Supplement_G_PICO_5_screening of adherence to exercise

PICO 5 – How is non-adherence to exercise screened/detected?

Clinical Question	P	I	C	O	D
How should non-adherence be screened?	Any	Questions, questionnaires, tailored assessments	Adherence	Validation	Systematic Review (SR)

Rationale

Exercise improves fitness and functional ability for people with long-term conditions, as long as these are adherent to the prescribed exercise and levels of physical activity.

Our objective was to identify adherence measurement methods used to quantify adherence to exercise and physical activity.

Methods

We performed an overview of systematic reviews (SR).

Three search strategies were designed, each directed to capture the elements of our PICOD in different databases. The databases queried were Medline (via PubMed), Embase, and Cochrane Library. All retrieved references were exported into EndNote and screened by title and abstract selection. The full texts of the potentially eligible studies were retrieved and read in detail. Afterwards, the SR selected were assessed with the AMSTAR-2 tool.

Results

On August 22, 2019 the following search strategies were performed returning a total of **21** studies:

PubMed		
#1	Search "Exercise Therapy"[Mesh]	47148
#2	Search "Sports"[Mesh]	173939
#3	Search "Exercise"[Mesh]	182086
#4	Search "Exercise Movement Techniques"[Mesh]	7661
#5	Search kinesiotherap*[Title/Abstract] OR exercise*[Title/Abstract] OR motion*[Title/Abstract] OR train*[Title/Abstract] OR sport*[Title/Abstract] OR fitness[Title/Abstract])	1002036
#6	Search #1 OR #2 OR #3 OR #4 OR #5	1125814
#7	Search "Patient Compliance"[Mesh]	72580
#8	Search "Exercise Adherence"[Mesh]	0
#9	Search #7 OR #8	72580
#10	Search "sensitivity and specificity"[MeSH Terms]	559701
#11	Search "sensitivity and specificity"[MeSH Terms] OR ("sensitivity"[All Fields] AND "specificity"[All Fields]) OR "sensitivity and specificity"[All Fields] OR "sensitivity"[All Fields] OR "specificity"[All Fields] OR "validation studies"[Publication Type]	1865629
#12	Search (("sensitivity and specificity"[MeSH Terms] OR ("sensitivity"[All Fields] AND "specificity"[All Fields]) OR "sensitivity and specificity"[All Fields] OR "sensitivity"[All Fields] OR "specificity"[All Fields] OR "validation studies"[Publication Type] OR "validation studies as topic"[MeSH Terms] OR "validation studies"[All Fields] OR "roc curve"[MeSH Terms] OR ("roc"[All Fields] AND "curve"[All Fields]) OR "roc curve"[All Fields] OR "Reproducibility of Results"[Mesh] OR reproducibility[Title/Abstract] OR Reliability[All Fields] OR Validity[All Fields] OR "Feasibility Studies"[Mesh] OR Feasibility[All Fields] OR "construct validity"[All Fields] OR (clinimetric[All Fields] AND (properties[All Fields]) OR "Psychometrics"[Mesh] OR responsiveness[All Fields] OR "sensitivity to change"[Title/Abstract]	296313
#13	Search #10 or #11 or #12	2025750
#14	Search systematic[sb]	137225
#19	Search #6 AND #9 AND #13 AND #14	**13**

Embase		
#1	'kinesiotherapy'/exp OR 'sport'/exp OR 'exercise'/exp	500,993
#2	'exercise therapy':ti,ab OR 'exercise movement techniques':ti,ab OR kinesiotherap*:ti,ab OR exercise*:ti,ab OR motion*:ti,ab OR train*:ti,ab OR sport*:ti,ab OR fitness:ti,ab	1,308,149
#3	#1 OR #2	1,481,738
#4	'patient compliance'/exp OR 'exercise adherence':ti,ab	150,143
#5	'sensitivity and specificity'/exp OR ('sensitivity':ti,ab AND 'specificity':ti,ab) OR 'sensitivity and specificity':ti,ab OR 'sensitivity':ti,ab OR 'specificity':ti,ab	1,415,544
#6	'validation study'/exp OR 'validation studies as topic':ti,ab OR 'validation studies':ti,ab	82,660
#7	'receiver operating characteristic'/exp OR ('roc':ti,ab AND 'curve':ti,ab) OR 'roc curve':ti,ab	127,788
#8	'reproducibility'/exp OR 'reproducibility of results':ti,ab OR reproducibility:ti,ab OR reliability:ti,ab OR validity:ti,ab	534,600
#9	'feasibility study'/exp OR feasibility:ti,ab OR 'construct validity':ti,ab OR (clinimetric:ti,ab AND properties:ti,ab)	281,993
#10	'psychometry'/exp OR responsiveness:ti,ab OR 'sensitivity to change':ti,ab	214,141
#11	#5 OR #6 OR #7 OR #8 OR #9 OR #10	2,330,625
#12	#3 AND #4 AND #11	1,559
#13	#12 AND [embase]/lim NOT ([embase]/lim AND [medline]/lim)	388
#14	#12 AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND [systematic review]/lim	8
Cochrane		
#1	[mh "Exercise Therapy"]	12204
#2	[mh Sports]	14624
#3	[mh Exercise]	22235
#4	[mh "Exercise Movement Techniques"]	1890
#5	(kinesiotherap* OR exercise* OR motion* OR train* OR sport* OR fitness):ti,ab	152080
#6	#1 OR #2 OR #3 OR #4	34069
#7	[mh "Patient Compliance"]	11316
#8	[mh "Exercise Adherence"]	0
#9	#7 OR #8	11316
#10	[mh "sensitivity and specificity"]	16128
#11	((("sensitivity" AND "specificity") OR ("sensitivity and specificity")):ti,ab	10265
#12	("sensitivity" OR "specificity"):ti,ab	47741
#13	("validation studies"):pt	2429
#14	[mh "validation studies as topic"] OR "validation studies":ti,ab	252
#15	[mh "roc curve"] OR (("roc" AND "curve") OR "roc curve"):ti,ab	2723
#16	[mh "Reproducibility of Results"] OR (reproducibility OR reliability OR validity):ti,ab	26501
#17	[mh "Feasibility Studies"] OR (Feasibility OR "construct validity"):ti,ab	30778
#18	(clinimetric AND properties):ti,ab	31
#19	[mh "Psychometrics"]	2844
#20	responsiveness:ti,ab	6721
#21	"sensitivity to change":ti,ab	335
#22	#10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21	114684
#23	#6 AND #9 AND #22 in Cochrane Reviews	0

After title selection, **13** studies were excluded. The remaining **8** studies were selected for a Full-text reading. After the full-text reading, **5** studies were excluded. The reasons for their exclusion are shown in **Table 1.**

Table 1. Excluded studies after full-text reading.

Study	Reason for exclusion
[1]	Wrong outcome (not a validation study).
[2]	Wrong comparator (self-efficacy).
[3]	Wrong outcome (not a validation study).
[4]	Wrong intervention (barriers and facilitators).
[5]	Wrong outcome (not a validation study).

The remaining 3 studies were included and a basic description of them is shown in **Table 2**. In total they include **162** individual studies (some maybe duplicate) and **76** ways of measuring adherence to prescribed exercises.

Table 2. Description of the 3 included studies.

Study	Setting	Population	Design	n	Quality by AMSTAR 2
[6]	Adherence to prescribed unsupervised home-based rehabilitation exercises	Long-term physical conditions (cancer, RMD, CV, respiratory, neurological, genitourinary and endocrine conditions)	SR – All study designs	58 studies → 61 measures	Critically low
[7]	Phase 1: methods for measuring adherence in home-based rehabilitation.	RMD, neurological, CV, urinary and others	Phase 1: SR of RCT Phase 2: SR of validation studies of measures identified	Phase 1: 56 studies → 8 measures Phase 2: 109 studies	Critically low
[8]	Phase 2: evaluation of the psychometric properties	Stroke	Phase 1: SR with all designs. Phase 2: SR of validation studies	Phase 1: 48 studies → 7 measures Phase 2: 0	Critically low

The results will be presented by each study.

Table 3 shows a detailed description of the measures captured by the SR by Bollen et al.

Table 3. Measures described in the SR by Bollen *et al.*.

Author	Type	Name	How devised	Condition	Description	Score
[9]	Questionnaire	NR	NR	Carpal tunnel surgery	Questionnaire conducted as an interview. Questions on home exercise performance, frequency, and obstacles to the exercise program	Weekly adherence was rated from 0 = non-compliant to 3 = compliant Total score (6 weeks) range = 0 - 18
[10]	Questionnaire	NR but referred to as a self-report scale	NR	Ankle sprain	Scales of adherence to the 5 methods of treatment: exercise, icing, not participating in activities that could be damaging to recovery, strapping of ankle, resting and elevating ankle	Adherence rated 1-5 for each applicable method of treatment
[11]	Questionnaire	NR but referred to as a self- report questionnaire	NR	Osteoarthritis	2 questions at 3,6,9,12,15 and 18 months: Frequency of exercises during the past 2 weeks Adherence to the home-based exercises	Each rated as 1 = "not at all" to 11 = "completely as instructed"
[12]	Questionnaire	NR	NR but based on questionnaire by Sluijs et al '93	Urinary incontinence	9 questions: 2 on frequency of exercises and completing all repetitions with choice of 4 answers. 7 questions on exercise barriers ('yes', 'no' and 'uncertain') Minor alterations to make it relevant during the follow-up period.	Weekly average No. exercises per day * No. days per week / 7
[13]	Questionnaire	NR	NR	Genitourinary conditions: Urge incontinence	3 items Items 1 and 2 on time spent and No. exercises completed on a 5 and 6 item scale, respectively. Item 3 was VAS ranging from 0-10 where participants rate compliance. Completed face to face if possible but could also be posted.	Sum of scores. Range from 2 to 21
[14]	Questionnaire	Leisure Score Index (LSI) modified from the Godin Leisure-Time Exercise Questionnaire	Added a question to the pre-existing questions regarding the average length of time spent exercising	Colorectal cancer	3 open-ended questions on frequency and intensity of exercise. Weekly over the telephone.	Average frequency of exercise * average duration of exercise at 3 intensity levels (mild, moderate and strenuous). Minutes spent in moderate and strenuous exercise are then summed.
[15]	Questionnaire	General Adherence Scale (GAS)	Based on a previous questionnaire for hypertensive medication adherence	Fibromyalgia	5 scales each rated 1 – 6 on inclination to adhere in the past month	Average of the 5 items → converted into a 0-100% scale

Author	Type	Name	How devised	Condition	Description	Score
[15]	Questionnaire	Specific Adherence Scale (SAS)	Devised by authors	Fibromyalgia	17 items 4-point (0-3) scales on adherence in the past week. Self-reported by participants	Average of the 17 items → converted into a 0-100% scale
[16]	Questionnaire	The Heart Failure Compliance Questionnaire	Based on an existing measure for MI. ← interviews to 3 heart failure patients → generate items relevant to the target population Reviewed by 6 specialist nurses, 1 sociologist + 10 participants regarding comprehensiveness and length	Heart failure	6 subsections on health behaviors with 5-point scales Overall adherence on a 5-point scale	Mean for each health behavior and combined. Participants were deemed adherent if the combined score > 75%
[17]	Questionnaire	NR	Devised by authors based on literature and piloted on the target population and physical therapists	Older people: Impaired balance	A 43 item questionnaire containing 1 open ended question and 7 subscales (4-point scales).	Subscale scores were summed up
[18]	Questionnaire	NR but referred to as a survey	Devised by authors for the study. Content validity was attempted including experts but no-one from the target population. Test-retest reliability was also attempted utilizing 10 participants over a 1-week timespan	Stress urinary incontinence	Questionnaire with 4 sections on: No. times per day the exercises were conducted on average; time spent performing the exercises; time for each exercise; reason for doing the exercises. Additional questions on the use of a cassette tape if in group with this intervention	
[19]	Questionnaire	Adherence to Exercise Scale for Older Patients (AESOP)	Used items from pre-existing scales which could be modified, deleted or added to. This was then checked for applicability in the target population.	Elderly	Interview. 3 subscales with a total of 45 items (5- point scales)	The scores for each of the subscales were summed separately resulting in 3 totals

Author	Type	Name	How devised	Condition	Description	Score
[20]	Questionnaire	No name	Devised by authors based on literature. Attempts at face and content validity were made piloting the measure on 5 experts and 5 individuals from the target population	Osteopathy patients	Self-administered. 3 subscales on: attitudes and experiences to exercise and health; whether the participant had an exercise program; whether the exercise program had been carried out as specified (All 5-point scales). The final question required a yes or no answer regarding their completion of prescribed exercises	Sum of subscales
[21]	Questionnaire	NR	Modified from a questionnaire by Marzolini and literature. Not validity or reliability testing. Face validity was attempted by asking patients, physicians and cardiac rehabilitation staff about relevance and range of questions	Stroke	Self-report 16-item questionnaire. Multiple choice for most questions but can write different response	
[22]	Questionnaire	NR	NR	Huntington's Disease	Weekly telephone-administered questionnaire on: Whether they had conducted their exercises in the previous week, frequency, which exercises they had carried out, difficulties, and concerns	NR
[23]	Questionnaire	NR	NR but based on 7- day physical activity questionnaire	Type 2 diabetes	Recall questionnaire of all physical activity conducted during the last 7 days. Cues such as time of the day were used to aid recall. Items on frequency, duration and intensity of activity or exercise.	MET's were calculated based on responses
[24]	Questionnaire	NR	NR but based on Bassett (2003)	Overuse tendonitis	Items on adherence to exercises, cryotherapy and avoiding participating in activities that could aggravate injury on a 5 point scale 1= not at all- 5= as advised	Sum of all items
[25]	Questionnaire	NR	NR but the questionnaire was developed for the study	Hip or knee replacement	By interview. Items on regularity, performance difficulties, problems remembering to do the exercises, satisfaction with rehabilitation whilst an inpatient and satisfaction with therapeutic exercises	NR
[26]	Questionnaire	NR	NR	Chronic low back pain	Global impression of how often the exercises were performed per week (4-point scale from 'never' to '>5 times a week'.	

Author	Type	Name	How devised	Condition	Description	Score
[27]	Questionnaire	NR	Devised by a physician, researcher and a cardiac rehabilitation clinician, in conjunction with a market research professional	Cardiac patients	52-item questionnaire	NR
[28]	Questionnaire	NR	NR	Osteoarthritis	4-item questionnaire on frequency of weekly exercises over the past month, time spent doing the exercises, stops, time since last time doing the exercises, perception of change in physical activity levels during the last six months. Multiple-choice.	NR
[29]	Questionnaire	NR	NR but adapted from Sluijs et al (1993)	Neck and low back pain	5-point scale on frequency and duration of the exercise program ('never', 'seldom', 'often', 'almost always', 'always') for the past week	If 'always' or 'almost always' → deemed as adherent
[30]	Questionnaire	NR	NR	Injured athletes	5-item self-reported questionnaire with 3 domains: frequency (2), duration (2) and perceived quality /performance of the exercises (1)	% were calculated combined for each domain
[31]	Questionnaire	NR	NR but devised by the author	Chronic low back pain	No. days and time spent on the rehabilitation program during the past week	NR
[32]	Questionnaire	Exercise Compliance Questionnaire	Devised by author based on literature	Cardiac rehabilitation	8-item questionnaire with 6 questions on frequency, duration, intensity and method of exercise scored on a 5-point scale + 2 questions on aspects before heart attack	Scores were weighted for questions 1 to 6 → 30 - 150. If score <50 then 'low adherers' If score >100 'high adherence'
[33]	Questionnaire	NR	NR	Physiotherapy patients	1 4-point question on whether regularly exercised in the past week (from 'not at all' to 'very regularly')	NR
[34]	Questionnaire	No name	NR how it was devised. Face validity was conducted and the authors attempted to establish applicability	Rheumatoid arthritis	2-sections: 1) 6 questions on the exercise program, and 2) 11 questions on factors that may influence adherence.	Means and frequencies calculated combining the 2 sections
[35]	Questionnaire	NR	NR but developed for this study and based on the Manchester Cystic Fibrosis Compliance Questionnaire. Piloted by 2 individuals from the target population who provided feedback	Cystic fibrosis	By interview. 3 sections: 1) background, 2) adherence to airway clearance, and 3) adherence to exercise program.	NR

Author	Type	Name	How devised	Condition	Description	Score
[36]	Log/diary	7- day diary	NR	Urinary incontinence	5-point scale on No. days during the week carried out the exercises as per the physiotherapist's instructions.	The first 3 response options were deemed as 'nonadherence', the 4th option as 'moderate adherence' and the 5th as 'ideal level of adherence'
[37]	Log/diary	NR but referred to as a diary	NR but physical therapists had input into the adherence rating categories	Low back pain	The diary recorded exercise frequency each week.	Adherence was rated between 0-2 based on the review of the log (2 = 'highly adherent', 1 = 'low adherer', 0 = 'not adherent')
[38]	Log/diary	NR but referred to as Exercise Diary	NR	Stress urinary incontinence	Record exercise sessions attended / carried out each week	% of the No. exercise sessions / No. exercises sessions prescribed
[39]	Log/diary	NR but referred to as Exercise Log	NR	Older People: Activity	Log recorded various activities frequency and duration providing the duration was >10 minutes.	Mean of reported activities per week
[40]	Log/diary	NR but referred to as self-report and follows a log format	NR but designed for study	Physiotherapy patients	Each exercise was recorded with number of repetitions and duration of session	% of No. exercise sessions actually completed / No. sessions prescribed
[41]	Log/diary	NR	NR	Pulmonary rehabilitation	Standardized questions used (NR) to record the type and frequency of exercises carried out at home in addition to any attendance at exercise classes and other physical activity.	NR
[42]	Log/diary	NR but referred to as a daily log	NR	COPD	Recorded the time, number of walks and level of dyspnea after each walk per day	No. walks done / No. prescribed
[43]	Log/diary	NR but referred to as an exercise diary	Unclear	Heart failure	Recorded duration and frequency of the prescribed exercises + type of exercise carried out	No. exercise sessions carried out / No. sessions prescribed.
[44]	Log/diary	NR but referred to as an exercise log	NR	Osteoarthritis	Recorded frequency and duration of the exercises.	No. exercise sessions carried out / No. sessions prescribed.
[45]	Log/diary	Daily Mobile phone diary	NR	Sedentary Women	The log was completed every evening between 7pm-12am. Recorded frequency, intensity and duration of physical activity carried out + No. steps taken that day and if they wore the pedometer as they were supposed to for the study	% No. diary entries over a month / 21 days

Author	Type	Name	How devised	Condition	Description	Score
[46]	Log/diary	NR but referred to as a Step/ chord calendar	NR	Heart failure	Recorded No. exercises carried out, repetitions and Thera-chord color + RPE Collected by nurse or exercise specialist	2 resistance exercise sessions had to be recorded on the calendar in addition to another exercise session recorded differently to be deemed 'adherent'
[19]	Log/diary	NR but referred to as a daily home exercise log	NR	Older people: Activity	Days where participants exercised, an 'E' was marked on the calendar log. If participant had a fall they marked an 'F' to detract from the variable of adherence	Individuals were rated adherent if exercise was conducted 3 times/week
[22]	Log/diary	NR but referred to as an exercise diary	NR	Huntington's Disease	The log recorded which exercises were carried out each week between 1 and 3 times.	NR
[47]	Log/diary	NR but described as an exercise log	NR	Activity program	Recorded type, frequency and duration of exercise, heart rate while exercising and an RPE for each exercise session	Monthly No. sessions completed / No. prescribed sessions
[48]	Log/diary	NR but referred to as diaries	NR but reference to Bassett 2003 commenting self-report measures are a good technique to assess adherence	Stroke	Recorded frequency and duration of sessions. Participants were aware that sessions should be <90 minutes.	NR
[49]	Log/diary	NR but referred to as a home exercise diary	NR	Distal radius fracture Surgery	Recorded No. exercise sessions + No. exercises conducted per session	% No. exercises * sessions conducted / prescribed
[50]	Log/diary	NR but referred to as a daily exercise diary	NR	Chronic low back pain	Recorded frequency	% No. sessions conducted / prescribed
[51]	Log/diary	NR but referred to as a daily log	NR	Veteran's illness	Recorded frequency, intensity and duration of exercise. Report how they measure intensity from the choice type + heart rate + METs or RPEs	NR
[52]	Log/diary	NR but referred to as an activity log	NR	Heart failure	Recorded RPE, heart rate, exercises completed and duration of the session, as well as any symptoms that occurred	% No. exercises * sessions conducted / prescribed

Author	Type	Name	How devised	Condition	Description	Score
[53]	Log/diary	NR but referred to as a daily diary	Devised by authors and used in previous studies but not measuring adherence. Content validity was attempted by a panel of oncology nurses and nurse researchers and exercise physiologists. No target population input.	Breast Cancer	Recorded fatigue, duration of walking, pulse rate before and after walking in addition to any side effects or symptoms of disease experienced	NR
[54]	Log/diary	NR but referred to as a personalized record sheet	Designed by the authors	Injured athletes	Content of sheet individualized by participant with the doctor and completed each week	Weekly mean by inspection
[55]	Log/diary	NR but referred to as exercise diaries	NR	Chronic neck pain	Recorded frequency, which exercises, repetitions and weights	Mean and standard deviation of the training frequency
[56]	Log/diary	NR but referred to as a diary and log sheet	Taken from pre-existing diary recording wet episodes in incontinence patients	Osteoarthritis	Recorded No. exercises / day	% No. exercises conducted / prescribed
[57]	Log/diary	NR but referred to as a daily exercise diary	NR	Elderly at Podiatry/Falls	Recorded No. exercises / day	Adherence was deemed as the participant completed >=50% of prescribed exercise
[58]	Log/diary	NR but referred to as exercise logs	NR	Osteoarthritis	Recorded frequency and duration of exercise + pain + exertion experienced	% No. exercises conducted / prescribed
[59]	Log/diary	NR but referred to as a log book	NR	Myocardial Infarction	Duration and frequency of exercises per week	% No. exercises and duration conducted / prescribed
[60]	Log/diary	NR but referred to as diaries	NR	Weight loss	Frequency of exercise providing it was >2/week + a minimum of 30 minutes	NR
[61]	Log/diary	NR but referred to as exercise logs	NR	Sedentary healthy women	Recorded date, completion of warm up and cooldown, time spent walking and estimated No. miles walked. Participants were encouraged to note weather, terrain, route taken, and how the participant felt whilst walking.	NR

Author	Type	Name	How devised	Condition	Description	Score
[62]	Log/diary	NR but referred to as a weekly exercise log	NR	Bariatric surgery	Frequency and duration of exercise sessions, type of exercise performed, Borg scale rating during exercise and data pertaining to pedometer use per week	Means and standard deviations were calculated
[63]	VAS	NR but was a VAS	NR	Physiotherapy patients	14.5 cm line with 0, 25, 50, 75 and 100% marked as anchors	Perceived adherence in cm
[64]	VAS	NR but was a VAS	NR	Physiotherapy patients	10 cm line with the anchors at each end ('no exercise' to 'completing all exercises for the week')	Adherence was assessed depending on the number of VAS returned and the level of adherence they had indicated in cm
[65]	Monitor	Tally counter	NR	Voice therapy	A small device record each time the exercises were performed for at least a 2 minute duration.	NR

NR, not reported; VAS, Visual Analogue Scale; No., number of; RPE, Rating of Perceived Exertion

According to the quality criteria proposed for measurement properties of health status questionnaires (Terwee et al. 2007), only The Heart Failure Compliance Questionnaire and Adherence to Exercise Scale for Older Patients (AESOP) achieved a positive rating (Evangelista et al. 2001, Hardage et al. 2007).

Most measures had no evidence that they had undergone any sort of psychometric evaluation although a small number of researchers had attempted to evaluate some measurement properties but used dubious methods or the property being assessed fell below suitable quality thresholds. In addition, some authors referenced that their measure had established psychometric properties but then modified the scale or used it with a completely different population without re-examining the properties in the revised scale.

No studies assessed agreement or responsiveness

Table 4 shows a summary of the measurement methods identified by the SR by [7].

Table 4. Measurement methods identified in Frost et al. and evaluation of validity.

Type	Description	Validity	Reliability	Acceptability
StepWatch Activity Monitor (SAM)	Research-grade ankle-worn activity monitor. Described as a pedometer, accelerometer or activity monitor as the internal mechanisms have not been disclosed.	Small percentage error and mean bias and high percentage accuracy compared to direct observation for measuring step counts in healthy populations, individuals with COPD and individuals with MS in laboratory settings. Fair predictive validity in persons with intermittent claudication for changes in Peak Walking Time.	High quality studies were not found	Highly acceptable across populations for 1-28 days' wear (most commonly worn for 1 week) including persons with MS, TKA, neurological conditions, sarcoma, lower limb prosthesis, knee OA and older, sedentary and obese adults. In most studies >90% patients complied with SAM wear, but this was variable. Acceptable for 7 days wear in persons with knee osteoarthritis and older, sedentary or obese adults
Problematic Experiences of Therapy Scale (PETS)	12-item scale measuring general non-adherence – the degree to which socially acceptable reasons prevented patients adhering e.g. symptom severity/aggravation, efficacy doubts, practical challenges.	Excellent structural validity in populations with chronic dizziness from vestibular conditions.	Excellent internal consistency in populations with dizziness	High completion rates in a Meniere's disease rehabilitation study. Requires testing in a wider variety of populations.
Adherence diaries (AD)	ADs were defined by their function of regular (usually daily) patient self-report of an activity. All AD types were aggregated (electronic method, telephone interview, questionnaire [patient and provider], diary + provider questionnaire, diary + patient questionnaire, diary + telephone interview, and diary + heart rate self-assessed).	Moderate-excellent criterion validity for measuring adherence to exercise frequency and duration compared to a heart rate monitor, pedometers and radiofrequency identification card system in sedentary women, older adults, cancer patients and pregnant women. Fair to no predictive validity for walking adherence and changes in fitness in sedentary women. Good construct validity was found compared to the Physical Activity Questionnaire in cancer patients	High quality studies were not found	Moderate to high (50-100% return rates) across a variety of patient populations recording adherence from 2 weeks to 12 months. Higher return rates were found in persons with TKA, systematic sclerosis, heart failure, coronary heart disease, diabetes, Crohn's, elbow pain and osteoarthritis. Mixed return rates were found in persons with COPD and back pain. Strategies that appeared to have a higher return rate included remuneration, weekly collection and weekly review. Monthly collection did not engender particularly high return rates and studies using reminders had mixed return rates.
Bassett & Prapavessis' Scale (B&P)	Self-report scale measuring general adherence (rated 1-5) to 5 dimensions of home-based physiotherapy: exercises, ice, rest, strapping and elevation.	Poor predictive validity for adherence and functional outcomes in patients with ankle sprains. Fair construct validity compared to intentions to adhere in patients with ankle sprains.	Good internal consistency between scale items in patients with ankle sprains	High quality studies were not found

Type	Description	Validity	Reliability	Acceptability
Borg 6-20 rating of perceived exertion (RPE) scale	15-grade scale of self-reported exertion commonly used in rehabilitation, exertion testing and training.	Fair criterion validity compared to a heart rate monitor in older adults in two activities. Fair construct validity compared to other walk parameters (e.g. gait speed).	High quality studies were not found	High quality studies were not found
Yamax Digiwalker CW series pedometer	It records and displays the number of steps taken. It has a two-week memory and a three-year battery life. All CW series contain the same internal mechanisms and so all were included.	Limited criterion validity compared to a GT1M ActiGraph accelerometer in pregnant women (overcounted at high step rates and undercounted at low step rates). Moderate to good 'active' and 'inactive' classifications.	High quality studies were not found	CW-701 had data for 58/61 pregnant women for four days' wear
Joint Protection Behaviour Assessment (JPBA)	20-task observational scale assessing performance accuracy of arthritis joint protection behaviours when making a hot drink and snack in a kitchen. Behavior is graded as correct, partially correct or incorrect and converted to a percentage score.	High quality studies were not found	High quality studies were not found	83/127 individuals with rheumatoid arthritis agreed to be recorded performing the JPBA
Polar A1 series Heart Rate Monitors	A family of Polar heart rate monitors. The models from this family with the same T31 transmitter include the FS1, A1, FT1, FT4, FT60, FT7 and RCX5. All these models were included in this review, though the A1 and FS1 may no longer be in production.	High quality studies were not found	High quality studies were not found	The Polar FT60 was used in 76% of exercise session by healthy adults. Interviews showed that adults found the polar monitor motivational, fun and increased understanding of exercise. However, it was unsuitable for certain sports, could be forgotten and the guidance was not always applicable for people.

[8] found 6 measurement instruments (See Table 5), but none passed their criteria to have psychometric properties assessed.

Table 5. Measurement methods identified in the SR by Levy et al.

Type	Description	Metric properties
Diary	The content of the diaries was not discussed however the diaries were completed by the people with the disease and they registered the type of physical activity, frequency, duration and the intensity/repetitions.	NT
Logbook	Logbooks or daily activity logs were used as adherence measurement the studies used a log to record the duration and the type of activity performed. Other parameters recorded in the logbooks included weekly step activity, intensity and number of sets and repetitions of exercise.	NT
Record of practice	Three studies ask participant to record a daily training record indicating exercise completion and any adverse events.	NT
Journal (1 study)	One study utilized a journal for recording adherence. Repetitions and a quality reflection were recorded.	NT
Survey (2 studies)	One study developed and used survey to explore exercise beliefs and adherence but the author acknowledged that a limitation of the survey was a lack of information about the validity of it. Another study used a phone survey but there are no details about the survey content.	NT
Questionnaire (4 studies)	Three studies develop their own questionnaires to measure adherence [21, 66, 67]. Jurkiewicz et al.developed a 16-item questionnaire comprising questions about the type and amount of exercise performed, factors that motivated patients to participate and reasons why they missed their workout. Touillet et al. described using a semi-structured activity questionnaire, which explored type of activity as well as duration and frequency. An additional study developed a questionnaire that examined consistency between prescribed treatment and exercises completed [67]. In a study exploring longitudinal patterns of adherence to exercises in people with stroke researchers utilized the Questionnaire of Exercise Adherence, a 14-item questionnaire consisting of three dimensions: adherence to exercise, effective supervision and advice seeking [68].	NT
The Physical Activity Scale for Individuals with Physical Disabilities [PASIPD] (4 studies)	The PASIPD is a 13-item self-report tool that assesses physical activity in three domains: recreation, household and occupational activities. However, this tool was not designed for measuring adherence.	NT

NT, not tested or assessed.

Synthesis

- Currently, there is no gold standard of exercise adherence measurement.
- Measures of adherence included in this review are limited by the quality of the evidence and by the low applicability across interventions.
- Measures of adherence to exercise can be categorized as:
    - Questionnaires / scales / surveys
    - Diaries / logbooks
    - Other type of assessment (different types of monitors).
- The majority of tools reported have not had a proper description of their psychometric properties, except for:
    - The Heart Failure Compliance Questionnaire and Adherence to Exercise Scale for Older Patients (AESOP) → positive rating for content validity.
    - The **Problematic Experiences of Therapy Scale** can validly and reliably assess general adherence across vestibular rehabilitation populations.
    - **Adherence diaries** which can approximate adherence to intervention frequency and duration, reported an acceptability that ranged from moderate to high
    - **StepWatch Activity Monitors** are likely to be valid and acceptable to assess adherence to walking interventions.

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