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Measurement, determinants, barriers, and interventions for exercise adherence: A scoping review

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ABSTRACT

Background: Adherence to exercise interventions is the cornerstone of a successful rehabilitation program. However, there is limited evidence on multifaceted components of exercise adherence. Therefore, we aimed to summarize the existing literature on measurement, determinants, barriers, theoretical frameworks, and evidence-based interventions that support exercise adherence.

Methods: We conducted a scoping review based on the PRISMA extension for scoping reviews guidelines and searched the literature in PubMed, Cochrane Databases of Systematic Reviews, ScienceDirect, and Web of Science. Two reviewers independently screened articles. The included articles were subjected to data extraction and qualitative synthesis.

Results: A total of 72 articles were included for this review. Data synthesis showed that there are no gold standard methods of measuring exercise adherence; however, questionnaires and daily logs are commonly used tools. The determinants of adherence are personal, disease-related, therapy-related, provider-related, and health system-related. The common barriers to adherence are the absence of a caregiver, low health literacy, poor communication by healthcare providers, cost, and lack of access to health facilities. Few evidence-based interventions used for supporting adherence are behavioral strategies, improving self-efficacy, motivational therapy, and mHealth or multimedia.

Conclusion: Non-adherence to exercises is a challenge for healthcare providers. There are no standard guidelines for the evaluation and management of non-adherence to exercises. Future studies should aim at developing objective measures of exercise adherence and investigate the long-term effects of adherence strategies in different disease populations. It is an under-researched area and requires multipronged strategies to improve adherence levels among patients.

1. Introduction

Exercise-based interventions are an integral component of Physiotherapy. Exercise interventions target muscle strengthening, flexibility, balance, and motor control training that are prescribed for various orthopedic and neurological conditions (Shen et al., 2016) (Fredin and Lorås, 2017). Adhering to the prescribed exercises is essential for the effectiveness of exercise interventions (Hubbard et al., 2012).

Adherence is defined by World Health Organization (WHO) as "the extent to which a person's behavior – taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a healthcare provider." (Sabate, 2003) Some of the attributes of adherence are complex and multidimensional behavior, dynamic and measurable, changeable, situational, voluntary, and collaborative (Dalvandi and Ebadi,

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2020). Adherence requires active involvement of the patient in treatment planning, and its implementation, and maintenance (Meichenbaum and Turk, 1987).

Adherence is crucial for the success of any intervention since the treatment outcomes mostly depend on the level of adherence to prescribed interventions (Ogwumike et al., 2014). Healthcare system effectiveness cannot be assessed without addressing the issue of adherence. Often, chronic diseases require self-management of multiple therapies, and without a good adherence rate, the treatment does not yield the desired outcome (Sabate, 2003). Addressing poor adherence in chronic diseases can enhance the benefits of healthcare and ensure the safety of patients (Sabate, 2003)(Haynes et al., 2002).

Poor adherence to prescribed treatment is a global issue especially in chronic conditions (Sabate, 2003). Adherence to long-term interventions is around 50% in the developed countries and assumed to be even lesser in developing countries (Sabate, 2003). Adherence to home-based exercises is low because 60%–76% of patients do not entirely follow the prescribed exercises (Bassett and Prapavessis, 2007). The adherence rate to long-term exercises reduces to 30%–50% in the first year and almost 45%–80% within the first four years of initiation of treatment (Ice, 1985). Adherence was believed to be improved by correcting patient-related issues alone, neglecting most of the healthcare-related aspects (Sabate, 2003). However, patients' non-adherence is influenced by family, healthcare providers, community, and society (Sabate, 2003) (Ogwumike et al., 2015) (Rimmer, 2008) (Fernandez-Lazaro et al., 2019). Moreover, there are no standard protocols to support exercise adherence.

A scoping review on the factors that influence adherence, methods for measuring adherence, and interventions that support exercise adherence will be useful for implementation research. There is limited literature on multiple aspects of exercise adherence that can improve clinical practice. Hence, we conducted this review with the aim of summarizing the evidence on various aspects of exercise adherence and available evidence-based interventions to support it.

The specific research objectives were to explore and summarize the evidence on:

- Methods of measuring exercise adherence
- Determinants of adherence
- Barriers to exercise adherence
- Relevant theories and frameworks of behavior change that inform adherence interventions
- Interventions/strategies that have evidence of benefit for exercise adherence

2. Methods

We conducted a scoping review based on the framework given by PRISMA extension for scoping reviews (Tricco et al., 2018). We included the studies if they were published in the English language, included human participants, and reported any aspect of adherence such as barriers, facilitators, interventions, theories, or measurement. All study designs were included such as reviews, interventional, or observational studies. We excluded studies if the interventions were not focussed on supporting exercise adherence, did not state the methods of measuring adherence, or did not provide any information on factors affecting adherence.

2.1. Search strategy

We searched literature in PubMed, Cochrane Databases of Systematic Reviews, ScienceDirect, and Web of Science and included articles published from inception till January 2020. We used the MeSH terms 'exercise' and 'compliance.' The Boolean operator 'AND' and 'OR' were used to combine the keywords and for running the search. We also searched the literature from textbooks, cross-references, and bibliographies of the relevant articles. Supplementary file 1 shows the keywords used for literature search and search strategy.

2.2. Study selection

AM and PN conducted all the searches and completed the initial screening of titles and abstracts. After removing duplicates, AM and AD independently reviewed the full text of all potential articles. Any disagreements were resolved after discussing with CE, UB and JS.

2.3. Data charting/extraction and synthesis

Data were extracted from included studies by two reviewers (AM and PN). We extracted information on outcome measures of exercise adherence, adherence determinants, barriers to adherence, theories/framework that inform adherence interventions, and interventions that support adherence. AM and PN charted the data in Tables 1–4 and summarized the extracted data under the respective subheading.

3. Results

We obtained a total of 14,850 potentially relevant hits, of which 203 proceeded to full-text review. We included 72 articles for this review and synthesized the data. Fig. 1 shows the PRISMA flowchart for included studies. Based on our objective, we summarized the data under the following categories.

- Methods of measuring exercise adherence
- Determinants of adherence
- Barriers to exercise adherence
- Theories and frameworks of behavior change that inform adherence interventions
- Strategies that have evidence of benefit for exercise adherence

3.1. Methods of measuring exercise adherence

Accurately measuring adherence is difficult since it is a complicated behavior. There are no gold standard measures of exercise adherence to date (Sabate, 2003)(Bollen et al., 2014). Adherence to exercises is usually measured as clinic-based or home-based. Clinic-based adherence is commonly measured by the attendance to clinics. A few other measures of clinic-based exercise programs are Sports Injury Rehabilitation Adherence Scale (Kolt et al., 2007) and Exercise Proficiency Scale (Codori et al., 1992).

Self-report questionnaires or daily log books are frequently used to measure adherence to home-based programs (Bassett and Hons, 2003) (Newman-Beinart et al., 2017). The daily logs or diaries are beneficial since it also functions as a reminder to exercises (Bassett and Hons, 2003), however, it may not give an accurate measurement (Meichenbaum and Turk, 1987). Moreover, participants often lose adherence diaries or do not complete them (Newman-Beinart et al., 2017). (Cole, Andrew; Scott, 1991) The benefits of using self-report questionnaires are that these are convenient, simple, and requires lesser time. Nevertheless, it measures adherence at one-time point and may have recall bias or overestimation of performed exercises (Meichenbaum and Turk, 1987) (Bassett and Hons, 2003).

Table 1
Studies on measurement of exercise adherence (n = 11).

S. no	Author & year	Study design	Objectives	Sample size	Findings
1.	Bollen et al. (2014)	Systematic review	To identify self-report measures of adherence that have been used in this context and to critically evaluate the psychometric properties of these measures	7424	Found 58 studies reporting on 61 measures and many of the measures shared similarities but almost all lacked any psychometric validation
2.	Kolt et al. (2007)	Psychometric evaluation	To evaluate the factor structure, inter-rater agreement, and test–retest and inter-rater reliability of the Sport Injury Rehabilitation Adherence Scale (SIRAS)	105	SIRAS is a psychometrically sound measure of adherence to clinic-based rehabilitation for musculoskeletal injury
3.	Codori et al. (1992)	Exploratory study	To develop a valid clinical measure of compliance with hand rehabilitation	61	The correlation between exercise proficiency and compliance was 0.35. Therefore, exercise proficiency may be used to assess compliance to home exercises
4.	Bassett and Hons, 2003	Clinical commentary	To discuss the problems of adherence and methods used for assessing exercise adherence	NA	Assessment of adherence measures should be valid for identifying the type of adherence
5.	Newman-Beinart et al. (2017)	Questionnaire development	To develop and assess the initial psychometric evaluation of the first measure to assess adherence to prescribed home exercise: the Exercise Adherence Rating Scale (EARS)	224	Examination of the scale structure of the 6-item adherence scale revealed a one factor solution explaining 71% of the variance in adherence to exercise. The test-retest reliability is high
6.	Kaplan et al., 2013	Systematic review	To review the role of mobile technologies in the assessment of health-related behaviors, physiological responses, and self-reports	10,371	Mobile electronic technologies have had a profound effect on measurement
7.	Cole and Scott, 1991	Clinical study	To study the use of log books for self-evaluation	14	50% of the log books were lost or were returned with incomplete information
8.	Skotte et al.,	Validation study	To validate a triaxial accelerometer setup for identifying everyday physical activity types	17	The capability to detect sitting posture was some-what lower during unrestricted free living compared with the standardized condition for shorter periods of time
9.	Hawley-Hague et al. (2016)	Systematic review	To explore the definition and measurement of adherence to exercise in older adults	6670	Very little consensus on how adherence should be defined, and even when studies used the same conceptual approach, measurement used different approaches and/or had different cut-off points for what counted as being adherent. While use of sensors could help solve the problem of measuring adherence, they might of themselves provide a new source for a Hawthorne effect
10.	Frost et al. (2018)	Systematic review	To review methods of measuring home-based exercise adherence	10,399	Adherence diaries and self-developed questionnaires, were most commonly used measures. No gold standard measure of exercise adherence exists till date
11.	Mahmood et al. (2019)	Cross-sectional study	To develop and test the psychometric properties of Stroke-specific measure of exercise adherence	92	The pilot data showed that SS-MAHE was a reliable measure of home-based exercise adherence. The results showed that only 28% of people with stroke adhered to the prescribed exercises

Few objective measures of adherence include electronic devices and digital applications such as electromyography feedback, stop watches, and pedometers. Triangulation of multiple tools such as combining self-report questionnaires with digital devices is also used to measure adherence (Bassett and Hons, 2003). Adherence to physical activity can be accurately measured using accelerometers or mobile applications (Kaplan and Stone, 2013). However, such tools are unable to distinguish between sitting and supine activities (Skotte et al., 2014). Additionally, objective devices are often expensive and inconvenient to wear and may lead to over-estimation of exercises due to Hawthorne effect (Hawley-Hague et al., 2016).

Adherence to exercise dosage should include exercise duration, frequency, intensity, and correct performance of movement (Frost et al., 2018). A systematic review identified 61 outcome measures of adherence, out of which 29 were questionnaires, 29 were log diaries, 2 were visual analog scale, and one tally counter. Out of the 61 outcome measures, only two questionnaires were content validated (Bollen et al., 2014). A recent study developed and tested a scale to measure home-based exercise adherence specific to stroke and tested its psychometric properties (Mahmood et al., 2019a,b). However, no standardized objective tool was identified till date to measure exercise adherence.

3.2. Determinants of adherence

Adherence is a multi-faceted and complex phenomenon (Sabate, 2003). The factors influencing adherence can be personal, disease-related, therapy-related, provider-related, and healthcare system-related (Sabate, 2003) (Meichenbaum and Turk, 1987). The following are some of the determinants of adherence.

Personal factors: Personal characteristics consist of socio-demographic variables, motivational level, economic status, adherence history, previous engagement in sports, and social support (Sabate, 2003). Socioeconomic status is associated with the level of adherence. Patients were less likely to adhere if primary care physicians were unavailable or because of the higher perceived cost (Broadwater-Hollifield et al., 2015). In contrast, WHO 2003 reported that adherence was not directly related to income (Sabate, 2003).

Several studies have reported that socio-demographic variables are not related to adherence (Sabate, 2003). Similarly, other studies did not find any association between adherence and age, gender, or educational qualification (Sluljs and Kok, 1993)(Hartigan et al., 2000)(Adriano et al., 2016). The findings of a systematic review stated that the effect of education on adherence remains uncertain (Jin et al., 2008).

Personal beliefs play an important role in determining adherence. Low motivation and lack of perceived benefits of treatment are related to low adherence (Levin et al., 2016). Other contributors are poor cognition, self-efficacy, and perceived control over health and illness (Sabate, 2003) (Essery et al., 2017). Not only the psychological factors but awareness about the disease and its treatment are few predictors of adherence to treatment. (Sabate, 2003) (Mahmood et al., 2019a,b). Moreover, the content of knowledge or information also determines adherence (Jin et al., 2008). Previous

Table 2
Studies on determinants and barriers of adherence (n = 30).

S.no	Author & year	Study design	Objectives	Sample size	Findings
1	Sabate E., 2003	WHO report	To summarize evidence on adherence to long-term therapies	NA	Poor adherence to therapies is a worldwide challenge especially in chronic diseases. Adherence is influenced by multiple factors such as individual, disease, healthcare team/system, and social factors
2	Broadwater-Hollifield et al. (2015)	Cross-sectional study	To determine the predictors of adherence to medical recommendations	422	Presence of primary healthcare provider, higher income, and cost of treatment determined treatment adherence
3	Ogwumike et al. (2015)	Cross-sectional study	To identify barriers to clinical exercise adherence among people with stroke	52	Frequently reported barriers to clinical adherence were lack of caregiver, cost of treatment, pain, and fatigue in people with stroke. Demographic characteristics did not influence exercise adherence
4	Sluljs and Kok, 1993	Correlation study	To describe factors related to adherence to physical therapy exercises	222	Barriers perceived by the clients, lack of positive feedback, and helplessness were related to adherence. No correlation was found between demographic characteristics and exercise adherence
5	Hartigan et al. (2000)	Observational study	To assess exercise adherence in people with low-back pain	122	Adherence was found to be satisfactory due to reduced perceived helplessness by the patients thus reinforcing self-efficacy along with regular re-evaluation of pain
6	Adriano et al. (2016)	Cross-sectional study	To investigate the relationship between medical adherence and socio-demographic factors	43	The socio-demographic factors were not significantly related to adherence
7	Jin et al. (2008)	Systematic review	To identify common factors leading to non-adherence	102 studies	The effect of educational level on non-adherence was equivocal
8	Levin et al. (2016)	Literature review	To identify barriers and facilitators of medication adherence in bipolar disorders	NA	The barriers to adherence were perceived benefits of treatment, severity of disease, and cost of treatment
9	Essery et al.,	Systematic review	To identify predictors of home-based exercise adherence	3321	Significant predictors of adherence to home-based physical exercises were self-efficacy, motivation, previous adherence behavior
10	Mahmood et al. (2021)	Qualitative study	To assess factors influencing adherence to home-based exercises post stroke	10	Lack of knowledge about disease, its treatment, and benefits leads to non-adherence to home exercises
11	Rejeski et al. (1997)	RCT	To identify the predictors of adherence to exercises in people with osteoarthritis	439	Some of the strongest predictors of exercise adherence were previous exercise behavior and time spent in exercising
12	Godin and Shephard, 1990	Literature review	To discuss existing literature on exercise promotion	NA	Past exercise behavior, perceived barriers to exercises and attitude towards exercises influence intention to exercises
13	Voils et al. (2005)	Prospective cohort design	To assess the effect of social support and locus of control on medication adherence in elderly with depression	85	Social support and interactions were associated with better adherence in people with high locus of control
14	Seo M-A et al. (2005)	Cross-sectional study	To develop a model to explain mediation compliance in schizophrenia	208	Medication adherence can be improved with social support
15	Feinstein et al. (2005)	Cohort study	To find the factors associated with non-adherence to drugs in kidney transplant recipients	79	Family crisis and poor interpersonal environment negatively influenced adherence behavior in kidney transplant recipients
16	Bassett and Hons 2003	Literature review	To discuss problems of non-adherence to physiotherapy interventions	NA	People are less likely to adhere if they perceive the disease to be less severe and if they have to incorporate exercises in the long-term
17	Taylor and May, 1996	Observational study	To assess the effect of perceived severity of disease and self-efficacy on compliance in sport injuries	62	Compliance was associated with beliefs of treatment efficacy, higher self-efficacy, and training in clinics compared to home-based rehabilitation
18	Vlasnik et al. (2005)	Literature review	To summarize the existing literature on medical non-adherence	NA	Medication adherence is influenced by personal factors such as apathy, depression, motivation, and disease-related factors such as complicated prescription, cost, and noncompliance with previous regimens
19	Sluijs and Knibbe, 1991	Literature review	To discuss adherence to exercises in short-term and long-term rehabilitation	NA	Adherence to rehabilitation changes from short-term supervised therapy to long-term non-supervised exercises
20	Gascon et al.,	Qualitative study	To explore factors related to non-adherence in hypertension	44	Poor knowledge of hypertension, prolonged use of medications, and unsatisfactory clinician encounter influenced medication adherence
21	Hernández-Ronquillo et al., 2003	Cross-sectional study	To assess the effects of therapy parameters on non-adherence	79	The adherence to treatment was low if it included long-term modifications such as diet and exercises
22	Choi-Kwon et al. (2005)	Cross-sectional study	To assess the factors affecting caregiver burden post stroke	147	Long caregiving hours, disease severity, depression, and anxiety were associated with caregiver burden
23	Ellis and SR Erikson, 2004	Retrospective cohort	To evaluate factors leading to suboptimal adherence to statins	4802	The cost of medications and lack of insurance lead to suboptimal adherence to statins
24	Christensen DB (1978)	Literature review	To explore the compliance behavior to medical treatment and advice	NA	Patient-physician relationship plays an important role in compliance behavior
25	Moore et al. (2019)	Qualitative study	To explore exercise behavior in people with osteoarthritis knee	30	Therapeutic alliance emerged as an important facilitator of exercise adherence in people with osteoarthritis knee
26	JA Hall et al. (1988)	Literature review	To summarize the provider-related behaviors encountered during consultations	143	Patients' satisfaction, knowledge of provider, and interpersonal skills influence medical compliance
27	Lawson et al. (2005)	Qualitative study	To understand the factors associated with low clinic attendance in people with diabetes	11	Low clinic attendance is associated with poor infrastructure, low motivation, and unsatisfactory consultations
28	Peschin et al. (2008)	Consensus study	To identify barriers to patient adherence	37	Some of the barriers of adherence are poor health literacy, poor patient-provider relationship, lack of transport and access to healthcare systems, cost of treatment, and poor cognition
29	Okezue et al. (2019)		To explore factors influencing adherence to home-based physiotherapy	139	Non adherence was found to be associated with painful exercises, forgetfulness, fatigue, and negative beliefs about exercises

Table 2 (*continued*)

S.no	Author & year	Study design	Objectives	Sample size	Findings
		Cross-sectional study			
30	Marwaha et al. (2010)	Qualitative study	To explore physiotherapists' perceptions of non-adherence to exercises among patients in India	6	Poor awareness about physiotherapy, poor infrastructure, and poor communication leads to suboptimal exercise adherence

Table 3
Studies on theoretical framework for adherence (n = 9).

S. no	Author & year	Supporting theories
1	Madden et al. (1992)	•Theory of Reasoned Action •Theories of Planned Behavior
2	Glanz et al. (2008)	•Health Belief Model •Theory of Stages of Change
3	Becker MH, 1974	Health Belief Model
4	Prochaska et al., 1982	Theory of Stages of Change
5	Prochaska J., 1999	Theory of Stages of Change
6	Reckwitz A., 2002	Social Practice Theory
7	Michie et al. (2011)	Behavior Change Wheel
8	Bartholomew et al. (1998)	Intervention Mapping approach
9	Kok et al., 2008	Socio-Ecological Theory

adherence behavior and exercise history as well as previous physical activity level also determine adherence to future exercises (Rejeski et al., 1997)(Godin and Shephard, 1990).

Social support from friends and family members leads to higher adherence to interventions (Jin et al., 2008)(Essery et al., 2017). Patients with a strong family support system, emotional care, and positive reinforcement are more likely to adhere than those with lesser interpersonal support (Voils et al., 2005; Seo and Min, 2005; Feinstein et al., 2005). Family and friends lessen the negative impact of a disease, provide encouragement, and reminders to follow a prescribed treatment (Jin et al., 2008).

Disease or injury variables: These factors comprise of the perceived disease severity and duration of disease (Bassett and Hons, 2003). Patients are more adherent if they perceive the disease to be serious compared to those who perceive the disease to be less serious (Taylor & May 1996). Likewise, recovered patients or those in disease remission do not feel the need to adhere to treatment (Bassett and Hons, 2003) (Vlasnik et al., 2005). However, one systematic review provided equivocal findings on the level of adherence and disease severity of patients (Jin et al., 2008).

Therapy-related factors: It is one of the most influential factors of adherence and depend on treatment variables. Appointment time, treatment regimen, and clinic environment are associated with adherence (Bassett and Hons, 2003). Adherence is low if the treatment protocol is long and complicated (Jin et al., 2008). Similarly, adherence in chronic diseases falls because of the prolonged duration of treatment and the need for lifestyle modification (Sluijs and Knibbe, 1991). In comparison, people with acute illness show higher adherence level (Gascon et al., 2004). Active involvement of patients in therapy leads to better adherence to physiotherapy interventions (Bassett and Hons, 2003). The amount of behavior change required to follow a prescribed intervention determines adherence. Interventions that require changing habits will be more challenging to comply (Hernández-Ronquillo et al., 2003). The cost of therapeutic interventions is a noteworthy predictor of adherence (Jin et al., 2008). Lack of insurance cover, low income, and treatment regimens that have to be followed for a longer period often lead to non-adherence (Hernández-Ronquillo et al., 2003; Choi-Kwon et al., 2005; JJ Ellis and SR Erikson, 2004). Negative consequences of treatment have been cited as a reason for non-adherence (Jin et al., 2008). Physical discomfort, doubt about the effectiveness of the treatment, or lack of trust in the healthcare provider can impact adherence (Christensen, 1978).

Provider-related factors: Healthcare providers have a central role in determining adherence. A trusting and compassionate relationship between patient and doctor can improve adherence to treatment (Jin et al., 2008). Another term given for patient-provider relationship is therapeutic alliance which encompasses mutual trust, meaningful interaction, and compassion. A study reported therapeutic alliance as the most important determinant of exercise adherence (Moore et al., 2019). Patients' satisfaction was a consistent factor of adherence as reported in a meta-analysis and it depends on the amount of information delivered to the patients during consultation. Technical knowledge and interpersonal skills impact patients' satisfaction (Judith A Hall, Debra L. Roter, 1998). Healthcare providers have many roles to play such as assessing outcomes, designing treatment protocol, and delivering accurate feedback to the patients (Sabate, 2003). Thus, a clinician who is friendly and respectful as well as provides reassurance to the patients facilitates adherence (Lawson et al., 2005). Positive feedback, good communication, follow-up, regular monitoring, and encouragement by the healthcare provider play a role in developing a good rapport and adherent behavior (Sabate, 2003) (Sluljs and Kok, 1993) (Judith A Hall, Debra L. Roter, 1998). Thus, adherence is affected by the quality and quantity of communication between a patient and provider.

Health system factors: Healthcare services are less discussed aspects of non-adherence. However, it has a huge impact on patient's adherence level. Accessible hospitals or primary care centers with better support system for the patients, lower costs of investigations, provision of community centers, and training of healthcare provider are correlates of good adherence. (Hernández-Ronquillo et al., 2003) (Jin et al., 2008) Unsatisfactory infrastructure, longer waiting time, and difficulty in getting clinical appointment are related to poorer adherence (Lawsonbib_Lawson_et_al_2005et al., 2005).

3.3. Barriers to exercise adherence

Barriers may be defined as a negative predictor of adherence. In chronic diseases, the most common cause of non-adherence to clinic appointment was unavailbility of family member to accompany to the healthcare setting (Ogwumike et al., 2015). Thus, the absence of a primary caregiver who accompanies them to hospitals can be perceived as a barrier especially in people with disability (Ogwumike et al., 2015). Some other barriers of adherence are cultural/language barrier, miscommunication between healthcare provider and patients, lack of supervision by healthcare provider, poor health literacy, patients' readiness to change, presence of cognitive impairment, cost, and access to treatment centers (Peschin et al., 2008). Poor memory or forgetfulness among patients has also been reported as a barrier to exercise adherence (Okezue et al., 2019).

Table 4
Studies on interventions supporting adherence (n = 22).

S. no	Author & year	Study design	Objectives	Sample size	Adherence strategies	Behavioral or Implementation strategies
1	Burgess et al. (2017)	Systematic review and meta-analysis	To determine if behavioral strategies improve adherence to lifestyle modifications in obesity	2675	Goal setting, motivational interviewing, relapse prevention, cognitive restructuring	Behavioral
2	Jordan et al. (2010)	Systematic review	To evaluate the effect of interventions on exercise adherence in chronic musculoskeletal pain	8243	Goal setting, counselling, reinforcement techniques, self-monitoring, feedback, skills training including mastery of exercise program, and an exercise contract	Behavioral
3	Picha et al., 2017	Clinical commentary	To equip clinicians to use self-efficacy model for supporting exercise adherence	NA	Modify self-efficacy through exerting control over inner processes of goal setting, self-monitoring, feedback, problem solving and self-evaluation	Behavioral
4	Bachmann et al., 2017	Systematic review	To provide recommendations for improving home-based exercise adherence	10,974	Enhancing patients' self-motivation and self-efficacy, supervision and support, and prescription of maximum four exercises	Both
5	Argent et al. (2018)	Literature review	To explore the design features of mHealth devices for promoting exercise adherence	NA	Coaching, self-monitoring, goal-setting, and education are some of the features that can be used in mHealth technology	Behavioral
6	Meade et al. (2019)	Systematic review	To synthesize evidence from RCTs on the effect of adherence interventions in musculoskeletal pain	1018	Moderate level evidence for goal setting, social support, rehearsal of exercises, instructions, and demonstration of exercises	Both
7	Burridge et al. (2017)	RCT	To explore the use of telehealth for high intensity practice post stroke	19	Web-supported program along with constraint-induced therapy	Implementation
8	Sureshkumar et al. (2015)	Web-app development study	To develop a web-app for home-based stroke rehabilitation	NA	Web-based educational intervention for managing post stroke physical disabilities	Implementation
9	Plow and Golding, 2017	RCT	To examine the effect of mHealth app in self-management of interventions	46	M-health apps and paper-based approach. Social networking feature in apps to integrate social support	Implementation
10	Lambert et al. (2017)	RCT	To determine the effect of health apps versus paper-pen approach for improving home-based exercise adherence in people with musculoskeletal condition	77	Health apps were found to be have a significant on exercise adherence compared to paper-pen approach	Implementation
11	Khoja et al. (2018)	RCT	To determine the effect of mobile-based online educational session on BP, blood sugar, and cholesterol post stroke	310	Educational session via m-health app	Implementation
12	Jeong et al. (2019)	Cross-sectional study	To identify the predictors of adherence to telerehabilitaiton in multiple sclerosis	20	Baseline patient information is important for individualizing telerehabilitation and eliciting active participation	Implementation
13	Kwasnicka et al. (2016)	Systematic review	To synthesize evidence on the theories for behavior change maintenance	100 studies	Motive, resources, habit, self-regulation, and contextual factors influence behavior change maintenance	Behavioral
14	Reunanen et al. (2016)	Qualitative study	To understand factors in home-based rehabilitation that led to re-integration in society	14	Problem-solving, coaching, communication with the provider	Both
15	Fryer et al. (2016)	Systematic review	To evaluate the effect of self-management interventions post stroke	1863	Self-management interventions such as coping strategy, goal-setting, problem solving, self-monitoring, and decision making	Behavioral
16	McGrane et al. (2015)	Systematic review and meta-analysis	To synthesize the evidence for motivational interventions on exercise adherence	378	Motivational interviewing, motivational enhancement therapy, social cognitive theory, and cognitive behavior therapy	Behavioral
17	Kingston et al. (2010)	Systematic review	To summarize evidence on the use of video tapes or DVD on compliance	11	Use of DVD and videotapes	Implementation
18	Oesch et al. (2017)	RCT	To compare exergames with exercise leaflets for improving adherence	54	Exergames and self-regulated exercises using instruction leaflets	Implementation
19	Jongh et al. (2012)	Systematic review	To assess the effect of mobile-phone messages on self-management of symptoms	182	Mobile-phone messaging interventions	Implementation
20	Beauchamp (2019)	Literature review	To summarize the effect of self-categorization theory on promoting exercise adherence	NA	Social groups and social identity	Behavioral
21	Eynon et al. (2019)	Systematic review	To review evidence on psychological factors for promoting exercise adherence	2531	Intrinsic motivation, psychological need satisfaction, social support, and self-efficacy	Behavioral
22	Rodgers et al. (2002)	Validity study	To identify predictors of exercise behavior	589	Task and scheduling self-efficacy	Behavioral

Some of the environmental factors are lack of transportation, lack of awareness and accessibility to the rehabilitation unit, and not comfortable exercising in a facility (Rimmer, 2008). Negative beliefs, lack of motivation, laziness, boredom, and disinterest in exercising are few other barriers of exercise adherence (Mahmood et al., 2019a,b). Another prominent barrier identified in Indian context was cultural beliefs such as disabilities are a result of previous evil deeds of a person and, thus suffering is inevitable (Marwaha et al., 2010).

3.4. Theories and framework of behavior change that inform adherence interventions

Adherence is underpinned by multiple behavior change theories. *Theory of Reasoned Action* and *Theory of Planned Behavior* are supported by cognitive approaches to explain a behavior. It involves intention to act which stems from perceived control of a particular situation as well as attitudes and social norms (Madden et al., 1992). The *Health Belief Model* explains a person's behavior is based on the

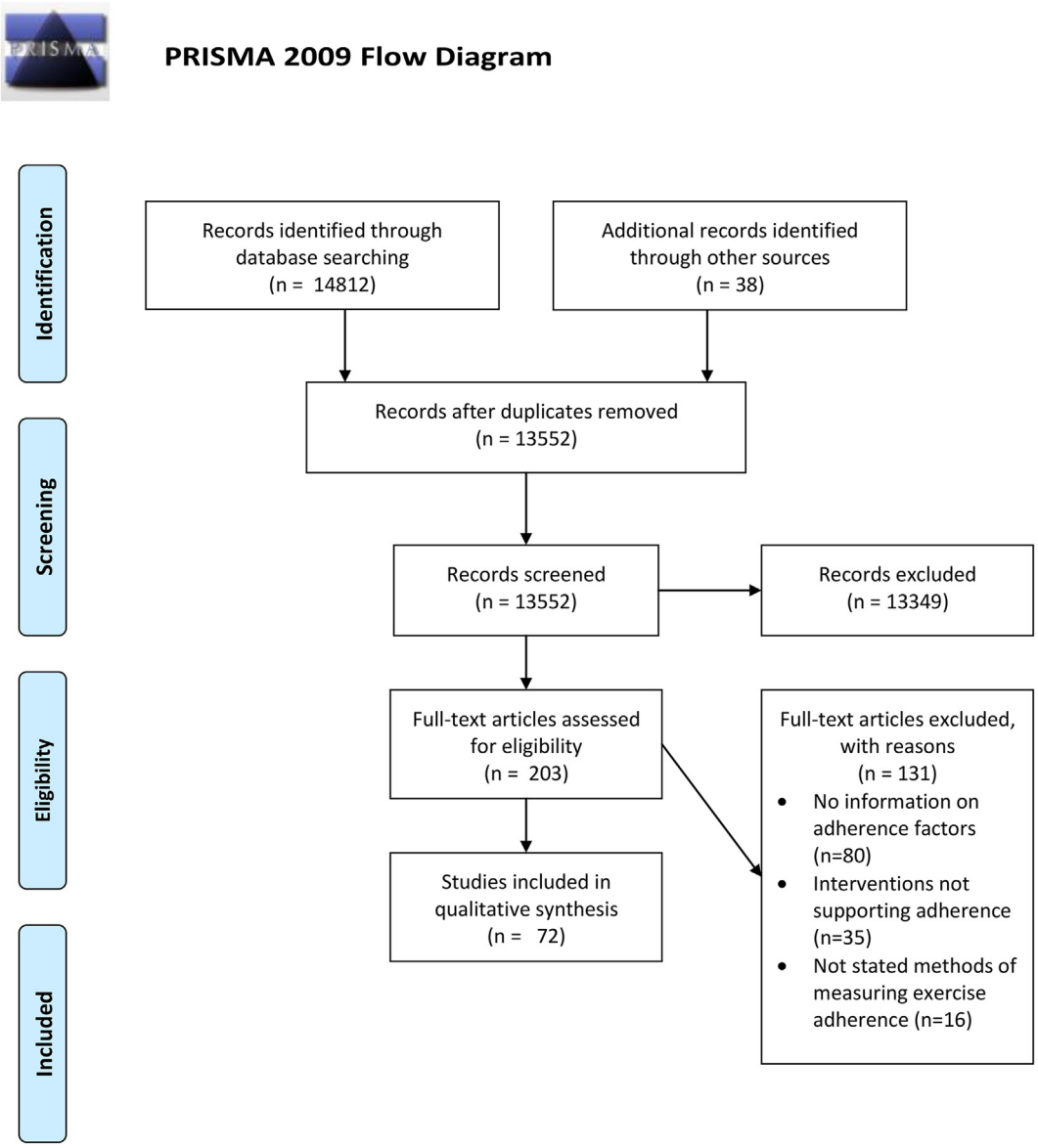

Fig. 1. PRISMA Flowchart showing selection of studies.

health-beliefs such as threat to well-being or effectiveness of an outcome or treatment. There is an association between person's readiness to act and their health beliefs for them to perform any action (Glanz et al., 2008) (Becker, 1974). The *Theory of Stages of Change* has been widely used in designing interventions for health behavior. (Glanz et al., 2008; Prochaska and DiClemente, 1982; Prochaska, 1999). The key concept of this theory includes motivational readiness which is divided into five stages. The five stages for any behavior change are pre-contemplation, contemplation, preparation, action, and maintenance. Behavior change occurs when a person moves step-by-step from pre-contemplation to maintenance phase which is determined by their self-efficacy and decision-making abilities (Prochaska and DiClemente, 1982; Prochaska, 1999). The *Social Practice Theory* incorporates human routines and practices to explain a behavior (Reckwitz, 2002). It includes knowledge, norms, and habits, mental and physical activities. It establishes a link between practice and social context.

The frameworks of behavior change provide directions for developing interventions for behavior modification. One of the popular frameworks is *Behavior Change Wheel* (Michie et al., 2011). It encompasses capacity, motivation, and opportunity to understand and modify behavior. Capability is classified into physical and psychological, motivation is divided into reflective and automatic, and opportunity is distinguished into physical and social (Michie et al., 2011). Mapping a behavior into these three domains can provide methods to change it.

Intervention Mapping (IM) approach is an iterative model for developing health promotion interventions (Bartholomew et al., 1998). This approach is based on Socio-Ecological Theory (Kok et al., 2008) and classifies determinants of behavior as personal and external agents. It includes core processes of literature review, understanding theory, evidence-based interventions and conducting new research. Thus, the interventions to support exercise adherence should apply the health behavior theories and models for developing an effective program.

3.5. Strategies/interventions that have evidence of benefit for exercise adherence

A plethora of strategies have been emerging globally to target

exercise adherence. Table 4 shows the summary of various interventions and classified those as behavioral and implementation strategies to improve exercise adherence in various disease populations.

Most of the strategies and techniques stated above were recommended by systematic reviews and meta-analyses. Psychological concepts were similar across studies with emphasis on behavioral modifications in facilitating adherence (Burgess et al., 2017; Jordan et al., 2010; Picha and Howell, 2017; Bachmann et al., 2017; Argent et al., 2018; Meade et al., 2019). Few other interventions for improving adherence are motivational interventions (McGrane et al., 2015), having a social identity (Beauchamp, 2019), intrinsic motivation (Eynon et al., 2019), task scheduling, and self-efficacy (Rodgers et al., 2002). Other implementation strategies include use of DVD or video tapes (Kingston et al., 2010), exergames with exercise leaflets (Oesch et al., 2017) and use of mobile phone messages (Jongh et al., 2012).

Telerehabilitation and mHealth were also deployed in various studies (Sarfo and Ovbiagele, 2017; Burridge et al., 2017; Sureshkumar et al., 2015; Plow and Golding, 2017; Lambert et al., 2017) since it provides enhanced education and awareness about diseases, has more control over risk factors and has lower health cost (Kamal et al., 2018). A study identified the predictors of adherence to telerehabilitation program and concluded that the baseline patient information may influence individualizing the support and training required for active participation in telerehabilitation (Jeong et al., 2019).

The strategies for behavior change initiation differ from those required for behavior maintenance. The factors which lead to initial behavior change may not have adequate role in maintaining a behavior. People tend to re-evaluate the benefits of performing a behavior after initiation and tend to quit a new behavior based on various factors. There are multiple theories for behavior change; however, there is scarcity of literature on behavior change maintenance. A systematic review provided five major themes for maintaining a changed behavior: maintenance motive, self-regulation, resources, habit, and contextual influences (Kwasnicka et al., 2016).

In a nutshell, different methods are stated in systematic reviews to support exercise adherence such as motivational interventions, behavioral strategies, use of multimedia, follow-up sessions, feedback, cognitive behavior therapy, skill training, self-monitoring, goal setting, coping strategies, and coaching (Jordan et al., 2010; Reunanen et al., 2016)

4. Discussion

This review is one of the first few reviews that have summarized different aspects of exercise adherence required for effective treatment implementation. Commonly reported individual-related factors of adherence were health beliefs, motivation, cognition, self-efficacy, previous adherence behavior, and knowledge about the disease. Social factors and interpersonal relations also influenced treatment adherence. Healthcare factors including longer waiting time, higher perceived cost of treatment, unavailability of healthcare providers, interventions requiring lifestyle modification, or lack of trust in healthcare providers impeded therapeutic adherence. The theoretical framework of adherence interventions are supported by behavior change theories and approaches such as Theories of Reasoned Action and Planned Behavior (Madden et al., 1992), Health Belief Model (Glanz et al., 2008), Theory of Stages of Change (Prochaska, 1999), Behavior Change Wheel (Michie et al., 2011), and Intervention Mapping approach (Bartholomew et al., 1998).

Measurement of adherence is essential and should be done regularly to account for behavior change (Hawley-Hague et al., 2016). Combining two outcome measures for data triangulation or using a self-report questionnaire can be a few practical options. Adherence contributes to treatment effectiveness and supporting it would increase the productivity of the healthcare system (Sabate, 2003). Different strategies existing in literature to improve adherence are either method of behavior change or the use of multimedia technology (Jordan et al., 2010; Reunanen et al., 2016; Fryer et al., 2016). A previous review recommended self-efficacy, prior engagement in exercises, motivation, and intention to engage in exercise as important predictors of exercise adherence (Essery et al., 2017).

Non-adherence is a challenge for healthcare providers and needs to be explicitly dealt with. Healthcare providers should be trained to recognize the attitude and perception of patients towards a treatment regimen, guide them about techniques to facilitate involvement, and evaluate adherence using standard outcome measures (Sabate, 2003). A recent RCT that used a similar multifactorial approach among stroke patients found their adherence to be significantly higher in the experimental group at 6 and 12 weeks of intervention (Mahmood et al., 2021).

This scoping review recommends considering different facets of exercise adherence before designing a treatment plan. The healthcare providers should understand the patients' beliefs, context, therapy goals, and develop a rapport for successful uptake of exercises. The exercises should be individualized and prescribed considering patients' motivational level, environmental and psychological barriers, and their confidence in the regular engagement of exercises. We also recommend using objective or real-time assessment of adherence to track patients' progress and monitor daily exercises. Exercise adherence cannot be enhanced without understanding the causes of non-adherence (Essery et al., 2017).

This comprehensive review will help the stakeholders to understand multiple aspects of adherence that can be incorporated in treatment planning and delivery. This review also paves way for conducting further research on exercise adherence. The current physiotherapy curriculum does not include modules on exercise adherence, despite it being a cornerstone for successful treatment implementation. The definition, measurement, and attributes of exercise adherence should be standardized. Training techniques to support adherence using case scenarios should be included in the curriculum.

4.1. Study limitations

There are a few limitations to this review. We did not exclude studies based on their quality that could have influenced the reporting. There are chances that we missed a few pertinent articles and hence, not all barriers, determinants, or interventions were identified. However, we aimed to synthesize available literature on exercise adherence that can serve as an all-in-one guide for clinicians and researchers.

Future studies should develop objective outcome tools of exercise adherence and can consider app-based measures for real-time reporting of adherence. Future studies should develop and test interventions to support exercise adherence specific to disease populations and explore their long-term effect.

5. Conclusion

Exercise adherence is crucial for recovery and successful implementation of exercise interventions. Adherence is a complex and multifactorial phenomenon that is less researched. To date, there are very few reliable measures of exercise adherence. The interventions that support adherence are varied and incorporate behavioral modifications. However, specific interventions for

different disease populations are not yet established. Future studies should investigate the use of real-time adherence measures and evaluate the effectiveness of strategies that target factors of non-adherence at an individual, interpersonal, health system, and society level.

6. Clinical relevance

- Adherence to exercises is crucial to optimize recovery and functions in people with movement dysfunctions
- There are no standard guidelines for the measurement and promotion of adherence to exercises
- Exercise adherence is an under-researched area and requires multipronged strategies to support adherence among patients
- Behavioral interventions and use of technology has been reported in the literature for facilitating exercise adherence

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Amreen Mahmood: Conceptualization, Supervision, Data curation, Writing – original draft. **Pradeepa Nayak:** Data curation, Writing – original draft. **Anagha Deshmukh:** Data curation, Writing – original draft. **Coralie English:** Conceptualization, Supervision, Writing – review & editing. **Manikandan N:** Writing – review & editing. **John Solomon M:** Conceptualization, Supervision, Writing – review & editing. **Unnikrishnan B:** Visualization, Data Charting, Writing – review & editing.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbmt.2022.09.014.

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