculoskeletal conditions, has reached comparable conclusions that there are multiple determinants of EPA adherence. It is possible that determinants of EPA across all clinical populations may be similar. However, research is required to confirm or reject this hypothesis.

Conclusion

This review found evidence of limited certainty for associations between several factors and adherence to EPA. Taking the existing literature into consideration, lower baseline EPA, lower self-rated health, and a number of psychosocial factors may be the most significant determinants of reduced EPA adherence. The findings of this review highlight the lack of research into the determinants of EPA adherence in MetS populations. While it is plausible that factors affecting EPA adherence are similar across all clinical populations, it is imperative to establish this through further research.

Disclosure

The authors report no conflicts of interest in this work.

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