

Please cite the Published Version

Mahmood, Amreen, Nayak, Pradeepa, Deshmukh, Anagha, English, Coralie, N, Manikandan, Solomon M, John and B, Unnikrishnan (2023) Measurement, determinants, barriers, and interventions for exercise adherence: a scoping review. *Journal of Bodywork and Movement Therapies*, 33. pp. 95-105. ISSN 1360-8592

DOI: <https://doi.org/10.1016/j.jbmt.2022.09.014>

Publisher: Elsevier

Version: Published Version

Downloaded from: <https://e-space.mmu.ac.uk/631392/>

Usage rights:  [Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)

Additional Information: This is an Open Access article which appeared in *Journal of Bodywork and Movement Therapies*, published by Elsevier.

Enquiries:

If you have questions about this document, contact openresearch@mmu.ac.uk. Please include the URL of the record in e-space. If you believe that your, or a third party's rights have been compromised through this document please see our Take Down policy (available from <https://www.mmu.ac.uk/library/using-the-library/policies-and-guidelines>)



Contents lists available at ScienceDirect

Journal of Bodywork & Movement Therapies

journal homepage: www.elsevier.com/jbmt

Prevention and Rehabilitation

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

Amreen Mahmood^a, Pradeepa Nayak^{a,*}, Anagha Deshmukh^b, Coralie English^c, Manikandan N^e, John Solomon M^e, Unnikrishnan B^d^a Department of Health Professions, Manchester Metropolitan University, Birley Fields Campus, Bonsall Street, M15 6GX, Manchester, United Kingdom^b Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India^c School of Health Sciences and Priority Research, Centre for Stroke and Brain Injury, University of Newcastle, Newcastle, Australia^d Department of Community Medicine, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India^e Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

ARTICLE INFO

Article history:

Received 15 July 2021

Received in revised form

21 May 2022

Accepted 18 September 2022

Keywords:

Exercise

Patient adherence

Exercise therapy

Review literature

Rehabilitation

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.

© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

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 Loràs, 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,

* Corresponding author. Department of Health Professions, Manchester Metropolitan University, Birley Fields Campus, Bonsall Street, M15 6GX, Manchester, United Kingdom.

E-mail addresses: A.Mahmood@mmu.ac.uk (A. Mahmood), P.Nayak@mmu.ac.uk (P. Nayak), anagha.deshmukh29@gmail.com (A. Deshmukh), coralie.english@newcastle.edu.au (C. English), mani.kandan@manipal.edu (M. N), john.solomon@manipal.edu (J. Solomon M), unnikrishnan.b@manipal.edu (U. B).

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 somewhat 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 (Sluijs 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 medication 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 |
|------|-----------------------|--|--|-------------|--|
| 30 | Marwaha et al. (2010) | Cross-sectional study 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) (Sluijs 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 unavailability 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 telerehabilitation 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



PRISMA 2009 Flow Diagram

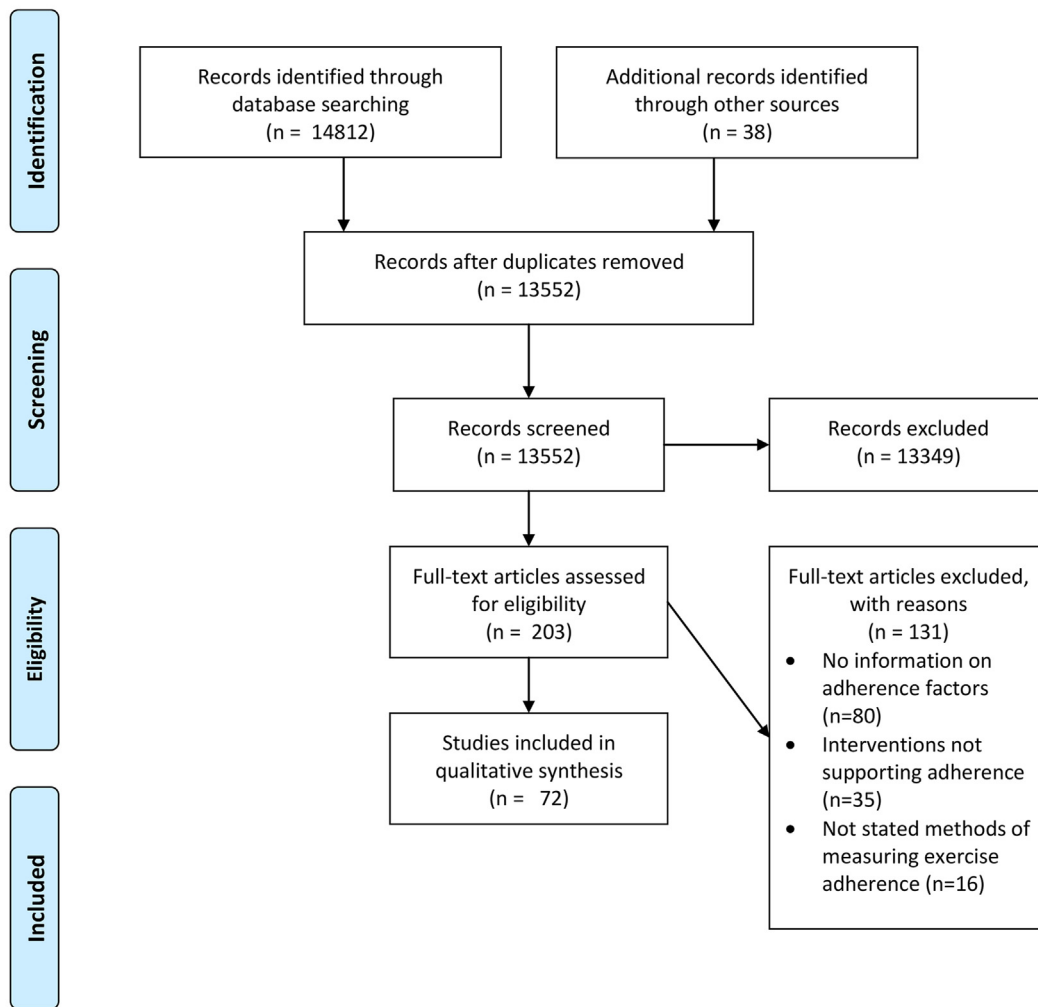


Fig. 1. PRISMA Flowchart showing selection of studies.

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

Funding

None.

CRediT authorship contribution statement

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>.

References

- Adriano, L.S., Fonteles, M.M. de F., Azevedo, M. de F.M., Beserra, M.P.P., Romero, N.R., 2016. Medication adherence in patients with juvenile idiopathic arthritis. *Rev. Bras. Reumatol.* 7 (1), 23–29. <https://doi.org/10.1016/j.rbr.2015.11.004>.
- Argent, R., Daly, A., Caulfield, B., 2018. Patient involvement with home-based exercise programs: can connected health interventions influence adherence? *J. Med. Internet Res.* 20 (3). <https://doi.org/10.2196/mhealth.8518>.
- Bachmann, C., Oesch, P., Bachmann, S., Valens, K., Valens, K., Med, P., Kuror, R., Valens, K., 2017. Recommendations for Improving Adherence to Home-Based Exercise: a Systematic Review Empfehlungen zur Verbesserung der Adhärenz zu Heimübungsprogrammen: eine Übersichtsarbeit Authors. *Phys. Med. Rehab. Kuror.* 28, 20–31. <https://doi.org/10.1055/s-0043-120527>.
- Bartholomew, L.K., Parcel, G.S., Kok, G., 1998. Intervention mapping: a process for developing theory- and evidence-based health education programs. *Health Educ. Behav.* 25 (5), 545–563. <https://doi.org/10.1177/109019819802500502>.
- Bassett, S.F., Hons, M., 2003. The assessment of patient adherence to physiotherapy rehabilitation. *NZ Journal of Physiotherapy* 31 (January 2003), 2. https://www.researchgate.net/publication/284411604_The_assessment_of_patient_adherence_to_physiotherapy_rehabilitation.
- Bassett, S.F., Prapavessis, H., 2007. Home-based physical therapy intervention with adherence-enhancing strategies versus clinic-based management for patients with ankle sprains. *Phys. Ther.* 87 (9), 1132–1143.
- Beauchamp, M.R., 2019. Promoting exercise adherence through groups: a self-categorization theory perspective. *Exerc. Sport Sci. Rev.* 47 (1), 54–61. <https://doi.org/10.1249/JES.0000000000000177>.
- Becker, M.H., 1974. The health belief model and sick role behavior. *Health Educ. Monogr.* 2 (4), 409–419. <https://doi.org/10.1177/109019817400200407>.
- Bollen, J.C., Dean, S.G., Siegert, R.J., Howe, T.E., Goodwin, V.A., 2014. A systematic

- review of measures of self-reported adherence to unsupervised home-based rehabilitation exercise programmes, and their psychometric properties. *BMJ Open* 4. <https://doi.org/10.1136/bmjopen-2014-005044>.
- Broadwater-Hollifield, C., Madsen, T.E., Porucznik, C.A., Sundwall, D.N., Youngquist, S.T., Vlastic, K., et al., 2015. Predictors of patient adherence to follow-up recommendations after an ED visit. *AJEM (Am. J. Emerg. Med.)* 33 (10), 1368–1373. <https://doi.org/10.1016/j.ajem.2015.07.032>.
- Burgess, E., Hassmén, P., Welvaert, M., Pumpa, K.L., 2017. Behavioural treatment strategies improve adherence to lifestyle intervention programmes in adults with obesity: a systematic review and meta-analysis. *Clinical Obesity* 16. <https://doi.org/10.1111/cob.12180>.
- Burridge, J.H., Lee, A., Turk, R., Stokes, M., Whitall, J., Vaidyanathan, R., Clatworthy, P., Hughes, A.M., Meagher, C., Franco, E., Yardley, L., 2017. Telehealth, wearable sensors, and the internet: will they improve stroke outcomes through increased intensity of therapy, motivation, and adherence to rehabilitation programs? *J. Neurol. Phys. Ther.: J. Neurol. Phys. Ther.* 41 (Suppl. 3), S32–S38. <https://doi.org/10.1097/NPT.0000000000000183>.
- Choi-Kwon, S., Kim, H.S., Kwon, S.U., Kim, J.S., 2005. Factors affecting the burden on caregivers of stroke survivors in South Korea. *Arch. Phys. Med. Rehabil.* 86 (5), 1043–1048. <https://doi.org/10.1016/j.apmr.2004.09.013>.
- Christensen, D.B., 1978. *Drug-taking Compliance: A Review and Synthesis*. Health Services Research, pp. 171–187.
- Codori, A.-M., Nannis, E.D., Pack, A.D., 1992. The development of a clinical measure of compliance with hand rehabilitation. *J. Hand Ther.* 5 (1), 29–33. [https://doi.org/10.1016/S0894-1130\(12\)80195-5](https://doi.org/10.1016/S0894-1130(12)80195-5).
- Cole, Andrew, Scott, J., 1991. Training matters A study of the use of log books in the training of psychiatrists. *Psychiatr. Bull.* 15, 214–216.
- Dalvandi, A., Ebadi, A., 2020. Adherence to a rehabilitation regimen in stroke patients: a concept analysis adherence to a rehabilitation regimen in stroke patients: a concept analysis. *Iran. J. Nurs. Midwifery Res.* 25 (2), 139–145. <https://doi.org/10.4103/ijnmr.IJNMR>.
- Ellis, J.J., SR Erikson, S.J., 2004. Suboptimal statin adherence and discontinuation in primary and secondary prevention populations. *J. Gen. Intern. Med.* 19, 638–645.
- Essery, R., Geraghty, A.W.A., Kirby, S., Yardley, L., 2017. Predictors of adherence to home-based physical therapies: a systematic review. *Disabil. Rehabil.* <https://doi.org/10.3109/09638288.2016.1153160>.
- Eynon, Michael, Foad, Jessica, Downey, John, Bowmer, Yasmin, Mills, H., 2019. Assessing the psychosocial factors associated with adherence to exercise referral schemes: a systematic review. *Scand. J. Med. Sci. Sports* 1–13. <https://doi.org/10.1111/sms.13403>. September 2018.
- Feinstein, S., Keich, R., Becker-Cohen, R., Rinat, C., Schwartz, S.B., Frishberg, Y., 2005. Is noncompliance among adolescent renal transplant recipients inevitable? *Pediatrics* 115 (4), 969–973. <https://doi.org/10.1542/peds.2004-0211>.
- Fernandez-Lazaro, C.I., García-González, J.M., Adams, D.P., Fernandez-Lazaro, D., Mielgo-Ayuso, J., Caballero-García, A., et al., 2019. Adherence to treatment and related factors among patients with chronic conditions in primary care: a cross-sectional study. *BMC Fam. Pract.* 20 (1), 1–12. <https://doi.org/10.1186/s12875-019-1019-3>.
- Fredin, K., Lorås, H., 2017. Manual therapy, exercise therapy or combined treatment in the management of adult neck pain - a systematic review and meta-analysis. *Musculoskeletal Science & Practice* 31, 62–71. <https://doi.org/10.1016/j.msksp.2017.07.005>.
- Frost, R., Levati, S., Mcclurg, D., Brady, M., Williams, B., 2018. What adherence measures should be used in trials of home-based rehabilitation interventions? A systematic review of the validity, reliability, and acceptability of measures. *Arch. Phys. Med. Rehabil.* 98 (6), 1241–1256. <https://doi.org/10.1016/j.apmr.2016.08.482> e45.
- Fryer, C.E., Luker, J.A., McDonnell, M.N., Hillier, S.L., 2016. Self management programmes for quality of life in people with stroke. *Cochrane Database Syst. Rev.* (8), CD010442. <https://doi.org/10.1002/14651858.CD010442.pub2>, 2016.
- Gascon, J.J., Sánchez-Ortuño, M., Llor, B., Skidmore, D., Saturno, P.J., 2004. Why hypertensive patients do not comply with the treatment: results from a qualitative study. *Fam. Pract.* 21 (2), 125–130. <https://doi.org/10.1093/fampra/cmh202>.
- Glanz, K., Rimer, B.K., Viswanath, K. (Eds.), 2008. *Health Behavior and Health Education: Theory, Research, and Practice*. John Wiley & Sons.
- Godin, G., Shephard, R.J., 1990. Use of attitude-behaviour models in exercise promotion. *Sports Med.* 10 (2), 103–121. <https://doi.org/10.2165/00007256-199010020-00004>.
- Hall, J.A., Roter, D.L., Katz, N.R., 1988. Meta-analysis of correlates of provider behavior in medical encounters. *Med. Care* 657–675.
- Hartigan, C., Rainville, J., Sobel, J.B., Hipona, M., 2000. Long-term exercise adherence after intensive rehabilitation for chronic low back pain. *Med. Sci. Sports Exerc.* 32 (3), 551–557.
- Hawley-Hague, H., Horne, M., Skelton, D.A., Todd, C., 2016. Review of how we should define (and measure) adherence in studies examining older adults' participation in exercise classes. *BMJ Open* 6 (6). <https://doi.org/10.1136/bmjopen-2016-011560>.
- Haynes, R.B., McDonald, H., Garg, Montague, P., 2002. Interventions for helping patients to follow prescriptions for medications. *Cochrane Database Syst. Rev.* 2, CD000011. <https://doi.org/10.1002/14651858.CD000011>.
- Hernández-Ronquillo, L., Tellez-Zenteno, J.F., Guarduno-Espinosa, J., González-Aceve, E., 2003. Factors associated with therapy non compliance in type-2 diabetes patients. *Salud Publica Mex.* 45, 191–197. <https://doi.org/10.1590/S0036-36342003000300008>.

- Hubbard, I.J., Harris, D., Kilkenny, M.F., Faux, S.G., Pollack, M.R., Cadiilhac, D.A., 2012. Adherence to clinical guidelines improves patient outcomes in Australian audit of stroke rehabilitation practice. *Arch. Phys. Med. Rehabil.* 93 (6), 965–971. <https://doi.org/10.1016/j.apmr.2012.01.011>.
- Ice, R., 1985. Long-term compliance. *Phys. Ther.* 65 (12), 1832–1839.
- Jeong, I.C., Liu, J., Finkelstein, J., 2019. Factors affecting adherence with tele-rehabilitation in patients with multiple sclerosis. In: *ITCH*, pp. 189–193. <https://doi.org/10.3233/978-1-61499-951-5-189>.
- Jin, J., Sklar, G.E., Oh, V.M.S., Li, S.C., 2008. Factors affecting therapeutic compliance: a review from the patient's perspective. *Therapeut. Clin. Risk Manag.* 4 (1), 269.
- Jongh, T. de, Guroi-Urganci, I., Vodopivec-Jamsek, V., Car, J., Atun, R., 2012. Mobile Phone Messaging for Facilitating Self-management of Long-term Illnesses. The Cochrane Library. <https://doi.org/10.1002/14651858.CD007459.pub2>.
- Jordan, J.L., Holden, M.A., Mason, E.E., Foster, N.E., 2010. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Syst. Rev.* (1).
- Kaplan, R.M., Stone, A.A., 2013. Bringing the laboratory and clinic to the community: mobile technologies for health promotion and disease prevention. *Annu. Rev. Psychol.* 64, 471–498. <https://doi.org/10.1146/annurev-psych-113011-143736>.
- Khoja, A., Kamal, A.K., Usmani, B., Magsi, S., Munaf, A., Feroz, Z., et al., 2018. Showing 5-minute Movies via a Smartphone Application to Educate Stroke Survivors and Their Caregivers in an LMIC Country Does Not Increase Adherence but Reduces Mortality after Stroke-Results of Movies4Stroke. <https://doi.org/10.2196/preprints.12113>.
- Kingston, G., Gray, M. a, Williams, G., 2010. A critical review of the evidence on the use of videotapes or DVD to promote patient compliance with home programmes. *Disabil. Rehabil. Assist. Technol.* 5 (3), 153–163. <https://doi.org/10.3109/17483101003671709>.
- Kok, G., Gottlieb, N.H., Commers, M., Smerecnik, C., 2008. The ecological approach in health promotion programs: a decade later. *Am. J. Health Promot.* 22 (6), 437–441. <https://doi.org/10.4278/ajhp.22.6.437>.
- Kolt, G.S., Brewer, B.W., Pizzari, T., Schoo, A.M., Garrett, N., 2007. The sport injury rehabilitation adherence scale: a reliable scale for use in clinical physiotherapy. *Physiotherapy* 93 (1), 17–22.
- Kwasnicka, D., Dombrowski, S.U., White, M., Sniehotka, F., 2016. Theoretical explanations for maintenance of behaviour change: a systematic review of behaviour theories. *Health Psychol. Rev.* 10 (3), 277–296. <https://doi.org/10.1080/17437199.2016.1151372>.
- Lambert, T.E., Harvey, L.A., Avdalis, C., Chen, L.W., Jeyalingam, S., Pratt, C.A., et al., 2017. An app with remote support achieves better adherence to home exercise programs than paper handouts in people with musculoskeletal conditions: a randomised trial. *J. Physiother.* 63 (3), 161–167. <https://doi.org/10.1016/j.jphys.2017.05.015>.
- Lawson, V.L., Lyne, P. a, Harvey, J.N., Bundy, C.E., 2005. Understanding why people with type 1 diabetes do not attend for specialist advice: a qualitative analysis of the views of people with insulin-dependent diabetes who do not attend diabetes clinic. *J. Health Psychol.* 10 (3), 409–423. <https://doi.org/10.1177/1359105305051426>.
- Levin, J.B., Krivenko, A., Howland, M., Schlachet, R., Sajatovic, M., 2016. Medication adherence in patients with bipolar disorder: a comprehensive review. *CNS Drugs* 30 (9), 819–835. <https://doi.org/10.1007/s40263-016-0368-x>.
- Madden, T.J., Ellen, S.P., Ajzen, I., 1992. *Pers. Soc. Psychol. Bull.* 18 (1), 3–9.
- Mahmood, A., Solomon, J., English, C., Bhaskaran, U., Menon, G., Manikandan, N., 2019a. Measurement of adherence to home-based exercises among community-dwelling stroke survivors in India. *Physiother. Res. Int.* <https://doi.org/10.1002/pri.1827>. December.
- Mahmood, A., Nayak, P., Kok, G., English, C., Manikandan, N., Solomon, J.M., 2019b. Factors influencing adherence to home-based exercises among community-dwelling stroke survivors in India: a qualitative study. *European Journal of Physiotherapy* 1–7. <https://doi.org/10.1080/21679169.2019.1635641>.
- Mahmood, A., Nayak, P., English, C., Deshmukh, A., Umakanth, S.N., Manikandan, Solomon, J.M., 2021. Adherence to home exercises and rehabilitation (ADHERE) after stroke in low-to-middle-income countries: a randomized controlled trial. *Top. Stroke Rehabil.* 1–11. <https://doi.org/10.1080/10749357.2021.1940800>.
- Marwaha, K., Horabin, H., McLean, S., 2010. Indian physiotherapists' perceptions of factors that influence the adherence of Indian patients to physiotherapy treatment recommendations. *Int. J. Physiother Rehabil.* 1, 9–18.
- McGrane, N., Galvin, R., Cusack, T., Stokes, E., 2015. Addition of motivational interventions to exercise and traditional Physiotherapy: a review and meta-analysis. *Physiotherapy* 101 (1), 1–12. <https://doi.org/10.1016/j.jphysio.2014.04.009>.
- Meade, L.B., Bearne, L.M., Sweeney, L.H., Alageel, S.H., Godfrey, E.L., 2019. Behaviour Change Techniques Associated with Adherence to Prescribed Exercise in Patients with Persistent Musculoskeletal Pain: Systematic Review, pp. 10–30. <https://doi.org/10.1111/bjhp.12324>.
- Meichenbaum, D., Turk, D.C., 1987. *Facilitating Treatment Adherence: A Practitioner's Guidebook*. Plenum Press.
- Michie, S., van Stralen, M.M., West, R., 2011. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement. Sci.* 6 (1), 42. <https://doi.org/10.1186/1748-5908-6-42>.
- Moore, A.J., Holden, M.A., Foster, N.E., Jinks, C., 2019. Therapeutic alliance facilitates adherence to physiotherapy-led exercise and physical activity for older adults with knee pain: a longitudinal qualitative study. *J. Physiother.* <https://doi.org/10.1016/j.jphys.2019.11.004>.
- Newman-Beinart, N.A., Norton, S., Dowling, D., Gavriloff, D., Vari, C., et al., 2017. The development and initial psychometric evaluation of a measure assessing adherence to prescribed exercise: the Exercise Adherence Rating Scale (EARS). *Physiotherapy* 103 (2), 180–185. <https://doi.org/10.1016/j.physio.2016.11.001>.
- Oesch, P., Kool, J., Fernandez-Luque, L., Brox, E., Evertsen, G., Civit, A., et al., 2017. Exergames versus self-regulated exercises with instruction leaflets to improve adherence during geriatric rehabilitation: a randomized controlled trial. *BMC Geriatr.* 17 (1), 77. <https://doi.org/10.1186/s12877-017-0467-7>.
- Ogwumike, O.O., Badaru, U.M., Adeniyi, A.F., 2014. Factors influencing adherence to home-based exercise by stroke survivors in North Western Nigeria. *Int. J. Ther. Rehabil. Res.* 3 (1), 1. <https://doi.org/10.5455/ijtrr.00000023>.
- Ogwumike, O.O., Badaru, U.M., Adeniyi, A.F., 2015. Barriers to treatment adherence among stroke survivors attending outpatient physiotherapy clinics in North-western Nigeria. *Clinical Health Promotion - Research and Best Practice* 5 (3), 4–10. <https://doi.org/10.29102/clinhp.15002>.
- Okezie, O.C., Nwafor, G.C., Ezeukwu, O.A., John, J.N., Uchenwoke, C.I., 2019. Adherence to home exercise programmes and its associated factors among patients receiving physiotherapy. *Clinical Health Promotion - Research and Best Practice for Patients, Staff and Community* 9 (1), 7–14. <https://doi.org/10.29102/clinhp.19003>.
- Peschin, S., Doane, C.M., Roberts, M.E., Farley, M.A., Gucciardo, A., Haddow, C.M., et al., 2008. Patient Adherence: identifying barriers and defining solutions. *The American Journal of Pharmacy Benefits* 2 (2), 137–140.
- Picha, K.J., Howell, D.M., 2017. A model to increase rehabilitation adherence to home exercise programmes in patients with varying levels of self-efficacy. *Muscoskel. Care* 1–5. <https://doi.org/10.1002/msc.1194>.
- Plow, M., Golding, M., 2017. Using mHealth technology in a self-management intervention to promote physical activity among adults with chronic disabling conditions: randomized controlled trial. *JMIR MHealth and UHealth* 5 (12), e185. <https://doi.org/10.2196/mhealth.6394>.
- Prochaska, J.O., 1999. How do people change, and how can we change to help many more people?. In: *The Heart and Soul of Change: what Works in Therapy*. American Psychological Association, pp. 227–255. <https://doi.org/10.1037/11132-007>.
- Prochaska, J.O., DiClemente, C.C., 1982. Transtheoretical therapy: toward a more integrative model of change. *Psychother. Theory Res. Pract.* 19 (3), 276–288. <https://doi.org/10.1037/h0088437>.
- Reckwitz, A., 2002. Toward a theory of social practices: a development in culturalist theorizing. *Eur. J. Soc. Theor.* 5 (2), 243–263. <https://doi.org/10.1177/1368431022225432>.
- Rejeski, W.J., Brawley, L.R., Ettinger, W., Morgan, T., Thompson, C., 1997. Compliance to exercise therapy in older participants with knee osteoarthritis: implications for treating disability. *Med. Sci. Sports Exerc.* 29 (8), 977–985.
- Reunanen, M.A.T., Jarvikoski, A., Talvitie, U., Pyoria, O., Harkapaa, K., 2016. Individualised home-based rehabilitation after stroke in eastern Finland—the client's perspective. *Health Soc. Care Community* 24 (1), 77–85. <https://doi.org/10.1111/hsc.12190>.
- Rimmer, J.H., 2008. Barriers associated with exercise and community access for individuals with stroke. *J. Rehabil. Res. Dev.* 45 (2), 315–322. <https://doi.org/10.1682/JRRD.2007.02.0042>.
- Rodgers, W.M., Hall, C.R., Blanchard, C.M., McAuley, E., Munroe, K.J., 2002. Task and scheduling self-efficacy as predictors of exercise behavior. *Psychol. Health* 17 (4), 405–416.
- Sabate, 2003. *Adherence to Long Term Therapies*. World Health Organisation.
- Sarfo, F.S., Ovbiagele, B., 2017. Mobile health for stroke: a promising concept for research and practice. *mHealth* 3 (6), 4. <https://doi.org/10.21037/mhealth.2017.02.01>, 4.
- Seo, M.-A., Min, S.-K., 2005. Development of a structural model explaining medication compliance of persons with schizophrenia. *Yonsei Med. J.* 46 (3), 331. <https://doi.org/10.3349/ymj.2005.46.3.331>.
- Shen, X., Wong-Yu, I.S.K., Mak, M.K.Y., 2016. Effects of exercise on falls, balance, and gait ability in Parkinson's disease: a meta-analysis. *Neurorehabilitation Neural Repair* 30 (6), 512–527. <https://doi.org/10.1177/1545968315613447>.
- Skotte, J., Korshøj, M., Kristiansen, J., Hanisch, C., Holtermann, A., 2014. Detection of physical activity types using triaxial accelerometers. *J. Phys. Activ. Health* 11 (1), 76–84. <https://doi.org/10.1123/jpah.2011-0347>.
- Sluijs, E.M., Knibbe, J., 1991. Patient compliance with exercises: different theoretical approaches to short-term and long-term compliance. *Patient Educ. Counsel.* 17, 191–204.
- Sluijs, E.M., Kok, G.J., 1993. Correlates of exercise compliance in physical therapy. *Phys. Ther.* 73 (1).
- Sureshkumar, K., Murthy, G.V.S., Munuswamy, S., Goenka, S., Kuper, H., 2015. 'Care for Stroke', a web-based, smartphone-enabled educational intervention for management of physical disabilities following stroke: feasibility in the Indian context. *BMJ Innovations* 1 (3), 127–136. <https://doi.org/10.1136/bmjinnov-2015-000056>.

- Taylor, a H., May, S., 1996. Threat and coping appraisal as determinants of compliance with sports injury rehabilitation: an application of Protection Motivation Theory. *J. Sports Sci.* 14 (6), 471–482. <https://doi.org/10.1080/02640419608727734>.
- Tricco, A.C., Lillie, E., Zarin, W., O'Brien, K.K., Colquhoun, H., Levac, D., et al., 2018. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann. Intern. Med.* 169 (7), 467–473. <https://doi.org/10.7326/M18-0850>.
- Vlasnik, J.J., Aliotta, S.L., DeLor, B., 2005. Medication adherence: factors influencing compliance with prescribed medication plans. *Case Manag.* 16 (2), 47–51. <https://doi.org/10.1016/j.casemgr.2005.01.009>.
- Voils, C.I., Steffens, D.C., Flint, E.P., Bosworth, H.B., 2005. Social support and locus of control as predictors of adherence to antidepressant medication in an elderly population. *Am. J. Geriatr. Psychiatr. : Official Journal of the American Association for Geriatric Psychiatry* 13 (2), 157–165. <https://doi.org/10.1176/appi.ajgp.13.2.157>.