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How should we define (and measure) adherence in studies examining older adults' participation in exercise classes?

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ABSTRACT

Exercise classes provide a range of benefits to older adults, reducing risk of illness, promoting functional ability and improving well-being. However, to be effective and achieve long-term outcomes exercise needs to be maintained. Adherence is poor and reporting of adherence differs considerably between studies.

Objective

To explore how adherence to exercise classes for older people is defined in the literature and makes suggestions for a consistent definition for future studies, so as to guide future study design and so that adherence data can be pooled for meta-analysis.

Design

Methodological review

Methods

A review of the literature was carried out based on systematic searches of common literature databases. Two investigators identified eligible studies and extracted data independently.

Results

Thirty-seven papers (34 studies) were identified. Seven papers (seven studies) defined adherence as completion (retention). Thirty papers (27 studies) identified adherence using attendance records. Twelve papers (11studies) based adherence on duration of exercise and five papers (four studies) specified the intensity with which participants should exercise. Several studies used multiple methods.

Conclusions

There was little consensus between studies on how adherence should be defined, and even when studies used the same conceptual measure they measured the concept using different

approaches and/or had different cut-off points. Adherence related to health outcomes requires multiple measurements e.g. attendance, duration and intensity. It is important that future studies consider the outcome of the intervention when considering their definition of adherence, and we recommend a series of definitions for future use.

Keywords: ageing, adherence, exercise, definition, review

Strengths and limitations of this study

- The way that older adults' adherence to community exercise classes is reported differs considerably between studies.
- Data cannot be pooled for meta-analysis
- We define how adherence should be measured dependent on the outcomes of the intervention.

Competing Interests

All authors co-authored one of the papers included within the review.

INTRODUCTION

Promoting physical activity amongst the older population is an important public health and clinical issue.[1,2] Exercise reduces illness, improves functional ability and improves well-being.[3] However, to achieve long-term benefits older adults have to continue to do exercises and maintain activity either in exercise classes or alone (i.e. they have to adhere to gain benefit). Continuation of exercises by older adults in both the general population and within a rehabilitation setting is poor, which leads to little gain or even deterioration of function.[4,5,6]

There is a broad range of definitions of adherence used in the literature. In the general exercise literature adherence is defined as successful if participants complete a prescribed exercise routine for at least two thirds of the time.[7] This definition is very much related to functional improvements, as consistent exercise is needed to see improvements in (e.g.) strength and balance.[8] Self-report methods of physical activity performance in terms of minutes or hours of exercise carried out, using measures such as the Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity questionnaire have also been used.[9] Recent research looking at exercise classes considered two different measures of exercise continuation; class adherence, which was defined as still attending at follow-up.[10] and class attendance (number of classes attended over a set period). Results indicate there is a difference between attendance and adherence, since some variables measured only relate to one concept, indicating that different concepts are being measured.[10] This raises questions with regards to the way that adherence is defined. The outcome and impact of the intervention could be different dependent on the measure used.

The definition of adherence becomes particularly interesting when applied to exercise classes, as there is less reliance on self-report data. There seems to be no agreed definition of adherence in relation to exercise classes. This could have important implications for both general community based and rehabilitation exercise classes. Therefore a systematic style review of the literature has been carried out, to explore definitions of adherence to exercise classes for older adults. Visek et al [11] discuss four measures used for adherence to physical activity: 1) completion (ie, retention), 2) attendance (the number of sessions attended over the follow-up period) 3) duration adherence (how long they exercise for at each session) and 4) intensity adherence (the physical exertion). These measures will provide the framework for the review, with additional measures added if identified. This review explores how adherence to exercise classes is defined in the literature and makes suggestions for a consistent definition for future studies, so as to guide study design and so that meta-analyses of adherence to group exercise interventions can be performed in the future.

METHODS

Search strategy and selection criteria

We searched the Cochrane library, and then we undertook systematic searches of MEDLINE, EMBASE, CINAHL and PsychINFO. No date restrictions were placed on the search and all relevant evidence was included if in the English language. A direct journal search was also carried out on Age and Ageing and Journal of Aging and Physical Activity. Search terms were both free-text and MESH headings and were combined with Boolean operators. Key search terms included ‘older adults’, ‘seniors’, ‘exercise’, ‘strength’ and ‘balance’ and ‘adherence’, ‘maintenance’ and ‘compliance’. The electronic searches were carried out up to

01 June 2015. The searches were originally carried out for a systematic review on uptake and adherence to exercise classes and have been adopted for this review.

Types of study

All types of quantitative study designs were included. Most studies in this area of research are exploratory and there are few randomised controlled trials (RCTs).

Inclusion/exclusion criteria

Participants

We include all quantitative studies including older adults aged 50 and above. As pre-retirement age adults often have different needs,[12] the study participant mean age had to be ≥60 years.

Types of interventions

We focus on community based exercise classes or strength and balance classes. This includes community based exercise classes in trials. The classes had to have more than one fitness component, as the evidence indicates this is required to prevent/manage many conditions.[2,13] Studies considering Pilates and Tai Chi were excluded in the original review and so are not included here either. There is no agreed definition of an exercise class. We combine the standard definition for exercise [14] with the concept of a directed class to define the exercise classes included in this review as '*a group of people gathered together to follow a leader or instructor to carry out planned, structured and repetitive bodily movement done to improve more than one component of physical fitness'*.

To be included, studies had to report adherence (however that was defined) to an exercise class, but adherence did not have to be the primary outcome measure.

RESULTS

Figure 1 presents the PRISMA diagram for our review process. The searches were originally carried out for a separate systematic review, but for this review, we excluded papers that did not measure adherence (the original review also looked at uptake) or because they were qualitative. Table 1 presents details of the 37 papers (34 studies) identified which fulfilled inclusion criteria for this review. Below we identify the different ways these papers measured adherence, and the implications of defining and measuring adherence in that way.

Completion (i.e. retention)

Seven papers (seven studies) defined adherence as completion or conversely lack of adherence as drop-out. [10,15-20] Sometimes this was also assessed alongside another measure such as percentage of or number of attendances.[10,16,21] In one study, completion (adherence) was whether participants returned after a 10 week break [15] and another study described adherence as actual full completion of the programme and present at the last class .[19]

Drop-out was described in different ways in the studies. It was described as withdrawal from a programme/not returning to the class [10,20,21] or withdrawal due to health reasons after missing a number of sessions. Time until drop-out [18] was also measured in one study, which was the number of days between first and last attended class.

Attendance

Thirty papers (twenty-seven studies) defined adherence by using attendance records.[9,15,16,20- 46] One paper (one study) measured attendance but described retention

as adherence.[10] Fourteen papers (eleven studies) defined adherence as the percentage of classes attended.[9,20- 23,25, 29,30,31,35,39,42-44] Authors calculated percentage in a number of ways. In Estabrooks et al [16] attendance was calculated as a percentage of total number of classes available over the 4-week period. Eccelestone et al [21] calculated the percentage of classes attended out of the actual number of sessions offered for each class in each calendar month. Hays et al [33] calculated the mean number of classes attended, but also used exercise intensity as a measure. Eight papers (eight) studies defined different ordinal levels of adherence based on percentage of attendance thresholds, classified in different ways.[24,34,36-38,40,41,44] For example, in Stineman et al,[38] high adherence was classed as attending all sessions, whilst Sjosten et al [24] defined high adherence as 66.7–100% attendance and Grove and Spier [36] defined high adherence as the percentage of older adults who attended 90%-100% of sessions. In other papers,[40,41,44] high attendance was defined as participation in >75% of all exercise sessions. Some papers set a minimum attendance for low adherers, such as less than 30% of exercise classes [37] or less than 15 out of 20 sessions.[34] Mills et al,[28] called "maintained participation", attending at least one class a month, which was assessed through self-report, but validated by attendance records. Keogh et al [45] described high attendance as having attended one session a week over the previous three months. Finally, one paper also included drop-out as well as attendance in a combined adherence measure, for example Estabrooks et al [15] based adherence on attendance over six weeks (percentage of classes attended) but also return rate after a 10 week break.

Duration adherence

Twelve papers (eleven studies) based adherence on duration of exercise, which was measured in a variety of different ways.[9,29,30,39,42,43,47-52] Two papers (two studies) used self-

report exercise and calculated a level of physical activity using, for example, the physical activity questionnaires, PACE [29,30] or the Yale Physical Activity Survey (YPAS).[39] One paper (one study) just asked participants to record whether they had exercised 2 to 3 times a week over the set time period using a Likert scale.[47] Three papers (three studies) asked participants to record the number of minutes they were physically active,[49-51] whereas five papers (four studies) asked participants to record adherence to pre-defined minutes e.g. 30 minutes, 3 x a week.[9,42,43,48,52]

Intensity adherence

Five papers (four studies) specified the intensity with which participants should exercise.[33,42,43,48,52] Hays et al [33] stated adherence as a minimum of 20 minutes of continuous exercise at 55% to 70% of maximum heart rate (moderate intensity as defined by the American College of Sports Medicine, ACSM). Litt et al [52] asked that participants exercise at 'moderate intensity' as per the prescribed exercise regime. Caserta et al and Gillet et al,[42,43.48] asked participants to report how many times they exercised 3 times a week for 30 minutes at 60-80% of maximum heart rate.

Lack of uptake

Eccelestone et al [21] looked at attendance to a range of programmes and defined lack of adherence as not registered on any programmes, not attending a single session over a 12 month period or not returning to a class within the 12 month tracking period. Two of these three measures should be described as lack of uptake, rather than adherence.

CONCLUSIONS

There is clearly confusion in the literature about the definition of adherence, and even in differentiating adherence from uptake. There is very little consensus in the papers reviewed 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.[53] The majority of papers/studies included in this review focussed on attendance of classes, particularly percentage of attendance as the measure of adherence. Very few studies looked at exercise intensity and this was only used alongside another measure.[33,42,43,48,52]

Clearly adherence can be defined and measured in a variety of ways. How it is done should depend on the purpose of measurement. If adherence is being measured for management purposes, so as to ascertain if a programme is viable in a community, measurement in terms of weeks attended may suffice. This measurement will inform whether the class can continue to be provided and is economically viable, since regular weekly attendance is important, as if large numbers of participants are away from classes for long periods of time the class may become unviable. If however, adherence is being measured as a proxy for (or estimate of) health gain, for example for maintenance of strength and balance and to reduce falls risk, then the definition of adherence needs to focus on a number of measurements. These should be based on the evidence base for falls prevention and thus completion (ie, retention), attendance, duration and intensity adherence are all important to indicate whether older adults receive adequate dose of strength and balance training on an ongoing basis to prevent falls.[13]

If adherence is being measured for motivational reasons or even to test whether the group is cohesive, then we may want to focus on measuring attendance and completion (retention). Completion (retention) when used as a measure alone may mean that an individual may have missed a substantial number of classes, but could still be called adherent. Attendance when used as a single measure may indicate a lack of commitment, when the individual's attendance has been affected by ill-health or vacation and they are committed enough to always return to the class.[54] Completion and attendance as a combined measure helps us to understand participants' attitudes towards and commitment to the class, as well as their satisfaction with the class in terms of both physical and social outcomes. They may not be attending for valid and practical reasons (ill-health, caring duties, long holidays), and this combined measure may better reflect real life.

For research purposes adherence needs to reflect the outcomes that are being measured and there needs to be a consensus agreement on which measures are used for which outcomes. The way that each type of adherence is measured also varies and this causes issues for data pooling, meta- analysis and comparison of interventions. It is suggested that a consensus agreement is reached on when different types of measurement of adherence are used to provide consistency in the literature. In the absence of an agreed consensus we would recommend the following clear definitions be used for the following outcomes.

1. Health outcomes: completion (ie, retention), attendance, duration and intensity adherence

2. Group cohesion/motivation: completion (ie, retention) and attendance.

3. Financial viability: Attendance.

The cut off points for indicating each concept also differ and therefore we also suggest how each definition is measured (based on those used most frequently within the literature and our

suggestion of when different definitions should be used):

1. Completion (retention): Withdrawal from the class or where there is no formal withdrawal (without reason to the instructor) measured as not attending at follow-up.

2. Attendance: percentage of classes attended out of the actual number of sessions offered.

3. Duration: adherence to pre-defined minutes e.g. 30 minutes, 3 x a week

4. Intensity: 'moderate intensity' as per the prescribed exercise regime. Moderate intensity may differ dependent on the type of programme (e.g. strength and balance or aerobic), but the ACSM guidelines should be taken into consideration.

Even if these definitions of the types of adherence gain consensual acceptance by the research community, the measurement of adherence is not always valid or reliable. Minutes of exercise as a measure for example may be unreliable as this measure is often self-reported and there are a number of problems with self-report data.[55] There is potential to use technology to calculate number of minutes of exercise, types and intensity of exercise. The use of sensors could enable us to accurately measure older adults exercise within 'real-time' and work has been carried out exploring the accurate recording of movement.[56] Whilst use of sensors could help solve the problem of measuring adherence, they might of themselves provide a new source for a Hawthorne Effect.

It is important that future studies consider the outcome of the intervention when considering their definition of adherence but also that the way this is measured is clearly outlined so as to enable comparison and provide a full picture.

Authors' contributions

HHH, MH, DS and CT all participated in the design of the review and the selection of the search criteria. MH and HHH reviewed the papers against the selection criteria with DS providing a third opinion. All authors read and approved the final manuscript.

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Data Sharing Statement

No additional data available

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Figure 1: PRISMA diagram

Table 1: Details of studies included in the review.

Author, Date, Location	Main study aim	Study Design	Sample	Intervention	Adherence
Liu et al, 2014 U.S. [46]	To determine if sarcopenia modulates the response to a physical activity intervention in functionally limited older adults.	Randomised Controlled Trial	N= 177 (mean age 77.0) 71.1% female, 81.3% white Caucasian	**Intervention:** aerobic, strength, balance and flexibility exercises for 12 to 18 months, During weeks 1 to 8, 3 x weekly sessions were supervised at the field centre. From weeks 9 to 24, supervised sessions were 2x weekly and home-based exercises initiated. At 24 weeks, subjects transitioned to a home-based program with an optional weekly supervised session.	**Measure:** Number of sessions attended was compared to number of sessions available, excluding closings. For comparison of groups, the total number of sessions for each group at each site for the study was used.
Freiberger et al, 2013 Germany [44]	Feasibility of reaching functionally declined, but still	Randomised Controlled Trial	N=378 (mean age= 78.1), 75.4% female. No	**Intervention:** 16-week intervention included progressive and challenging balance,	**Measure:** participated in more than 75% of the supervised group sessions.

	independent older persons at risk of falls through their general practitioner (GP) and reduce their physiological and psychological fall risk factors with a complex exercise intervention		ethnicity stated community dwelling	gait, and strength exercise as well as changes to behavioural aspects. Sixteen sessions, once per week for 60 minutes, were supervised, and the participants added at least one unsupervised session starting from week 5.	Trained according to the protocol while unsupervised.
Courneya et al, 2012. Canada [49].	Examine the predictors of exercise adherence in the Alberta Physical Activity and Breast Cancer Prevention (ALPHA) Trial	Randomised Controlled Trial	N=160 No mean age stated (aged 50-74 with more participants >60) 100% women Ethnicity not stated community dwelling.	**Intervention:** Participants asked to perform at least 3 sessions/wk (approximately 123 of the 200 minutes) in supervised exercise at a fitness facility and up to 2sessions/wk (77 minutes) in unsupervised exercise. Specific interventions to improve adherence: Individualised exercise programme with regularly scheduled sessions, automatic telephone follow-up, plans for sessions missed because of	**Measure:** exercise adherence was weekly minutes of total, supervised, and unsupervised exercise excluding warm-up and cool-down periods. Supervised exercise minutes measured objectively by exercise trainers. Unsupervised exercise minutes assessed by exercise logs completed on weekly basis. Total exercise was sum of the supervised and unsupervised exercise minutes.

				vacations or illness, comprehensive educational package, group sessions, positive social interaction, donated incentives awarded at different milestones, regular newsletters, and study website.	
Evers et al, 2012. Germany [22].	Whether social cognitive variables and coping plans predict adherence to physical and mental activity intervention.	Randomised Controlled Trial	N=171 (mean age=73.7) 100% women, no ethnicity stated, community dwelling.	**Intervention: Physical exercise-** 3 times a week 90 minute multi-component sessions for 26 weeks. **Computer course-** sessions for 26 weeks.	**Measure:** defined as the number of course units attended, was recorded by all trainers for each participant in each course unit (percentage attended).
Evers et al, 2012 Germany [23].	Whether telephone or self-administered coping strategies affect long-term adherence.		N=86 (as above)	**Intervention:** As above. After 6 weeks (18 sessions) participants either had telephone-assisted (n=43) or a self-administered (n=43; control group) coping planning intervention.	**Measure:** As above.
Stineman et al, 2011. U.S [38].	To assess the recruitment, adherence, and	Randomised Controlled Trial	N=204 (mean age=76)	**Intervention:** endurance, resistance, and balance training.	**Measure:** Proportion of on-site exercise sessions attended out of a potential of 7 sessions in total.

	retention of urban elderly, pre-dominantly African Americans to a falls reduction exercise programme.		74.5% women, 88.7% African American, community dwelling.	Once a week class for first month, then monthly class and home exercise, with monthly home visits. 4 month programme. **Control:** generic pamphlet that discussed the benefits of walking three times a week for 30 min a day.	High adherence defined as attendance at all 7 classes. Home exercise: number of weeks exercised 3 or more days that week (self-report), percentage of weeks. High adherence defined as exercising at least 3 days every week for the 12 weeks.
Phillips et al, 2010. U.S [17].	Describe the characteristics of physical activity participants undergoing medical suspensions and distinguish those who never returned to the physical activity intervention from those who successfully returned to complete the intervention.	Randomised Controlled Trial	N=213 (mean age=76.5) 68.5% women, 75.1% white Caucasian. healthy sedentary community dwelling	**Intervention:** Group exercise 3 times per week, reduced to once per week after 8 weeks until 12 months. Intervention delivered by: instructor **Control:** Successful ageing education.	**Measure:** Participants classified as medically suspended if missed three or more consecutive sessions of centre-based physical activity (adoption and transition stage) or 2 or more weeks of home-based physical activity (maintenance) because of a health event
Fielding et al, 2007. U.S [9]	Whether older adults can reasonably participate and	Randomised Controlled Trial	N=213 (mean age=76.5) 68.5% women	Group exercise 3 times per week, reduced to 2 times a week after 8 weeks and then reduced	**Measure:** CHAMPS physical activity questionnaire. Above 150 minutes a week (self-report).

	adhere to a regular programme of physical activity. Looked at physical functioning but related to self-report adherence measure.		24.9% non-white. healthy sedentary community dwelling	to 1 a week at 25 weeks.	Attendance at sessions: percentage of available sessions (excluding sessions missed because of medical suspension). Home activity logs Adherence measured including intention to treat.
Sjosten et al 2007. Finland [24]	Determine the adherence rates and the predictors of adherence in four key activities of a multifactorial fall prevention trial	Randomised Controlled Trial	N= 293 (mean age=73) 86% female no ethnicity stated Community dwelling fallers	Multi-factorial falls prevention programme including multi-component class twice a month for 12 months.	**Measure:** Determined as a participation rate (number of attendances from number offered) in group session. (i) 0% adherence rate (non-adherence), (ii) 0.1–33.3% adherence rate (low adherence), (iii) 33.4–66.6% adherence rate (moderate adherence) and (iv) 66.7–100% adherence rate (high or full adherence).
McAuley, et al, 2003. U.S [30] & McAuley, et al, 2003. U.S [31]	Examined predictors of long-term exercise behaviour in older adults following a 6-month randomised controlled exercise trial	Randomised Controlled Trial	N= 89 (mean age=66.0) 94% white Caucasian healthy sedentary community	**Intervention:** Walking **Control:** exercise class 3 times a week for 1 hour, 6 months.	**Measure:** During trial attendance records were collected. However analysis related to Physical Activity Scale for the Elderly looking at physical activity levels at 6- and 18-month follow-up (self-report).
Gillett, White & Caserta	To test the effect of two nurse-delivered exercise/education	Randomised Controlled Trial	N=76 exercise group (mean	**Intervention:** exercise/education programme 3 times a	**Measure:** Self-report but also includes attendance records of class for first 16 weeks.

1996 U.S [43]	programmes specifically designed for obese, older women		age=64.7). 98% white Caucasian sedentary, overweight community dwelling.	week, 16 weeks Intervention delivered by: Nurse.	Analysis included self-report activity.
Gillett &Caserta 1996 U.S [42]	To test the effect of two nurse-delivered exercise/education programmes specifically designed for obese, older women.	Randomised Controlled Trial	N=76 exercise group (mean age=64.7). 100% women 98% white Caucasian sedentary, overweight community dwelling.	**Intervention:** exercise/education programme 3 times a week, 16 weeks Intervention delivered by: Nurse. **Intervention 2:** Health education sessions where encouraged to exercise 3 times a week at home, 16 weeks. **Control:** Test taken but no further intervention.	**Measure:** Attendance records, percentage of classes attended. Also, self-report particularly after 16 weeks. Self-report diaries. 3 times a week for 30 minutes at 60-80% of maximal heart rate reserve (MHRR), although this is not clear in the paper. Analysis tended to be based on self-report.
Hughes, Seymour et al, 2006. U.S [51]	Present final outcomes of multi component Fit and Strong! Intervention.	Randomised Controlled Trial	N=115 (mean age=73.3) 80.6% women. 69.4% white Caucasian mild to moderate osteoarthritis. community dwelling	**Intervention:** multi-component class and behaviour change 90 minutes, 3 times a week, 8 weeks. Intervention delivered by: Physical Therapists. **Control:** Waiting list.	**Measure:** Monitored attendance at sessions but they were asked to log activity. Frequency (number of times a week) and duration (minutes). Analysis was mostly done with self-report data.
Keogh et al, 2014	To quantify the objective benefits,	Exploratory Intervention	Study 1 N= 62	**Intervention:** group-based resistance,	**Measure:** current attendees defined as averaging at least one

New Zealand [45]	participant perceptions and retention rates of a New Zealand community-based exercise programme for adults (60 years or older).	Study (pre/post and cross sectional study) 3 studies	(mean age=71) 69% women Study 2 N= 153 (mean age=72) 63.4% women Study 3 N=264 (mean=72) 65% women ethnicity not stated for any studies. All community dwelling.	balance, cardiovascular and flexibility training activities, 60 minutes in duration and undertaken twice weekly for 12 weeks.	class a week over the previous three months. Based on attendance records, the length of programme participation (to the closest month) was also determined.
Toto et al, 2012. U.S. [39]	Evaluate effect of participation in multicomponent best-practice exercise and physical activity program (FSAH) on physical activity, ADL performance, physical performance,	Exploratory Intervention Study (pre/post)	N=15 (mean age=78.1) 100% women 100% white Caucasian sedentary, community-dwelling. low-income households	**Intervention:** 10-week intervention included multi-component group exercise sessions and a home exercise program. Group sessions also included key strategies for increasing self-efficacy. Participants met for 60-min group sessions 2 times week.	**Measure:** Yale Physical Activity Survey (YPAS), measuring self-report physical activity. Attendance at group sessions, percentage of sessions attended.

	depression.				
McAuley et al, 2011. U.S [31]	To examine the hypothesis that self-efficacy mediates the relationship between self-regulatory processes, such as executive function, and sustained exercise behaviour.	Exploratory Intervention Study (pre/post)	N=177 (mean age=66.4) 65.5% women 91% white Caucasian, community dwelling.	**Intervention:** participants randomised into a walking group or flexibility, toning, and balance (FTB) group. Classes met 3 days per week for approximately 1 hour over 12-month period	**Measure:** Adherence reflects percentage of attendance to exercise classes over the last 11 months of the program. Attendance data were recorded each day by staff, aggregated, and divided by the total possible number of sessions to arrive at percentage attendance. n.b attendance was no different for the walking or exercise group.
Sullivan-Marx et al, 2011. U.S [19].	Examined employment of specific recruitment and retention strategies in study evaluating outcomes of moderate activity exercise programme for older African American women	Exploratory Intervention Study (pre/post)	N=52 (mean age=79) 100% women 100% African American community dwelling.	**Intervention:** Three 5-min walking intervals interspersed with two strength and balance intervals. Programme held 5 days/week for 16 weeks; sessions lasted 30 min to 50-min sessions.	**Measure:** Completion of the exercise programme was considered to be at 16 weeks or 48 sessions. Attendance was logged by project staff.
Tiedmann, Sherrington & Lord, 2011. Australia [37].	Examine whether a diverse array of physiological, psychological, health and lifestyle measures are associated with exercise adherence in older retirement	Exploratory Intervention Study (pre/post)	N=344 (aged 62 and over) No other details available.	**Intervention:** group exercise or yoga classes twice a week for 6–12 months.	**Measure:** low adherers (those who attended less than 30% of exercise classes.

	village residents				
Shubert et al, 2011. U.S [41].	To translate a research-based intervention into a community programme, and to assess if similar outcomes were achieved.	Exploratory Intervention Study (pre/post)	N=68 (mean age= 78.8) 77.5% women 74% white Caucasian (non-Hispanic), community dwelling.	**Intervention** Stay Safe, Stay Active" (SASA). 60-75 minute, 12 week strength and balance class (2 classes offered twice a week).	**Measure:** Completion of the programme was defined as attending 75% (18) or more classes
Seymour et al, 2009. U.S [26].	To test the impact of a shift in instruction type (from physiotherapist to exercise instructor) on participant outcomes	Exploratory Intervention/2 group pre/post-test design study	N=161, PT group N=190, CEI (mean age= 71.2) 53.2% African American. healthy community dwelling	**Intervention:** 2 identical multi-component exercise classes, 90 minutes, 3 times a week, 8 weeks. Intervention delivered by: Therapist (PT) or exercise instructor (CEI).	**Measure:** based on attendance of 8 week intervention documented at sessions. Also, Community Healthy Activities Model Program (CHAMPS) measure to assess maintenance of physical activity (self-report) after intervention.
Hawley-Hague et al, 2014 U.K. [10]	To examine the influence of individual, instructor and group factors on participants' attendance and adherence to community exercise classes for older adults.	Longitudinal cohort study	N=193 (mean age= 76.1), 90.7% women, 94.3% white British. Community dwelling.	**Intervention:** Recruited existing multi-component community exercise classes. Including some community falls prevention. Delivered once a week for 60 minutes plus social time afterwards.	**Measure:** *Attendance in weeks.* Weekly class attendance records provided by the instructor. *Adherence.* Adherence levels calculated at each follow-up period. Non-adherence was defined as "those not attending at follow-up and have not attended for 4 weeks, and have not given a reason for nonattendance or those who

					have stated they are dropping out."
Hicks et al, 2012. Italy [40].	To identify factors that were predictive of improved pain status among older adults with chronic back pain participating in the Adaptive Physical Activity (APA) program and to identify factors that were predictive of adherence to APA	Observational Cohort study	N=392 (mean age=66.8) 84.2% women. No ethnicity stated. Community dwelling.	**Intervention** The APA multi-component exercise programmes were held twice a week for 1 hour.	**Measure:** Defined as participation in >75% of all exercise sessions for the entire12-month study period
Lucidi et al, 2006. Italy [35]	Whether, and to what extent, the constructs implicated in the theory of planned behaviour could predict behavioural intention to exercise and exercise-class attendance of older adults (age 65–90 years) already enrolled in a physical activity programme	Cross sectional study	N = 1,095 (mean age=69) Community dwelling	2 multi-component classes a week. Participants enrolled in exercise class for minimum of 6 months. Intervention delivered by: physical trainers.	**Measure:** Percentage ratio obtained by dividing the number of attended sessions by the number of possible sessions over the 3-month period. Registers used.
Sin et al,	Evaluate feasibility	Exploratory	N= 13, (mean	Evidence based exercise	**Measure:** Adherence to the

2005. U.S [25]	and effectiveness of a modified exercise programme for elderly Korean immigrants	intervention study	age=77) 100% Korean immigrants supported housing.	class 3 times a week, 12 weeks. Intervention delivered by: Korean/American exercise instructor.	exercise programme was calculated as percent of exercise classes attended over 12 weeks. Registers used.
Hays et al, 2005. U.S [33].	Explore the relationships between exercise self-definitions and participation in a group-based exercise programme	Exploratory intervention study	N=192 (mean age=64) 64.2 African-American 92% hypertension community dwelling	Multi-component community class available 2 times a day, 5 days week.	**Measure:** Mean number of exercise sessions attended over 24 weeks. A *completed session* was defined as a minimum of 20 minutes of continuous exercise at 55% to 70% of maximal heart rate (moderate intensity as defined by the ACSM,^' 1995) as determined by the research assistant who was present at each exercise session.
Hughes, Seymour et al, 2004. U.S [50]	Assess impact of low cost, multi-component physical activity intervention.	Randomised Controlled Trial	N=80 (mean age=73.5). 81.0% women 84.6% white Caucasian mild/moderate osteoarthritis. community dwelling	**Intervention:** multi-component class and behaviour change, 90 minutes, 3 times a week, 8 weeks. Intervention delivered by: Physical Therapists. **Control:** Waiting list.	**Measure:** Monitored attendance at sessions but they were asked to log activity. Frequency (number of times a week) and duration (minutes). Analysis was mostly done with self-report data.
Tu et al, 2004. U.S [18].	Investigates the effects of health and environmental factors on the dropout and intermittent	Exploratory intervention study	N=110 (mean age=63.7) 100% women. 66% African American, 34% white	2 multi-component classes each day offered 5 days a week for 2 years.	**Measures:** Number of days between the patient's first and last attended exercise classes (i.e., time until dropout) or the date of the last class offered

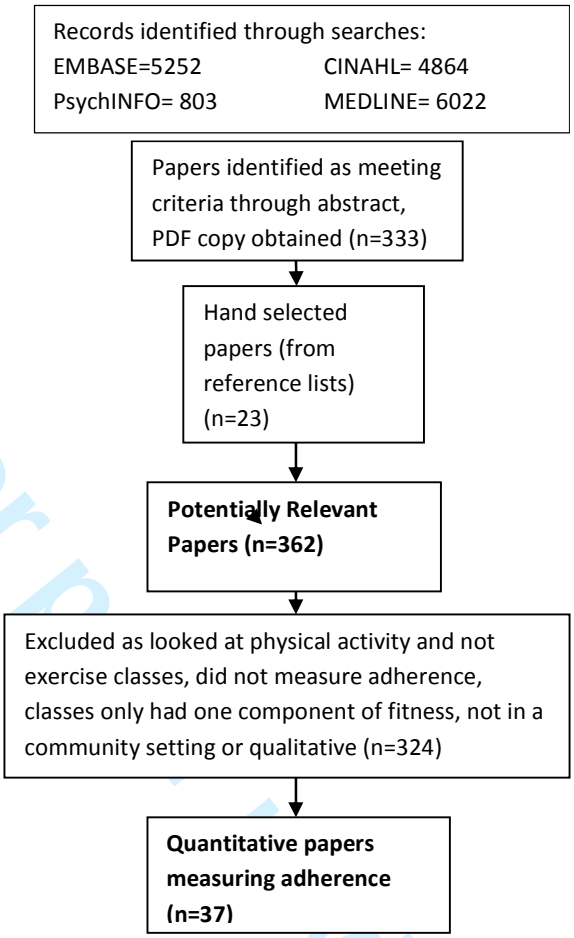
	nonattendance of an exercise programme designed specifically for older, female, primary-care patients living in the inner city		Caucasian. community dwelling		Participant's daily attendance record (1 = attended, 0 = did not attend) starts with first attendance and concludes with last attended class.
Litt et al, 2002. U.S [52]	To determine the extent to which modifiable social learning constructs predicted long-term adherence to an exercise programme.	Exploratory intervention study	N=189 (mean age=67.4) randomised to upper (n=92) or lower body (n=97) exercise. 100% women no ethnicity stated low bone density. community dwelling	2 classes a week for 2 months, 1 a week for 2 months, 1 a fortnight for 2 months. Then two classes a month.	**Measure:** Participants were asked the number of days in the previous 30 on which they had exercised, at moderate intensity, as per the prescribed regimen. Verified by examination of bi-weekly exercise logs. Analysis looked at "days of exercise".
Nigg et al, 2002. U.S [27]	To investigate effects of a community-based physical activity intervention grounded in the Transtheoretical Model	Exploratory intervention study	N= 48, (mean age 78.2) 90% women, 98% white Caucasian community dwelling	Pamphlets on benefits of exercise and 45 min in-house exercise class 2 times a week for 7 months.	**Measure:** Regular attendance, attending a minimum of 80% of the sessions. Based on movement between stages of change (TTM). Participants were labelled improved, unchanged, declined.
Estabrooks et al, 1999. Canada [16]	Examined the relationship of group cohesion to attitude and control	Exploratory intervention study	N=179 (mean age=67) 73% women no ethnicity	Existing classes 2-3 times a week, mix of strength, cardiovascular, walking and tai chi.	**Measure:** Attendance was converted to a percentage of total classes available over the 4-week period

	beliefs toward exercise in a sample of older adults		stated healthy community dwelling	Followed for 4 weeks.	
Estabrooks et al, 1999 Study 2. U.S [15]	Examine the effectiveness of team building intervention for improving exercise class attendance of previously sedentary older adults.	Exploratory intervention study	N= 33 (mean age= 75.1) N=12 intervention, placebo N=11, control N=11. 91% women no ethnicity stated healthy sedentary community dwelling.	Exercise class including instructor led team building, 2 times a week, 6 weeks. **Placebo**: Exercise class 2 times a week, 6 weeks with visit from researcher enquiring how participants progressing. **Control:** Basic exercise class 2 times a week, 6 weeks.	**Measure:** Adherence based on attendance over 6 weeks (percentage of classes attended) but also return rate after 10 week break.
Grove and Spier, 1999. U.S [36]	To evaluate the usefulness of intervention strategies in motivating adherence to an exercise programme.	Exploratory intervention study	N=14 (mean age= 78) 100% women 100% white Caucasian healthy community dwelling	Multi-component exercise group 2 times a week. Delivered by: exercise video with support from a nurse for 6 weeks, then once a week for 4 ½ months and a peer captain after 6 weeks.	**Measure:** Percentage of older adults who attended more than 50% and 90%-100% of sessions
Brenes & Storandt, 1998. U.S.[47]	To examine the effectiveness of the theory of planned behaviour in predicting exercise by older adults 1,3, and 9 months after beginning an	Exploratory intervention study	N= 105 (mean age= 68.3) 89% women. 66% white Caucasian 31% African-American healthy	Older adults new to exercise attending existing exercise groups. Not stated how often classes offered.	**Measure: Self report.** Participants rated on a 7-point scale ***(disagree*** to ***agree)*** the following statement: "I have exercised 2 to 3 times a week over the past 1 (3, 9) month(s)."

	exercise class.		community dwelling		
Caserta & Gillett, 1998 U.S [48]	Determine acute and follow-up effects of 4 months of health and fitness education with and without exercise.	Randomised Controlled Trial	N=76 exercise group (mean age=64.7). 100% women 98% white Caucasian sedentary, overweight community dwelling.	**Intervention:** exercise/education programme 3 times a week, 16 weeks Intervention delivered by: Nurse. **Control:** Health education sessions were encouraged to exercise 3 times a week at home, 16 weeks.	**Measure:** Self-report diaries. 3 times a week for 30 minutes at 60-80% of MHRR (although this is not clear in the paper).
Ecclestone et al, 1998. Canada [21]	Examine the pattern of enrolment, attendance and adherence across a variety of programmes.	Exploratory intervention study	N=67 and N=31 (mean age=75 and 73) 96.5% women no ethnicity stated healthy community dwelling.	2 Osteoporosis classes offered 3 times a week for 3 years. Intervention delivered by: instructors majority of which are peer (55+) leaders.	**Measure:** Percentage of classes attended divided by the actual number of sessions offered for each class in each calendar month. **Drop out defined as:** Not registered on any programmes, not attending a single session over a 12 month period and not returning to a session over the 12 month tracking period.
Mills et al, 1997. U.S [28]	Explores activity preference in relation to activity adoption and maintenance.	Exploratory intervention study	N=98 (mean age=76) 81% women, 92% white Caucasian fairly healthy community dwelling	CHAMPS programme, intervention promoting exercise including conditioning classes, provided counselling, follow-up calls, monthly group meetings, for 6 months	**Measure:** Self-report activity logs, a sample of the most popular class registers were used to validate attendance. Maintained participation, described as attending at least one class a month, assessed through self-report, but validated by

			sheltered housing.		attendance records
Williams and Lord, 1995. Australia. [20]	Whether psychological, physiological, and health and lifestyle measures were associated with adherence to a structured exercise programme for older women	Exploratory intervention study	N=102 (mean age=71.6) 100% women no ethnicity stated healthy community dwelling	5 multi-component classes, 1 hour twice a week for 12 month trial.	**Measure:** Adherence was defined as the number of exercise classes attended. **Dropout:** used to describe participants who withdrew from the formal exercise programme.
Hickey et al, 1995. U.S [32]	Effectiveness of low-intensity physical activity for improving functional ability and psychological well-being in chronically impaired older individuals Exploring initiating and maintaining an exercise programme for physically inactive persons who are limited by chronic impairments	Exploratory intervention study	N=90 (mean age=72.6) 94% female 52% white Caucasian 48% black chronically impaired, sedentary, senior centres	4 structured low-intensity exercise classes, 2 times a week by instructor for 6 weeks, followed by peer led group with instructor support up to 18 weeks.	**Measure:** Adherence if they attended two thirds of the sessions.
Howze et al, 1989. U.S [34]	Examines factors affecting the adoption of regular	Exploratory multiple intervention	N=47 (mean age= 65.3), mixed gender,	Multi-component exercise programme. Running for 1 month	**Measures:** Number of attendances. High attenders categorised as 15/20 sessions, low

	exercise by sedentary older adults	percentage not stated. 100% white Caucasian healthy community, middle class.	before data collection (no further detail about classes).	attenders were less than 15/20.



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A review of how we should define (and measure) adherence in studies examining older adults' participation in exercise classes

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ABSTRACT

Exercise classes provide a range of benefits to older adults, reducing risk of illness, promoting functional ability and improving well-being. However, to be effective and achieve long-term outcomes exercise needs to be maintained. Adherence is poor and reporting of adherence differs considerably between studies.

Objective

To explore how adherence to exercise classes for older people is defined in the literature and devise a definition for pooling data on adherence in future studies.

Design

Methodological review of the approaches used to measure adherence

Methods

A review of the literature was carried out using narrative synthesis, based on systematic searches ofMEDLINE, EMBASE, CINAHL and PsychINFO . Two investigators identified eligible studies and extracted data independently.

Results

Thirty-seven papers including thirty-four studies were identified. Seven papers (seven studies) defined adherence as completion (retention). Thirty papers (27 studies) identified adherence using attendance records. Twelve papers (11studies) based adherence on duration of exercise and five papers (four studies) specified the intensity with which participants should exercise. Several studies used multiple methods.

Conclusions

There was little consensus between studies on how adherence should be defined, and even when studies used the same conceptual measure they measured the concept using different approaches and/or had different cut-off points. Adherence related to health outcomes

requires multiple measurements e.g. attendance, duration and intensity. It is important that future studies consider the outcome of the intervention when considering their definition of adherence, and we recommend a series of definitions for future use.

Keywords: ageing, adherence, exercise, definition, review

Strengths and limitations of this study

- The way that older adults' adherence to community exercise classes is reported differs considerably between studies.
- Data cannot be pooled for meta-analysis
- We define how adherence should be measured dependent on the outcomes of the intervention.

Competing Interests

All authors co-authored one of the papers included within the review.

INTRODUCTION

Promoting exercise amongst the older population is an important public health and clinical issue.[1,2] Exercise reduces illness, improves functional ability and improves well-being.[3] However, to achieve long-term benefits older adults have to continue to do exercises and maintain activity either in exercise classes or alone (i.e. they have to adhere to gain benefit). Continuation of exercises by older adults in both the general population and within a rehabilitation setting is poor, which leads to little gain or even deterioration of function.[4,5,6]

There is a broad range of definitions of adherence used in the literature. In the general exercise literature adherence is defined as successful if participants complete a prescribed exercise routine for at least two thirds of the time.[7] This definition is very much related to functional improvements, as consistent exercise is needed to see improvements in (e.g.) strength and balance.[8] It not only bases adherence on the number of sessions and their intensity, but also provides a cut-off point (two thirds or more of the prescribed sessions is adherent). Self-report methods of exercise performance in terms of minutes or hours of exercise carried out, using measures such as the Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity questionnaire have also been used.[9] Recent research looking at exercise classes considered two different measures of exercise continuation; class adherence, which was defined as still attending at follow-up.[10] and class attendance (number of classes attended over a set period). Results indicate there is a difference between attendance and adherence (as defined in the study), since some variables measured only relate to one concept, indicating that different concepts are being measured.[10] This raises questions with regards to the way that adherence is defined and the cut off points used as part of that definition. Attendance could be seen as a subset of

adherence and continues to be an important measure in its own right. For this study we focus on the broader concept of adherence, as the outcome and impact of an intervention could be different depending on the definition and measurement used.

The definition of adherence becomes particularly interesting when applied to exercise classes, as there is less reliance on self-report data. There seems to be no agreed definition of adherence in relation to exercise classes. This could have important implications for both general community based and rehabilitation exercise classes. Therefore a review of the literature has been carried out (based on systematic searches), to explore definitions of adherence to exercise classes for older adults. Visek et al [11] discuss four measures used for adherence to structured exercise in trials: 1) completion (ie, retention), 2) attendance (the number of sessions attended over the follow-up period) 3) duration adherence (how long they exercise for at each session) and 4) intensity adherence (the physical exertion). These measures will provide the framework for the review, with additional measures added if identified. This review explores how adherence to exercise classes is defined in the literature and makes suggestions for a consistent definition for future studies, so as to guide study design and so that meta-analyses of adherence to group exercise interventions can be performed in the future.

METHODS

Search strategy and selection criteria

We searched the Cochrane library, and then we undertook systematic searches of MEDLINE, EMBASE, CINAHL and PsychINFO. No date restrictions were placed on the search and all relevant evidence was included if in the English language. A direct journal search was also carried out on Age and Ageing and Journal of Aging and Physical Activity. Search terms

were both free-text and MESH headings and were combined with Boolean operators. Key search terms included 'older adults', 'seniors', 'exercise', 'strength' and 'balance' and 'adherence', 'maintenance' and 'compliance'. The terms strength and balance were included as additional terms as community classes for falls prevention are often referred to as strength and balance training/classes rather than exercise. The electronic searches were carried out up to 01 June 2015. The searches were originally carried out for a systematic review on uptake and adherence to exercise classes and have been adopted for this review. Two investigators identified eligible studies and extracted data independently, where there was any disagreement a decision was made through discussion with a third investigator.

Types of study

All types of quantitative study designs were included. Most studies in this area of research are exploratory and there are few randomised controlled trials (RCTs).

Inclusion/exclusion criteria

Participants

We include all quantitative studies including older adults aged 50 and above. As pre-retirement age adults often have different needs,[12] the study participant mean age had to be ≥60 years.

Types of interventions

We focus on community based exercise classes or strength and balance classes. This includes community based exercise classes in trials. The classes had to have more than one fitness component, as the evidence indicates this is required to prevent/manage many conditions.[2,13] These components were defined as including aerobic, strength, balance,

stretching and mobility. Studies considering Pilates and Tai Chi were excluded in the original review and so are not included here either. There is no agreed definition of an exercise class. We combine the standard definition for exercise [14] with the concept of a directed class to define the exercise classes included in this review as '*a group of people gathered together to follow a leader or instructor to carry out planned, structured and repetitive bodily movement done to improve more than one component of physical fitness'*.

To be included, studies had to report adherence (however that was defined) to an exercise class, but adherence did not have to be the primary outcome measure. Narrative synthesis was adopted.

RESULTS

Figure 1 presents the PRISMA diagram for our review process. The searches were originally carried out for a separate systematic review, but for this review, we excluded papers that did not measure adherence (the original review also looked at uptake) or because they were qualitative. Table 1 (supplementary file) presents details of the 37 papers (34 studies) identified which fulfilled inclusion criteria for this review. Below we identify the different ways these papers measured adherence, and the implications of defining and measuring adherence in that way.

Completion (i.e. retention)

Seven papers (seven studies) defined adherence as completion or conversely lack of adherence as drop-out. [10,15-20] Sometimes this was also assessed alongside another measure such as percentage of or number of attendances.[10,16,21] In one study, completion (adherence) was whether participants returned after a 10 week break [15] and another study described adherence as actual full completion of the programme and present at the last class .[19]

Drop-out was described in different ways in the studies. It was described as withdrawal from a programme/not returning to the class [10,20,21] or withdrawal due to health reasons after missing a number of sessions. Time until drop-out [18] was also measured in one study, which was the number of days between first and last attended class.

Attendance

Thirty papers (twenty-seven studies) defined adherence by using attendance

records.[9,15,16,20- 46] One paper (one study) measured attendance but described retention as adherence.[10] Fourteen papers (eleven studies) defined adherence as the percentage of classes attended.[9,20- 23,25, 29,30,31,35,39,42-44] Authors calculated percentage in a number of ways. In Estabrooks et al [16] attendance was calculated as a percentage of total number of classes available over the 4-week period. Eccelestone et al [21] calculated the percentage of classes attended out of the actual number of sessions offered for each class in each calendar month. Hays et al [33] calculated the mean number of classes attended, but also used exercise intensity as a measure. Eight papers (eight) studies defined different ordinal levels of adherence based on percentage of attendance thresholds, classified in different ways.[24,34,36-38,40,41,44] For example, in Stineman et al,[38] high adherence was classed as attending all sessions, whilst Sjosten et al [24] defined high adherence as 66.7–100% attendance and Grove and Spier [36] defined high adherence as the percentage of older adults who attended 90%-100% of sessions. In other papers,[40,41,44] high attendance was defined as participation in >75% of all exercise sessions. Some papers set a minimum attendance for low adherers, such as less than 30% of exercise classes [37] or less than 15 out of 20 sessions.[34] Mills et al,[28] called "maintained participation", attending at least one class a month, which was assessed through self-report, but validated by attendance records. Keogh et al [45] described high attendance as having attended one session a week over the previous three months. Finally, one paper also included drop-out as well as attendance in a combined adherence measure, for example Estabrooks et al [15] based adherence on attendance over six weeks (percentage of classes attended) but also return rate after a 10 week break.

Duration adherence

Twelve papers (eleven studies) based adherence on duration of exercise, which was measured

in a variety of different ways.[9,29,30,39,42,43,47-52] Duration adherence was often used to measure self-reported exercise that included exercise carried out both within the classes and outside of the classes. This was primarily used for longitudinal follow-up after a time-limited intervention. [30] Two papers (two studies) used self-report exercise and calculated a level of physical activity using, for example, the physical activity questionnaires, PACE [29,30] or the Yale Physical Activity Survey (YPAS).[39] One paper (one study) just asked participants to record whether they had exercised 2 to 3 times a week over the set time period using a Likert scale.[47] Three papers (three studies) asked participants to record the number of minutes they were physically active,[49-51] whereas five papers (four studies) asked participants to record adherence to pre-defined minutes e.g. 30 minutes, 3 x a week.[9,42,43,48,52]

Intensity adherence

Five papers (four studies) specified the intensity with which participants should exercise.[33,42,43,48,52] Hays et al [33] stated adherence as a minimum of 20 minutes of continuous exercise at 55% to 70% of maximum heart rate (moderate intensity as defined by the American College of Sports Medicine, ACSM). Litt et al [52] asked that participants exercise at 'moderate intensity' as per the prescribed exercise regime. Caserta et al and Gillet et al,[42,43.48] asked participants to report how many times they exercised 3 times a week for 30 minutes at 60-80% of maximum heart rate.

Lack of uptake

Eccelestone et al [21] looked at attendance to a range of programmes and defined lack of adherence as not registered on any programmes, not attending a single session over a 12

month period or not returning to a class within the 12 month tracking period. Two of these three measures should be described as lack of uptake, rather than adherence.

DISCUSSION

There is clearly confusion in the literature about the definition of adherence, and even in differentiating adherence from uptake. There is very little consensus in the papers reviewed 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.[53] The majority of papers/studies included in this review focussed on attendance of classes, particularly percentage of attendance as the measure of adherence. Very few studies looked at exercise intensity and this was only used alongside another measure.[33,42,43,48,52]

Clearly adherence can be defined and measured in a variety of ways. How it is done should depend on the purpose of measurement. If adherence is being measured for management purposes, so as to ascertain if a programme is viable in a community, measurement in terms of weeks attended may suffice. This measurement will inform whether the class can continue to be provided and is economically viable, since regular weekly attendance is important, as if large numbers of participants are away from classes for long periods of time the class may become unviable. If however, adherence is being measured in a study which is looking to see if the intervention brings about a health gain, for example for maintenance of strength and balance and to reduce falls risk, then the definition of adherence needs to focus on a number of measurements. Using falls prevention as an example, the definition should be based on the evidence base for falls prevention and thus completion (ie, retention), attendance, duration and intensity adherence are all important to indicate whether

older adults receive adequate dose of strength and balance training on an ongoing basis to prevent falls.[13]

If adherence is being measured for motivational reasons or even to test whether the group is cohesive, then we may want to focus on measuring attendance and completion (retention). Completion (retention) when used as a measure alone may mean that an individual may have missed a substantial number of classes, but could still be called adherent. Attendance when used as a single measure may indicate a lack of commitment, when the individual's attendance has been affected by ill-health or vacation and they are committed enough to always return to the class.[54] Completion and attendance as a combined measure helps us to understand participants' attitudes towards and commitment to the class, as well as their satisfaction with the class in terms of both physical and social outcomes. They may not be attending for valid and practical reasons (ill-health, caring duties, long holidays), and this combined measure may better reflect real life.

For research purposes adherence needs to reflect the outcomes that are being measured and there needs to be a consensus agreement on which measures are used for which outcomes. The way that each type of adherence is measured also varies and this causes issues for data pooling, meta- analysis and comparison of interventions. It is suggested that a consensus agreement is reached on when different types of measurement of adherence are used to provide consistency in the literature. In the absence of an agreed consensus we recommend the following clear definitions be used.

1. Health outcomes: completion (ie, retention), attendance, duration and intensity adherence

2. Group cohesion/motivation: completion (ie, retention) and attendance.

3. Financial viability: Attendance.

The cut off points for indicating each concept also differ and therefore we also recommend how each definition is measured (based on those used most frequently within the literature and our suggestion of when different definitions should be used):

1. Completion (retention): Those who are still attending the class/still attending at follow-up. Non-completion includes withdrawal from the class or where there is no formal withdrawal measured as not attending at follow-up (without reason given to the instructor).

2. Attendance: percentage of classes attended out of the actual number of sessions offered.

3. Duration: adherence to pre-defined minutes e.g. 30 minutes, 3 x a week

4. Intensity: 'moderate intensity' as per the prescribed exercise regime. Moderate intensity may differ dependent on the type of programme (e.g. strength and balance or aerobic), but the ACSM guidelines should be taken into consideration.

Even if these definitions of the types of adherence gain consensual acceptance by the research community, the measurement of adherence is not always valid or reliable. Minutes of exercise as a measure for example may be unreliable as this measure is often self-reported and there are a number of problems with self-report data.[55] There is potential to use technology to calculate number of minutes of exercise, types and intensity of exercise. The use of sensors could enable us to accurately measure older adults exercise within 'real-time' and work has been carried out exploring the accurate recording of movement.[56] Whilst use of sensors could help solve the problem of measuring adherence, they might of themselves provide a new source for a Hawthorne Effect.

The limitations of this study are that it only provides definitions of adherence for exercise classes and not general physical activity. We believe that the definition of

adherence for physical activity will differ because there is an increased reliance on self-report data. We also excluded studies which looked at Tai Chi and Pilates. This was because there are sufficient studies on these types of exercise class for a separate review. Both Tai Chi and Pilates have the potential to provide important benefits to older people and therefore further research is required to assess whether our recommended definitions can also be applied to these interventions,

Although in this study we only define adherence to exercise classes, some of the included studies looked at changes during and after the exercise class and therefore use a self-reported exercise duration measure throughout their studies that is not always directly related to the time spent exercising in the class. If we had excluded studies which carried out follow-up after the class, then this may have allowed us to present simpler results. However, their inclusion highlights an important complexity that has arisen in the literature that needs to be considered and our definition take into account these different measurements used.

Our cut off-point for intensity of exercise focuses on moderate intensity exercise. We know that even low intensity exercise has benefits for older adults. [57] However, all of the included studies that measured exercise intensity based their measure of adherence on moderate intensity. Our proposed cut-off point takes into consideration that moderate intensity exercise may differ dependent on the individual and type of programme.

It is important that future studies consider the outcome of the intervention when considering their definition of adherence but also that the way this is measured is clearly outlined so as to enable comparison and provide a full picture.

Authors' contributions

HHH, MH, DS and CT all participated in the design of the review and the selection of the search criteria. MH and HHH reviewed the papers against the selection criteria with DS providing a third opinion. All authors read and approved the final manuscript.

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Data Sharing Statement

No additional data available

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Figure 1: PRISMA diagram

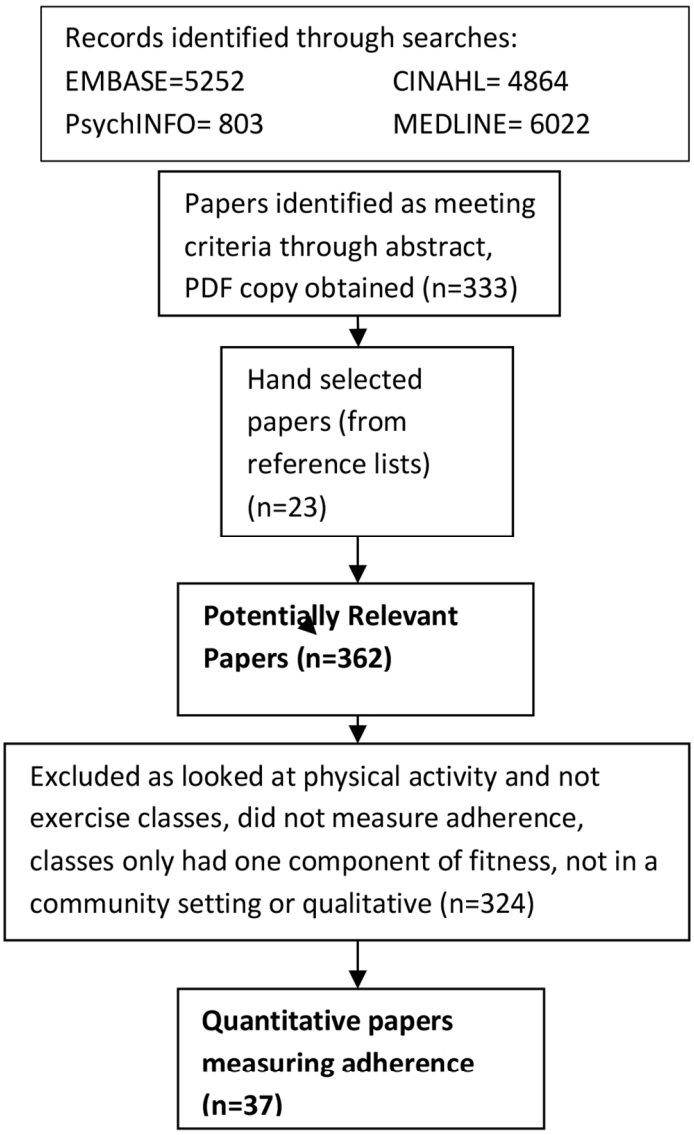

Figure 1: PRISMA Diagram
92x139mm (300 x 300 DPI)

Table 1: Details of studies included in the review.

Author, Date, Location	Main study aim	Study Design	Sample	Intervention	Adherence
Liu et al, 2014 U.S. [46]	To determine if sarcopenia modulates the response to a physical activity intervention in functionally limited older adults.	Randomised Controlled Trial	N= 177 (mean age 77.0) 71.1% female, 81.3% white Caucasian	**Intervention:** aerobic, strength, balance and flexibility exercises for 12 to 18 months, During weeks 1 to 8, 3 x weekly sessions were supervised at the field centre. From weeks 9 to 24, supervised sessions were 2x weekly and home-based exercises initiated. At 24 weeks, subjects transitioned to a home-based program with an optional weekly supervised session.	**Measure:** Number of sessions attended was compared to number of sessions available, excluding closings. For comparison of groups, the total number of sessions for each group at each site for the study was used.
Freiberger et al, 2013 Germany [44]	Feasibility of reaching functionally declined, but still	Randomised Controlled Trial	N=378 (mean age= 78.1), 75.4% female. No	**Intervention:** 16-week intervention included progressive and challenging balance,	**Measure:** participated in more than 75% of the supervised group sessions.

	independent older persons at risk of falls through their general practitioner (GP) and reduce their physiological and psychological fall risk factors with a complex exercise intervention		ethnicity stated community dwelling	gait, and strength exercise as well as changes to behavioural aspects. Sixteen sessions, once per week for 60 minutes, were supervised, and the participants added at least one unsupervised session starting from week 5.	Trained according to the protocol while unsupervised.
Courneya et al, 2012. Canada [49].	Examine the predictors of exercise adherence in the Alberta Physical Activity and Breast Cancer Prevention (ALPHA) Trial	Randomised Controlled Trial	N=160 No mean age stated (aged 50-74 with more participants >60) 100% women Ethnicity not stated community dwelling.	**Intervention:** Participants asked to perform at least 3 sessions/wk (approximately 123 of the 200 minutes) in supervised exercise at a fitness facility and up to 2sessions/wk (77 minutes) in unsupervised exercise. Specific interventions to improve adherence: Individualised exercise programme with regularly scheduled sessions, automatic telephone follow-up, plans for sessions missed because of	**Measure:** exercise adherence was weekly minutes of total, supervised, and unsupervised exercise excluding warm-up and cool-down periods. Supervised exercise minutes measured objectively by exercise trainers. Unsupervised exercise minutes assessed by exercise logs completed on weekly basis. Total exercise was sum of the supervised and unsupervised exercise minutes.

				vacations or illness, comprehensive educational package, group sessions, positive social interaction, donated incentives awarded at different milestones, regular newsletters, and study website.	
Evers et al, 2012. Germany [22].	Whether social cognitive variables and coping plans predict adherence to physical and mental activity intervention.	Randomised Controlled Trial	N=171 (mean age=73.7) 100% women, no ethnicity stated, community dwelling.	**Intervention: Physical exercise-** 3 times a week 90 minute multi-component sessions for 26 weeks. **Computer course-** sessions for 26 weeks.	**Measure:** defined as the number of course units attended, was recorded by all trainers for each participant in each course unit (percentage attended).
Evers et al, 2012 Germany [23].	Whether telephone or self-administered coping strategies affect long-term adherence.		N=86 (as above)	**Intervention:** As above. After 6 weeks (18 sessions) participants either had telephone-assisted (n=43) or a self-administered (n=43; control group) coping planning intervention.	**Measure:** As above.
Stineman et al, 2011. U.S [38].	To assess the recruitment, adherence, and	Randomised Controlled Trial	N=204 (mean age=76)	**Intervention:** endurance, resistance, and balance training.	**Measure:** Proportion of on-site exercise sessions attended out of a potential of 7 sessions in total.

	retention of urban elderly, pre-dominantly African Americans to a falls reduction exercise programme.		74.5% women, 88.7% African American, community dwelling.	Once a week class for first month, then monthly class and home exercise, with monthly home visits. 4 month programme. **Control:** generic pamphlet that discussed the benefits of walking three times a week for 30 min a day.	High adherence defined as attendance at all 7 classes. Home exercise: number of weeks exercised 3 or more days that week (self-report), percentage of weeks. High adherence defined as exercising at least 3 days every week for the 12 weeks.
Phillips et al, 2010. U.S [17].	Describe the characteristics of physical activity participants undergoing medical suspensions and distinguish those who never returned to the physical activity intervention from those who successfully returned to complete the intervention.	Randomised Controlled Trial	N=213 (mean age=76.5) 68.5% women, 75.1% white Caucasian. healthy sedentary community dwelling	**Intervention:** Group exercise 3 times per week, reduced to once per week after 8 weeks until 12 months. Intervention delivered by: instructor **Control:** Successful ageing education.	**Measure:** Participants classified as medically suspended if missed three or more consecutive sessions of centre-based physical activity (adoption and transition stage) or 2 or more weeks of home-based physical activity (maintenance) because of a health event
Fielding et al, 2007. U.S [9]	Whether older adults can reasonably participate and	Randomised Controlled Trial	N=213 (mean age=76.5) 68.5% women	Group exercise 3 times per week, reduced to 2 times a week after 8 weeks and then reduced	**Measure:** CHAMPS physical activity questionnaire. Above 150 minutes a week (self-report).

	adhere to a regular programme of physical activity. Looked at physical functioning but related to self-report adherence measure.		24.9% non-white. healthy sedentary community dwelling	to 1 a week at 25 weeks.	Attendance at sessions: percentage of available sessions (excluding sessions missed because of medical suspension). Home activity logs Adherence measured including intention to treat.
Sjosten et al 2007. Finland [24]	Determine the adherence rates and the predictors of adherence in four key activities of a multifactorial fall prevention trial	Randomised Controlled Trial	N= 293 (mean age=73) 86% female no ethnicity stated Community dwelling fallers	Multi-factorial falls prevention programme including multi-component class twice a month for 12 months.	**Measure:** Determined as a participation rate (number of attendances from number offered) in group session. (i) 0% adherence rate (non-adherence), (ii) 0.1–33.3% adherence rate (low adherence), (iii) 33.4–66.6% adherence rate (moderate adherence) and (iv) 66.7–100% adherence rate (high or full adherence).
McAuley, et al, 2003. U.S [30] & McAuley, et al, 2003. U.S [31]	Examined predictors of long-term exercise behaviour in older adults following a 6-month randomised controlled exercise trial	Randomised Controlled Trial	N= 89 (mean age=66.0) 94% white Caucasian healthy sedentary community	**Intervention:** Walking **Control:** exercise class 3 times a week for 1 hour, 6 months.	**Measure:** During trial attendance records were collected. However analysis related to Physical Activity Scale for the Elderly looking at physical activity levels at 6- and 18-month follow-up (self-report).
Gillett, White & Caserta	To test the effect of two nurse-delivered exercise/education	Randomised Controlled Trial	N=76 exercise group (mean	**Intervention:** exercise/education programme 3 times a	**Measure:** Self-report but also includes attendance records of class for first 16 weeks.

1996 U.S [43]	programmes specifically designed for obese, older women		age=64.7). 98% white Caucasian sedentary, overweight community dwelling.	week, 16 weeks Intervention delivered by: Nurse.	Analysis included self-report activity.
Gillett &Caserta 1996 U.S [42]	To test the effect of two nurse-delivered exercise/education programmes specifically designed for obese, older women.	Randomised Controlled Trial	N=76 exercise group (mean age=64.7). 100% women 98% white Caucasian sedentary, overweight community dwelling.	**Intervention:** exercise/education programme 3 times a week, 16 weeks Intervention delivered by: Nurse. **Intervention 2:** Health education sessions where encouraged to exercise 3 times a week at home, 16 weeks. **Control:** Test taken but no further intervention.	**Measure:** Attendance records, percentage of classes attended. Also, self-report particularly after 16 weeks. Self-report diaries. 3 times a week for 30 minutes at 60-80% of maximal heart rate reserve (MHRR), although this is not clear in the paper. Analysis tended to be based on self-report.
Hughes, Seymour et al, 2006. U.S [51]	Present final outcomes of multi component Fit and Strong! Intervention.	Randomised Controlled Trial	N=115 (mean age=73.3) 80.6% women. 69.4% white Caucasian mild to moderate osteoarthritis. community dwelling	**Intervention:** multi-component class and behaviour change 90 minutes, 3 times a week, 8 weeks. Intervention delivered by: Physical Therapists. **Control:** Waiting list.	**Measure:** Monitored attendance at sessions but they were asked to log activity. Frequency (number of times a week) and duration (minutes). Analysis was mostly done with self-report data.
Keogh et al, 2014	To quantify the objective benefits,	Exploratory Intervention	Study 1 N= 62	**Intervention:** group-based resistance,	**Measure:** current attendees defined as averaging at least one

New Zealand [45]	participant perceptions and retention rates of a New Zealand community-based exercise programme for adults (60 years or older).	Study (pre/post and cross sectional study) 3 studies	(mean age=71) 69% women Study 2 N= 153 (mean age=72) 63.4% women Study 3 N=264 (mean=72) 65% women ethnicity not stated for any studies. All community dwelling.	balance, cardiovascular and flexibility training activities, 60 minutes in duration and undertaken twice weekly for 12 weeks.	class a week over the previous three months. Based on attendance records, the length of programme participation (to the closest month) was also determined.
Toto et al, 2012. U.S. [39]	Evaluate effect of participation in multicomponent best-practice exercise and physical activity program (FSAH) on physical activity, ADL performance, physical performance,	Exploratory Intervention Study (pre/post)	N=15 (mean age=78.1) 100% women 100% white Caucasian sedentary, community-dwelling. low-income households	**Intervention:** 10-week intervention included multi-component group exercise sessions and a home exercise program. Group sessions also included key strategies for increasing self-efficacy. Participants met for 60-min group sessions 2 times week.	**Measure:** Yale Physical Activity Survey (YPAS), measuring self-report physical activity. Attendance at group sessions, percentage of sessions attended.

	depression.				
McAuley et al, 2011. U.S [31]	To examine the hypothesis that self-efficacy mediates the relationship between self-regulatory processes, such as executive function, and sustained exercise behaviour.	Exploratory Intervention Study (pre/post)	N=177 (mean age=66.4) 65.5% women 91% white Caucasian, community dwelling.	**Intervention:** participants randomised into a walking group or flexibility, toning, and balance (FTB) group. Classes met 3 days per week for approximately 1 hour over 12-month period	**Measure:** Adherence reflects percentage of attendance to exercise classes over the last 11 months of the program. Attendance data were recorded each day by staff, aggregated, and divided by the total possible number of sessions to arrive at percentage attendance. n.b attendance was no different for the walking or exercise group.
Sullivan-Marx et al, 2011. U.S [19].	Examined employment of specific recruitment and retention strategies in study evaluating outcomes of moderate activity exercise programme for older African American women	Exploratory Intervention Study (pre/post)	N=52 (mean age=79) 100% women 100% African American community dwelling.	**Intervention:** Three 5-min walking intervals interspersed with two strength and balance intervals. Programme held 5 days/week for 16 weeks; sessions lasted 30 min to 50-min sessions.	**Measure:** Completion of the exercise programme was considered to be at 16 weeks or 48 sessions. Attendance was logged by project staff.
Tiedmann, Sherrington & Lord, 2011. Australia [37].	Examine whether a diverse array of physiological, psychological, health and lifestyle measures are associated with exercise adherence in older retirement	Exploratory Intervention Study (pre/post)	N=344 (aged 62 and over) No other details available.	**Intervention:** group exercise or yoga classes twice a week for 6–12 months.	**Measure:** low adherers (those who attended less than 30% of exercise classes.

	village residents				
Shubert et al, 2011. U.S [41].	To translate a research-based intervention into a community programme, and to assess if similar outcomes were achieved.	Exploratory Intervention Study (pre/post)	N=68 (mean age= 78.8) 77.5% women 74% white Caucasian (non-Hispanic), community dwelling.	**Intervention** Stay Safe, Stay Active" (SASA). 60-75 minute, 12 week strength and balance class (2 classes offered twice a week).	**Measure:** Completion of the programme was defined as attending 75% (18) or more classes
Seymour et al, 2009. U.S [26].	To test the impact of a shift in instruction type (from physiotherapist to exercise instructor) on participant outcomes	Exploratory Intervention/2 group pre/post-test design study	N=161, PT group N=190, CEI (mean age= 71.2) 53.2% African American. healthy community dwelling	**Intervention:** 2 identical multi-component exercise classes, 90 minutes, 3 times a week, 8 weeks. Intervention delivered by: Therapist (PT) or exercise instructor (CEI).	**Measure:** based on attendance of 8 week intervention documented at sessions. Also, Community Healthy Activities Model Program (CHAMPS) measure to assess maintenance of physical activity (self-report) after intervention.
Hawley-Hague et al, 2014 U.K. [10]	To examine the influence of individual, instructor and group factors on participants' attendance and adherence to community exercise classes for older adults.	Longitudinal cohort study	N=193 (mean age= 76.1), 90.7% women, 94.3% white British. Community dwelling.	**Intervention:** Recruited existing multi-component community exercise classes. Including some community falls prevention. Delivered once a week for 60 minutes plus social time afterwards.	**Measure:** *Attendance in weeks.* Weekly class attendance records provided by the instructor. *Adherence.* Adherence levels calculated at each follow-up period. Non-adherence was defined as "those not attending at follow-up and have not attended for 4 weeks, and have not given a reason for nonattendance or those who

					have stated they are dropping out."
Hicks et al, 2012. Italy [40].	To identify factors that were predictive of improved pain status among older adults with chronic back pain participating in the Adaptive Physical Activity (APA) program and to identify factors that were predictive of adherence to APA	Observational Cohort study	N=392 (mean age=66.8) 84.2% women. No ethnicity stated. Community dwelling.	**Intervention** The APA multi-component exercise programmes were held twice a week for 1 hour.	**Measure:** Defined as participation in >75% of all exercise sessions for the entire12-month study period
Lucidi et al, 2006. Italy [35]	Whether, and to what extent, the constructs implicated in the theory of planned behaviour could predict behavioural intention to exercise and exercise-class attendance of older adults (age 65–90 years) already enrolled in a physical activity programme	Cross sectional study	N = 1,095 (mean age=69) Community dwelling	2 multi-component classes a week. Participants enrolled in exercise class for minimum of 6 months. Intervention delivered by: physical trainers.	**Measure:** Percentage ratio obtained by dividing the number of attended sessions by the number of possible sessions over the 3-month period. Registers used.
Sin et al,	Evaluate feasibility	Exploratory	N= 13, (mean	Evidence based exercise	**Measure:** Adherence to the

2005. U.S [25]	and effectiveness of a modified exercise programme for elderly Korean immigrants	intervention study	age=77) 100% Korean immigrants supported housing.	class 3 times a week, 12 weeks. Intervention delivered by: Korean/American exercise instructor.	exercise programme was calculated as percent of exercise classes attended over 12 weeks. Registers used.
Hays et al, 2005. U.S [33].	Explore the relationships between exercise self-definitions and participation in a group-based exercise programme	Exploratory intervention study	N=192 (mean age=64) 64.2 African-American 92% hypertension community dwelling	Multi-component community class available 2 times a day, 5 days week.	**Measure:** Mean number of exercise sessions attended over 24 weeks. A *completed session* was defined as a minimum of 20 minutes of continuous exercise at 55% to 70% of maximal heart rate (moderate intensity as defined by the ACSM,^' 1995) as determined by the research assistant who was present at each exercise session.
Hughes, Seymour et al, 2004. U.S [50]	Assess impact of low cost, multi-component physical activity intervention.	Randomised Controlled Trial	N=80 (mean age=73.5). 81.0% women 84.6% white Caucasian mild/moderate osteoarthritis. community dwelling	**Intervention:** multi-component class and behaviour change, 90 minutes, 3 times a week, 8 weeks. Intervention delivered by: Physical Therapists. **Control:** Waiting list.	**Measure:** Monitored attendance at sessions but they were asked to log activity. Frequency (number of times a week) and duration (minutes). Analysis was mostly done with self-report data.
Tu et al, 2004. U.S [18].	Investigates the effects of health and environmental factors on the dropout and intermittent	Exploratory intervention study	N=110 (mean age=63.7) 100% women. 66% African American, 34% white	2 multi-component classes each day offered 5 days a week for 2 years.	**Measures:** Number of days between the patient's first and last attended exercise classes (i.e., time until dropout) or the date of the last class offered

	nonattendance of an exercise programme designed specifically for older, female, primary-care patients living in the inner city		Caucasian. community dwelling		Participant's daily attendance record (1 = attended, 0 = did not attend) starts with first attendance and concludes with last attended class.
Litt et al, 2002. U.S [52]	To determine the extent to which modifiable social learning constructs predicted long-term adherence to an exercise programme.	Exploratory intervention study	N=189 (mean age=67.4) randomised to upper (n=92) or lower body (n=97) exercise. 100% women no ethnicity stated low bone density. community dwelling	2 classes a week for 2 months, 1 a week for 2 months, 1 a fortnight for 2 months. Then two classes a month.	**Measure:** Participants were asked the number of days in the previous 30 on which they had exercised, at moderate intensity, as per the prescribed regimen. Verified by examination of bi-weekly exercise logs. Analysis looked at "days of exercise".
Nigg et al, 2002. U.S [27]	To investigate effects of a community-based physical activity intervention grounded in the Transtheoretical Model	Exploratory intervention study	N= 48, (mean age 78.2) 90% women, 98% white Caucasian community dwelling	Pamphlets on benefits of exercise and 45 min in-house exercise class 2 times a week for 7 months.	**Measure:** Regular attendance, attending a minimum of 80% of the sessions. Based on movement between stages of change (TTM). Participants were labelled improved, unchanged, declined.
Estabrooks et al, 1999. Canada [16]	Examined the relationship of group cohesion to attitude and control	Exploratory intervention study	N=179 (mean age=67) 73% women no ethnicity	Existing classes 2-3 times a week, mix of strength, cardiovascular, walking and tai chi.	**Measure:** Attendance was converted to a percentage of total classes available over the 4-week period

	beliefs toward exercise in a sample of older adults		stated healthy community dwelling	Followed for 4 weeks.	
Estabrooks et al, 1999 Study 2. U.S [15]	Examine the effectiveness of team building intervention for improving exercise class attendance of previously sedentary older adults.	Exploratory intervention study	N= 33 (mean age= 75.1) N=12 intervention, placebo N=11, control N=11. 91% women no ethnicity stated healthy sedentary community dwelling.	Exercise class including instructor led team building, 2 times a week, 6 weeks. **Placebo**: Exercise class 2 times a week, 6 weeks with visit from researcher enquiring how participants progressing. **Control:** Basic exercise class 2 times a week, 6 weeks.	**Measure:** Adherence based on attendance over 6 weeks (percentage of classes attended) but also return rate after 10 week break.
Grove and Spier, 1999. U.S [36]	To evaluate the usefulness of intervention strategies in motivating adherence to an exercise programme.	Exploratory intervention study	N=14 (mean age= 78) 100% women 100% white Caucasian healthy community dwelling	Multi-component exercise group 2 times a week. Delivered by: exercise video with support from a nurse for 6 weeks, then once a week for 4 ½ months and a peer captain after 6 weeks.	**Measure:** Percentage of older adults who attended more than 50% and 90%-100% of sessions
Brenes & Storandt, 1998. U.S.[47]	To examine the effectiveness of the theory of planned behaviour in predicting exercise by older adults 1,3, and 9 months after beginning an	Exploratory intervention study	N= 105 (mean age= 68.3) 89% women. 66% white Caucasian 31% African-American healthy	Older adults new to exercise attending existing exercise groups. Not stated how often classes offered.	**Measure: Self report.** Participants rated on a 7-point scale ***(disagree*** to ***agree)*** the following statement: "I have exercised 2 to 3 times a week over the past 1 (3, 9) month(s)."

	exercise class.		community dwelling		
Caserta & Gillett, 1998 U.S [48]	Determine acute and follow-up effects of 4 months of health and fitness education with and without exercise.	Randomised Controlled Trial	N=76 exercise group (mean age=64.7). 100% women 98% white Caucasian sedentary, overweight community dwelling.	**Intervention:** exercise/education programme 3 times a week, 16 weeks Intervention delivered by: Nurse. **Control:** Health education sessions were encouraged to exercise 3 times a week at home, 16 weeks.	**Measure:** Self-report diaries. 3 times a week for 30 minutes at 60-80% of MHRR (although this is not clear in the paper).
Ecclestone et al, 1998. Canada [21]	Examine the pattern of enrolment, attendance and adherence across a variety of programmes.	Exploratory intervention study	N=67 and N=31 (mean age=75 and 73) 96.5% women no ethnicity stated healthy community dwelling.	2 Osteoporosis classes offered 3 times a week for 3 years. Intervention delivered by: instructors majority of which are peer (55+) leaders.	**Measure:** Percentage of classes attended divided by the actual number of sessions offered for each class in each calendar month. **Drop out defined as:** Not registered on any programmes, not attending a single session over a 12 month period and not returning to a session over the 12 month tracking period.
Mills et al, 1997. U.S [28]	Explores activity preference in relation to activity adoption and maintenance.	Exploratory intervention study	N=98 (mean age=76) 81% women, 92% white Caucasian fairly healthy community dwelling	CHAMPS programme, intervention promoting exercise including conditioning classes, provided counselling, follow-up calls, monthly group meetings, for 6 months	**Measure:** Self-report activity logs, a sample of the most popular class registers were used to validate attendance. Maintained participation, described as attending at least one class a month, assessed through self-report, but validated by

			sheltered housing.		attendance records
Williams and Lord, 1995. Australia. [20]	Whether psychological, physiological, and health and lifestyle measures were associated with adherence to a structured exercise programme for older women	Exploratory intervention study	N=102 (mean age=71.6) 100% women no ethnicity stated healthy community dwelling	5 multi-component classes, 1 hour twice a week for 12 month trial.	**Measure:** Adherence was defined as the number of exercise classes attended. **Dropout:** used to describe participants who withdrew from the formal exercise programme.
Hickey et al, 1995. U.S [32]	Effectiveness of low-intensity physical activity for improving functional ability and psychological well-being in chronically impaired older individuals Exploring initiating and maintaining an exercise programme for physically inactive persons who are limited by chronic impairments	Exploratory intervention study	N=90 (mean age=72.6) 94% female 52% white Caucasian 48% black chronically impaired, sedentary, senior centres	4 structured low-intensity exercise classes, 2 times a week by instructor for 6 weeks, followed by peer led group with instructor support up to 18 weeks.	**Measure:** Adherence if they attended two thirds of the sessions.
Howze et al, 1989. U.S [34]	Examines factors affecting the adoption of regular	Exploratory multiple intervention	N=47 (mean age= 65.3), mixed gender,	Multi-component exercise programme. Running for 1 month	**Measures:** Number of attendances. High attenders categorised as 15/20 sessions, low

	exercise by sedentary older adults	percentage not stated. 100% white Caucasian healthy community, middle class.	before data collection (no further detail about classes).	attenders were less than 15/20.

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Page 2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Page 4-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	N/A as not a systematic review
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Page 6-7 where appropriate
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Page 5-6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	This can be offered as additional information if required.
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Page 7 and Figure 1 where applicable
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Page 6

PRISMA 2009 Checklist

Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Page 7
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	N/A
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A- qualitative synthesis of results as about measurement not outcomes.

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	See figure 1. Also Page 8
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Presented in table 1 where applicable.
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	N/A as about measurement not outcomes
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see item 15).	N/A

PRISMA 2009 Checklist

Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Where appropriate from page 11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Page 13-14.
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Pages 11-14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Page 15

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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