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Effectiveness and characteristics of physical fitness training on aerobic fitness in vulnerable older adults: an umbrella review of systematic reviews

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ABSTRACT

Objectives To present an overview of effectiveness and training characteristics of physical training on aerobic fitness, compared with alternative or no training, in adults aged over 65 years with various health statuses, providing a basis for guidelines for aerobic training of vulnerable older adults that can be used in geriatric rehabilitation.

Design An umbrella review of systematic reviews that included both randomised controlled trials and other types of trials.

Data sources MEDLINE, Embase, CINAHL and the Cochrane Library were searched on 9 September 2019.

Eligibility criteria for selecting studies We included systematic reviews reporting on physical training interventions that are expected to improve aerobic fitness, presenting results for adults aged 65 years and older, describing at least one of the FITT-characteristics: Frequency, Intensity, Time or Type of exercise, and measuring aerobic fitness at least before and after the intervention.

Data extraction and synthesis Two independent reviewers extracted the data and assessed the risk of bias. A narrative synthesis was performed.

Results We included 51 papers on 49 reviews. Positive effect of training on aerobic fitness was reported by 33 reviews, 11 reviews remained inconclusive and 5 reviews reported no effect. Training characteristics varied largely. Frequency: 1–35 sessions/week, Intensity: light–vigorous, Time: <10–120 min/session and Types of exercise: many. The methodological quality was most often low. Subgroup analyses revealed positive effects for all health conditions except for trauma patients. Exercise characteristics from current existing guidelines are widely applicable. For vulnerable older adults, lower intensities and lower frequencies were beneficial. Some health conditions require specific adjustments. Information on adverse events was often lacking, but their occurrence seemed rare.

Conclusion Physical fitness training can be effective for vulnerable older adults. Exercise characteristics from current existing guidelines are widely applicable, although lower frequencies and intensities are also beneficial. For some conditions, adjustments are advised.

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STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This review of systematic reviews provides a summary of the scientific literature on training of aerobic fitness in older adults with a wide variety of health statuses.
⇒ This review focuses on training characteristics, effects of aerobic fitness and adverse events.
⇒ The narrative analyses does justice to the diversity of vulnerabilities in older adults.
⇒ An important challenge is the interpretation of the large variety of interventions, outcomes and description of the training characteristics within the studies.

INTRODUCTION

Geriatric rehabilitation can be defined as diagnostic and therapeutic interventions aimed at restoring functional ability or enhancing residual physical function in vulnerable older people with disabling impairments.[1 2] Patients in geriatric rehabilitation are vulnerable with regards to their health status, typically characterised by a wide range of frailty, comorbidity and disability.[1–3] Ageing is associated with physiological changes that result in reductions in functional capacity, such as a reduction in aerobic fitness and in muscle performance.[3 4] This deterioration can be a cause of disabling impairments, but hindering functional recovery. Therefore, the training of functional capacity can be considered an essential focus for geriatric rehabilitation.[5 6] An important element of functional capacity is aerobic fitness, that is, the ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity. This can be improved through a number of therapeutic interventions such as walking, rowing and cycling.[7]

There are several international guidelines that provide exercise recommendations for improving aerobic fitness in healthy (older) adults or in adults with a specific disease or condition.[4 7–12] In general, these recommendations are based on the training principle of progressive overload. This principle implies that training should impose a greater load on the body than it is normally accustomed to and should increase throughout a training programme.[7] Exercise below a minimum training load will not challenge the body sufficiently enough to result in increased physical fitness.[8] This relation between training load and gain in physical fitness is not linear. Training itself has a ceiling effect: the closer the patients' fitness approaches their personal ceiling, the greater the training intensity needed for improvement. Conversely, if the training load is too high, it can lead to adverse effects, for example, a decrease in training effect, myocardial infarction and in extreme cases, sudden cardiac death.[13–16] It is thus important to find the optimal equilibrium between under-training and over-training.

Training load is determined by the Frequency, Intensity and Time of training.[17] Together with the Type of exercise performed, these characteristics are referred to as the FITT-characteristics, which are used for exercise prescription. Exercise intensity, for example, expressed as the proportion of maximal oxygen uptake, is the most important of these four characteristics as it has the largest influence on the training load and, therefore, on the exercise dose. Frequency refers to how often the exercise is performed, usually represented in the number of sessions per week. Time is the length of the physical activity, typically expressed in minutes per session. The Type of exercise refers to the specific physical activity performed, such as walking or swimming.[7]

Although guidelines provide a multitude of exercise recommendations, they lack specific recommendations on aerobic exercise for the vulnerable group of patients in geriatric rehabilitation. These patients often face problems regarding frailty, comorbidity or disability, and their interaction.[3] Further, the underlying problems are wide-ranging. It is unclear whether and how the FITT-characteristics of, for example, the American College of Sports Medicine (ACSM), apply to this group. This is important as application of inappropriate FITT-characteristics may lead to adverse events or to suboptimal training, resulting in the inadequate recovery of independence.[8 18] As well as a lack of specific training guidelines for vulnerable older adults, an overview of the evidence with regards to physical fitness training in vulnerable older adults is also lacking. Currently, there are several reviews available reporting on the effect of physical fitness training on aerobic fitness in healthy older adults,[9 19] or in older patients with specific diagnoses.[20–22] The combination of the body of evidence of such systematic reviews regarding both healthy and impaired older adults might help to improve the exercise prescription in vulnerable older adults who are undergoing geriatric rehabilitation. Therefore, the research questions for this study are:

1. What is the effect of physical fitness training on aerobic fitness outcomes compared with alternative or no training in adults over 65 years old with various health statuses?
2. What are the training characteristics in studies that showed an improvement in aerobic fitness in adults over 65 years old?

METHODS

Design

An umbrella review was performed[23] and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[24] Before the start of the study, a review protocol was created and registered at the PROSPERO International Prospective Register of Systematic Reviews, that is provided in online supplemental file A. Deviations from the protocol are reported in relevant parts of this methods section.

Data sources

We performed a systematic computerised search to identify systematic reviews reporting on the effect of physical fitness training on aerobic fitness in older adults. Four electronic databases were searched from their inception: MEDLINE, Embase, CINAHL and the Cochrane Library. The search strategy for MEDLINE is provided in online supplemental file B. We adapted the search strings accordingly for the other databases. The search was conducted on 9 September 2019.

Eligibility criteria

We included reviews that met all of the following criteria: (1) the review was a systematic review, according to our minimal criteria that the search strategy and inclusion and exclusion criteria were described; (2) the reported intervention was physical training that was expected to improve aerobic fitness; (3) the review had to present results for adults aged 65 years and older; (4) the description of the intervention contained at least one of the FITT-characteristics: Frequency, Intensity, Time or Type of exercise; (5) aerobic fitness was measured at least before and after the intervention.

The design of the studies included in the systematic reviews could be either randomised controlled trials (RCTs) or other types of studies (non-RCTs), such as before–after studies, non-randomised or quasi-randomised trials. We did this to ensure that we did not miss relevant studies on vulnerable patients for which RCT designs may not be feasible. We only included reviews published in English, with no restrictions on publication year.

Data extraction and synthesis

Two investigators (DV and EBS) independently reviewed the titles and abstracts. Potentially relevant articles were identified and the full texts were retrieved for independent assessment using the inclusion criteria. Any disagreements were resolved by consensus or in consultation with a third reviewer (KHLG) when necessary. The validated Joanna Briggs Institute Data Extraction Form for Systematic Reviews and Research Syntheses was used and adapted for data extraction.[23] Data from each included systematic review were extracted independently by both reviewers (DV and EBS). Results were compared and any discrepancies were resolved through discussion. We tabulated review characteristics, such as participants, setting, number of included studies and review results, such as effect of training on aerobic fitness, and training characteristics using the FITT-characteristics.[7] Our primary outcome was aerobic fitness by any measure, for example: VO_2max and VO_2peak,[25] 6-min walk test (6MWT),[26] endurance capacity with Graded Exercise Testing,[27] exercise tolerance with a BORG scale,[28] heart rate response during a graded or incremental exercise test and its recovery[29] and muscle fatigue measured as the decline in maximal power and electromyography activity after an incremental exercise test.[30]

The methodological quality of each included review was assessed independently by the two reviewers (DV and EBS), using the second version of 'A MeaSurement Tool to Assess systematic Reviews' (AMSTAR 2).[31] The results of the quality assessment were compared and any discrepancies were resolved through discussion.

A narrative synthesis was used to describe the characteristics of aerobic fitness training and the effect on aerobic fitness in older or frail patients. A narrative analysis enables us to handle the expected large variety in health statuses, interventions and outcomes. For the evaluation of the effect on aerobic fitness, reviews were classified into one of the following categories: 'positive effect', 'negative effect', 'inconclusive' or 'no effect', depending on the effect on aerobic fitness outcomes, such as VO_2max or 6MWT. Reviews, both meta-analyses and narrative reviews, were classified as 'positive' if all of the comparisons, or at least all of the comparisons with non-exercise controls, had a statistically significant positive result. Reviews with narrative analyses were also classified as 'positive' if at least 75% of the included comparisons had a statistically significant positive result. The same criteria (in the other direction) were used for classifying reviews as 'negative'. Reviews, both with meta-analyses and with narrative analyses, were classified as having 'no effect' if none of the comparisons had a statistically significant effect. Further, reviews were classified as 'inconclusive' if the comparisons returned mixed results: some statistically significant positive results alongside not significant results. This classification of reviews was not described in-depth in the PROSPERO protocol.

In addition, two subgroup analyses were performed. The first focused on reviews that specifically reported on dose-response relationships of aerobic fitness interventions to explore optimal training characteristics of aerobic fitness. This was not explicitly stated in the PROSPERO protocol, but was added as further insights into dose effects are important for optimal exercise prescription. The second, predefined subgroup analysis explored the effects of aerobic fitness training in groups with specific health statuses or diagnoses, such as trauma patients and patients with respiratory diseases. In this second analysis, only reviews with complete FITT-characteristics and with a risk of bias analysis were included. In the analyses of smaller subgroups, the reviews with incomplete reporting of FITT-characteristics could represent an inaccurate picture as it is unknown if the not-reported FITT-characteristics are within the range of the other reviews in the same subgroup. Moreover, we exclude studies with an unknown risk of bias as it is impossible to judge the quality of these studies in the analyses.

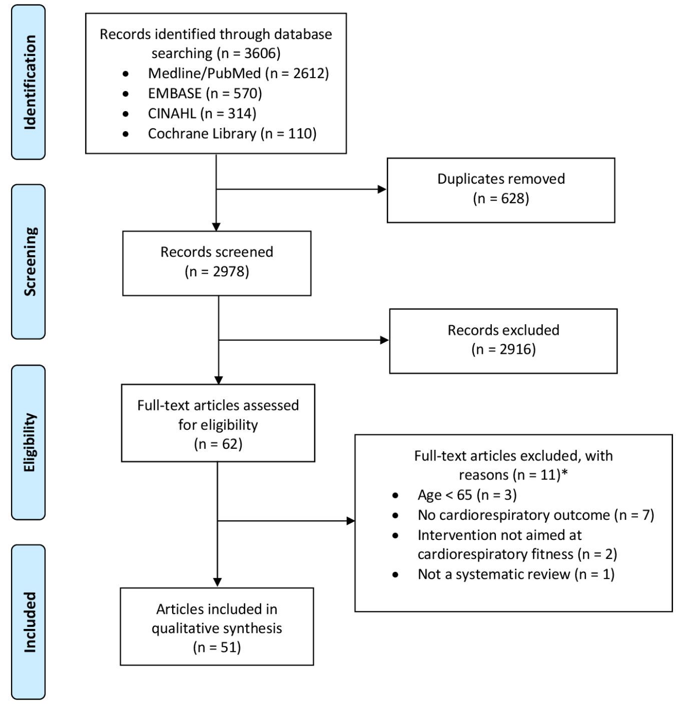

Figure 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) study flowchart. Full-text articles could be excluded for more than one reason, an overview per article can be found in online supplemental appendix 4. Adapted form Moher *et al*.[84]

Patient and public involvement

No patient involved.

Data sharing statement

All data relevant to the study are included in the article or uploaded as supplementary information.

RESULTS

The PRISMA flowchart can be found in figure 1. It shows that 2978 records were screened and 62 articles were assessed for full-text analysis. We finally included 51 articles in the narrative synthesis, of which 3 were based on the same data, leaving 49 individual systematic reviews for analysis.[15 19–22 32–77] Online supplemental file C shows the characteristics of the included reviews, and online supplemental file D describes the interventions and a summary of the evidence from the included reviews. A list of excluded reviews is presented in online supplemental file E.

Quality assessment

The quality of included reviews is presented in online supplemental file F. According to the AMSTAR 2 ratings, sources of bias were, for example, lacking a report of a Patient group, Intervention condition, Comparison condition and Outcome(s) (PICO) (14 reviews), no reported protocols prior to the start of the study (35 reviews) and no adequately explained decision to include RCTs, non-RCTs or their combination (44 reviews). Other sources of bias were: an incompletely described or incomprehensive literature search strategy (45 reviews) and the absence of a list of excluded studies in 41 reviews. A risk of bias analysis was performed in 40 reviews, but in only 13 did the authors take this risk of bias into account when discussing their results.

Participants

The total number of participants was 28 085 with a median number of 399 and a range of 92–5230 participants per review. Only one review did not report the number of included patients. Due to large differences in reporting methods, we were not able to calculate a mean age for all of the participants. However, the mean age per review, at least for the subgroup of studies that reported on aerobic fitness outcomes, was at least 65 years. Gender was reported in only half of the included reviews. Reviews differed largely with respect to the health conditions of the studied population, varying from healthy participants to frail, hospitalised or institutionalised participants and many reviews focused on patients with specific diseases, such as heart failure or chronic obstructive pulmonary disease (COPD). The experimental setting was unclear in the majority of studies. The settings that were reported mainly concerned community-dwelling older adults and, to a lesser extent, institutionalised patients, hospitalised patients or a mixed group.

Characteristics of the interventions

Of the included reviews, 30 reported on all of the FITT-characteristics of the underlying intervention studies. The frequency of interventions ranged from one session per week to five sessions per day. The exercise intensity was measured in several ways, for example, via estimated heart rate value, a percentage of the maximum workload or walking speed or a predefined experienced exertion. The duration of training sessions lasted from several minutes to 120 min per session. The most common type of intervention was a mixed aerobics exercise programme. Mixed programmes were either combinations of different aerobic exercises or aerobic exercises combined with alternative forms of training, such as strength training. Walking and cycling were usually the major aerobic components in these mixed programmes. Both were also widely used as single interventions. Other interventions consisted of: dancing, Pilates, interactive gaming, Nordic walking and rowing. The total duration of programmes ranged from 4 days to 2 years.

Outcome measures

Twenty-three of the included reviews reported multiple outcome measures of aerobic fitness, mainly a combination of distance covered (in metres) on various walking tests and VO_2 max or VO_2peak, which were both measured in different ways. The distance covered during walking tests was reported as the sole outcome measure of aerobic fitness for 16 reviews, and the VO_2max or VO_2peak was the sole outcome measure in 8 reviews. In the remaining two reviews, the outcome measure was not specified. Further, less commonly used outcome measures were time to reach a predefined rate of perceived exertion and the peg-and-ring test, among others.

Effect of physical training on aerobic fitness

The effect of training on aerobic fitness is displayed in table 1. Twenty-nine reviews contained a meta-analysis. Twenty-two of these reviews were classified as having a 'positive effect', three were 'inconclusive' and four were classified as having 'no effect'. Of the narrative reviews, 11 reviews were classified as having a 'positive effect', 8 were 'inconclusive' and only 1 showed 'no effect'. None of the reviews was classified as having a 'negative effect'.

Subgroup analysis: dose-response relationships

Four reviews reported that they could not draw conclusions about dose-response relationships.[36 37 41 48] One review found no dose-response relationships between physical training and aerobic capacity in older patients with heart failure.[75] Three publications, by the same authors and all based on the same 41 underlying studies, reported on dose-response relations of cardiorespiratory interventions in sedentary older adults.[51–53] In their most recent review, they concluded that a maximal gain in VO_2max could be induced by aerobic training at a mean intensity of 66%–73% of heart rate reserve (HRR), when engaging in 40–50 min per session for 3–4 days per week for 30–40 weeks. The older adults began attaining VO_2max improvements at lower training intensities of 35%–50% of HRR, and at a training length of at least 20–24 weeks. The studies in these reviews are 23 RCTs and 18 non-RCTs. The authors did not account for a risk of bias when interpreting the results.

Subgroup analyses: categories with specific health status or diagnosis

The reviews with complete FITT-characteristics and with a risk of bias analysis could be divided into nine categories according to health status or diagnoses of their participants: (healthy) older adults (N=1), frail older adults (N=2), older adults hospitalised for an acute medical illness (N=1), cardiovascular disease (N=5), cognitive disorders (N=2), oncological disease (N=3), respiratory disease (N=7) and trauma (N=1). Three studies, reporting on participants with mixed conditions, were not included

Table 1 Effect of aerobic fitness training according to health status or diagnosis

	(Healthy) older adults	Frail older adults	Hospitalised after critical illness	Cardiovascular disease	Cognitive impairment	Metabolic disease	Oncological disease	Respiratory disease	Trauma	Mixed*	Total
MA: positive effect for all comparisons	3 [40 52 65]			5 [22 44 45 69 75]	1 [58]	1 [46]	1 [72]	4 [21 59 63 67]		3 [37 49 50]	**18**
MA: positive effect, only for comparisons with non-exercise controls	1 [19]			1 [42]						2 [41 70]	**4**
NAn: positive effect for all studies	2 [38 54]	1 [47]		1 [60]	2 [36 48]						**6**
NAn: positive effect, only for all studies with non-exercise controls								1 [76]			**1**
NAn: positive effect for >75% of all studies		1 [33]	1 [55]			1 [39]				1 [71]	**4**
Subtotal positive results	*6*	*2*	*1*	*7*	*3*	*2*	*1*	*5*	*0*	*6*	***33***
MA: inconclusive				1 [66]				2 [43 61]			**3**
NAn: inconclusive		2 [35 73]	1 [74]	2 [64 77]			3 [15 20 56]				**8**
Subtotal inconclusive results	*0*	*2*	*1*	*3*	*0*	*0*	*3*	*2*	*0*	*0*	***11***
MA: no effect	1 [68]			1 [32]				1 [62]	1 [57]		**4**
NAn: no effect		1 [34]									**1**
Subtotal not significant results	*1*	*1*	*0*	*1*	*0*	*0*	*0*	*1*	*1*	*0*	***5***
Total	**7**	**5**	**2**	**11**	**3**	**2**	**4**	**8**	**1**	**6**	**49**

*Reviews of studies with multiple health conditions/diagnoses, for example, with healthy and frail participants and participants with impaired balance.
MA, meta-analysis; NAn, narrative analysis.

in this analysis. For each review, the intervention and the summary of results is presented in online supplemental file D. In this file, the reviews that are included in this subgroup analysis are highlighted in italics.

(Healthy) older adults

One review reported on (healthy) older adults.[19] This study showed positive effects on VO_2peak and 6MWT from combined aerobic and strength training, compared with non-exercise controls. Two to three sessions per week were given, with light-to-vigorous intensity for 30–90 min. Total duration of the programme varied from 6 to 52 weeks.

Frail older adults

Two reviews included frail older people,[33 73] with one showing a positive effect,[33] while the other was inconclusive.[73]

Older adults hospitalised for acute medical illness

One review reported on older adults hospitalised for an acute medical illness and showed positive results.[55] Almost all of the FITT-characteristics showed broad ranges.

Cardiovascular diseases

The group of cardiovascular diseases consisted of patients after heart surgery, with peripheral arterial disease or with an abdominal aortic aneurysm.[45 64 66 69 77] Two reviews focused on patients after heart surgery. One found a positive effect on aerobic fitness after the training programme in an uncontrolled before–after study.[69] The other review on heart surgery patients showed inconclusive results from *additional* aerobic or resistance training added to standard aerobic cardiac rehabilitation.[66] Two reviews investigated peripheral artery disease, of which one reported a positive effect and the other inconclusive results. One review showed positive effects on (pain-free) walking distance after a training programme consisting of walking at an intensity that evoked severe claudication pain.[45] Another review demonstrated inconclusive results both in walking tests and in VO_2peak compared with non-exercise controls, and no effect when aerobic exercise was compared with other types or intensities of exercise.[64] Both the type and intensity of the training differed from the positive review: the types consisted of (treadmill) walking, lower limb aerobics, pole striding and arm cranking at a vigorous intensity or at an intensity that evoked moderate-to-maximum claudication pain.[64] One review reported on the effect of preoperative exercise for patients with an abdominal aortic aneurysm and showed inconclusive results.[77]

Cognitive disorders

Both reviews showed a positive effect on walking tests.[36 58] The severity of cognitive disorders varied from mild cognitive impairment to dementia. Blankevoort *et al* reported better outcomes for programmes with a longer duration,[36] and Lam *et al* showcased an effective increase in training in studies with an intensity of 30%–60% of VO_2max or 40% HRR that gradually progressed to 85%.[58]

Oncological diseases

One review reported a positive effect in patients with prostate cancer.[72] The other two reviews had inconclusive findings for patients with colorectal cancer[20] and small-cell lung cancer.[15] The review showcasing a positive effect seemed to have a higher frequency and intensity than the inconclusive reviews.

Respiratory disease

The group concerning respiratory diseases consisted of patients with COPD, non-cystic fibrosis bronchiectasis or non-malignant, dust-related respiratory diseases.[21 43 59 61–63 76] Five reviews studied patients with moderate-to-severe COPD. Positive effects on aerobic fitness were found for aerobic training both in patients with stable COPD and in patients shortly after an exacerbation, and both for home-based and for outpatient rehabilitation.[21 63 76] The effect of (additional) resistance training is not clear; one review showed an inconclusive effect,[61] while another study showed no statistically significant effect.[62] The review on non-cystic fibrosis bronchiectasis was judged to be inconclusive, with positive effects on 6MWT but no effect on VO_2max.[59] The review on patients with non-malignant, dust-related respiratory disease demonstrated positive effects.[43]

Trauma patients

The last category consisted of trauma patients with hip fractures in one review.[57] Low-frequency and moderate intensity programmes showed no effect on aerobic fitness.

Adverse events

Twenty reviews intended to report on adverse events, but they all concluded that there was a lack of information on adverse events in the underlying studies.[15 21 22 34–37 41 43–45 50 58 60 62 65 67 70 72 76] Of these 20 reviews, 9 reviews either found no adverse events[21 34 36 43 60 62 72] or no difference in the presence of adverse events, compared with non-exercise controls.[22 45] Seven reviews reported no serious[35 41 44 76] or very few[15 58 67] adverse events. One review reported serious adverse events that occasionally resulted in discontinuation of the exercise and even resulted in one death.[37] The training programmes described in this review were for individuals with severe hypertension, mixed diagnoses or patients with heart failure, and had a frequency of three sessions per week, lasting 20–60 min for a duration of 12–24 weeks and were of light-to-vigorous intensity.

Description of excluded studies

Eleven of the 62 full-text papers were excluded after assessment (figure 1). The most important reasons for exclusion in this phase were the lack of aerobic outcomes, a participant mean age of under 65, or a lack of a subgroup analysis for this age criterion (see online supplemental file E).

DISCUSSION

This umbrella review was set up to study the effectiveness and characteristics of physical fitness training on aerobic fitness in vulnerable older adults and included 51 papers on 49 individual systematic reviews (N=28 085 participants). The majority of the included reviews found a statistically significant positive effect of physical fitness training on aerobic fitness. We found a large heterogeneity in the reported FITT-characteristics of the included interventions. Only one review found dose-effect relations for healthy older adults. For almost all categories of researched health statuses, studies with positive effects of physical fitness training were found with some variation in the FITT-characteristics reported between the categories.

Comparison with current guidelines

For older adults, the ACSM published general recommendations for physical activity (in conjunction with the American Heart Association (AHA)),[9] and specific critical issues for exercise and training.[4] Guidelines for aerobic training in the position stand were derived from one of the papers based on the review of Huang *et al* that we included in this umbrella review. It states that 'aerobic exercise training programmes of sufficient intensity (>60% of pre-training VO_2max), frequency, and length (>3 sessions per week for 16 weeks) can significantly increase VO_2max in healthy middle-aged and older adults'.[4 52] Recently, expert guidelines were published for exercising in older adults, including slightly adjusted FITT-criteria and modality-specific adaptations.[12] Our review shows that for healthy older adults the guidelines of ACSM/AHA still apply to a great extent, although lower frequencies of two to three sessions per week are also beneficial.[19] Another finding from our review is that for most groups of older adults with impaired health, cardiorespiratory fitness can be improved with programmes that are offered less frequently and with less intensity than the ACSM/AHA guidelines prescribe.[19 21 33 36 45 58 63 69 76] This lower intensity is in line with the expert guidelines of Izquierdo *et al*.[12] Also in accordance with Izquierdo and colleagues, for the most vulnerable older adults, short sessions were most appropriate.[33 55] The latter raises the question as to whether training load is best determined by separate FITT-characteristics or whether it should be merged in an overarching measure that is based on an interdependency between Frequency, Intensity and Time. In such an overarching measure, the underlying FITT-characteristics can be adjusted to a patient's needs as long as the combination of the characteristics meets the conditions of the overarching measure.[78]

Adverse events

Due to a lack of information on adverse events in the reviews, no firm conclusions can be drawn about safety, although the available information indicates that serious adverse events rarely occur.

Interpretation of results in the context of physiological principles of training

Aerobic fitness is the ability of the circulatory and respiratory systems to supply oxygen to the tissues. The transport of oxygen consists of several steps from ventilation of the alveoli to extraction of the oxygen from the blood at the tissue level.[79] In normal ageing, changes in the respiratory, cardiovascular and musculoskeletal systems lead to a decrease in aerobic fitness[4] that can be enhanced by specific health conditions. Impairment of one step in the aerobic pathway may be compensated by other steps. This means that the training of aerobic fitness in vulnerable older adults can focus on either improvement of impaired steps in the oxygen transport pathway, or on improvement of other, compensating steps.[79] An example of a mechanism of improvement of the impaired step is seen in the reviews concerning peripheral artery disease, where training at an intensity that induces severe claudication pain seems to be more beneficial for increasing (pain-free) walking distance than training at a moderate pain level or at a certain percentage of VO_2max.[45 64] Intensity beyond the pain threshold may lead to an increase in the local production of collateral blood vessels.[80] An improved vascularisation of the lower limbs leads to an increase in the oxygen delivery and thus contributes to improved aerobic fitness. The mechanism in which training focuses on the improvement of compensating steps is also expected for patients with COPD, where the lung function decrease is irreversible. Therefore, it is likely that training which emphasises improvement of cardiovascular or muscle functioning will be successful in improving aerobic fitness in this patient group.[80] From this perspective, it seems surprising that we only found inconclusive results for resistance training, with no effect on VO_2max and positive results on 6MWT and the peg-and-ring test. These results show that although the VO_2max cannot improve (due to irreversible lung damage), submaximal performance (6MWT, peg-and-ring test) can improve through compensating mechanisms.[81]

Our review shows that for frail older adults, short session durations, from as little as 8 min, are beneficial when they include both aerobic and resistance training. Most programmes were progressive in time or intensity. This suggests that the programmes were fit to the abilities of the frail older adults, and thus able to provide a suitable stimulus for improvement of aerobic fitness. The combination of aerobic and resistance training suggests that multiple steps in the aerobic pathway are trained leading to a general improvement of the aerobic pathway.

Another finding of our review is the fact that many reviews included studies with short intervention durations. A deeper exploration of those studies revealed improvements in aerobic fitness for interventions with a duration of less than 6 weeks (not reported in the results section). Generally, the cardiovascular system is the major limiting factor in aerobic fitness, and adaptations to the cardiovascular system are expected after at least 6 weeks.[82] The findings of the studies with short interventions in our

Box 1 Summary of the evidence

Healthy older adults
- ⇒ The guidelines of ACSM and AHA apply to a great extent, although lower frequencies of two to three sessions per week are also beneficial.
- ⇒ Optimal training programmes are three to four sessions per week, ranging from 40 to 50 min, for 32 to 36 weeks at a moderate-to-vigorous intensity of 66%–73% of HRR.

Vulnerable older adults: general
- ⇒ For almost all researched health conditions, aerobic fitness can improve through training.
- ⇒ High frequencies, short sessions and low intensity seem appropriate for *the most vulnerable older adults*. For example, after acute medical illness, heart surgery or exacerbation COPD.
- ⇒ For *most patient groups,* aerobic fitness can improve in programmes with a lower frequency and intensity than ACSM and AHA guidelines prescribe.

Vulnerable older adults: specific health conditions
- ⇒ For *frail older adults* aerobic fitness can improve in programmes with shorter sessions and programmes that consist of both aerobic and resistance training.
- ⇒ For *patients after cardiovascular surgery* and for *patients with COPD* there is no evidence that the addition of extra aerobic or resistance training to an aerobic training programme does improve cardiovascular fitness.
- ⇒ For *patients with peripheral artery disease* walking at an intensity that evokes severe claudication pain improves (pain-free) walking distance.
- ⇒ For *patients with non-malignant, dust-related diseases* low frequencies (two to three per week) and relatively short sessions (15–30 min) are advised.
- ⇒ For *patients with non-small-cell lung cancer* vigorous intensities are advised.
- ⇒ For *patients after trauma* training programmes with a low frequency, relatively short sessions and programme duration do not improve their cardiovascular fitness.
- ⇒ For *patients with abdominal aortic aneurysm* there is no evidence that exercise improves aerobic fitness.

ACSM, American College of Sports Medicine; AHA, American Heart Association; COPD, chronic obstructive pulmonary disease; HRR, heart rate reserve.

review suggest that in those patients the improvements in aerobic fitness are induced by capillary and/or mitochondrial adaptations that can be initiated within 14 days of endurance training.[83]

In box 1, we summarise our interpretation of the findings of this review, in comparison with the existing guidelines.

Strengths and limitations

An important strength of our review is our conceptual approach to the ‘geriatric rehabilitation population’. This population is characterised by a combination of older age and vulnerability, with a large degree of heterogeneity, which is difficult to operationalise within inclusion criteria. For that reason, we decided to use an age criterion (>65 years), and to include reviews with a large variety of health statuses, which may influence the degree of vulnerability. A second strength is the use of a narrative approach which enabled us to make the variety in the evidence visible, instead of reducing the evidence to a simplified number that may not be applicable to a specific situation. Through these choices, we aimed to do justice to the heterogeneity of vulnerability in older adults.

Our review has several limitations. First, there is significant heterogeneity among the designs of the studies included in the reviews, ranging from RCTs to studies without a control group. This results in evidence of varying scientific quality, including a great variety in the risk of bias. Second, in the subgroup analyses on categories with specific health statuses, we excluded the reviews with incomplete FITT-characteristics and the reviews without a risk of bias. This decision had the disadvantage that not all of the available evidence was used for our final conclusions of these subgroup analyses. Nevertheless, this decision led to better justified evidence. A third limitation is the fact that the reported training prescription may not always reflect the actual performed training. Authors should make an effort to report on these measures as well. A last limitation is the large variation of the interventions, the outcomes and the description of the FITT-characteristics across studies, in particular with regards to the intensity. Intensity is described with robust measures (such as percentage of VO_2peak, and their derivative measures, such as percentage of maximal heart rate), with measures that depend on multiple body functions (for example, a percentage of the speed on a given walking test) and lastly with measures that are hard to interpret or compare, such as ‘comfortable walking speed’ or an unspecified ‘moderate-to-high’ intensity.

Due to this large heterogeneity in intensity measures, it is difficult to ascertain which measure is the best representation of intensity of aerobic fitness training. Training should be based on an intensity that enforces physiological adaptations. For this purpose, the so-called ventilatory thresholds have been proposed, which represent the extent to which the aerobic system is able to meet the energy demand. The aerobic thresholds are dependent on aerobic fitness and can be used for safe and personalised exercise prescription.[79] These thresholds are not so much determined by a fixed percentage of, for example VO_2max, but require specialised equipment that is usually not available in exercise settings for vulnerable older adults. In just two of the reviews, were these thresholds used.[19 33] The development of easily accessible methods to establish the ventilatory thresholds could contribute to a more personalised prescription of exercise intensity.

Recommendations

Future research should focus on easily accessible methods that reflect relevant markers of aerobic exercise intensity more appropriately, such as based on the ventilatory thresholds, and on the feasibility of an overarching measure for training load that relates to the FITT-characteristics. The effect of aerobic training programmes with low frequencies combined with light intensities should be further assessed, and finally, effective aerobic training programmes for trauma patients (eg, after hip fracture) should be developed and investigated.

CONCLUSIONS

In conclusion, physical fitness training can be an effective intervention to improve aerobic fitness in older adults in general, and also in the majority of categories of older adults with specific health statuses or diagnoses, including the most frail and vulnerable older adults. The effective training characteristics of Frequency, Intensity, Time and Type comply to a great extent to the guidelines of the ACSM and the AHA. For vulnerable older adults, we found evidence that lower frequencies of two to three sessions per week and lower intensities were most beneficial, for most categories. For some conditions, specific adjustments to the FITT-characteristics are advised. These findings can be used for better exercise prescription for vulnerable older adults in general, and thus the specific group of patients in geriatric rehabilitation.

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Review question

1. What is the effectiveness of physical fitness training on cardiorespiratory fitness compared to other or no training in adults over 65 years old?

2. What are the training characteristics that are associated with significant effects on cardiorespiratory fitness in adults over 65 years old?

3. Which recommendations for physical fitness training for older people over 65 can be made as a result of this umbrella review?

Searches

PubMed, EMBASE, CINAHL and the Cochrane Library.

Search to be performed.

Language restriction: English only.

Types of study to be included

Systematic reviews

Condition or domain being studied

This review studies the effects of physical fitness training on the cardiorespiratory fitness of older adults. There are many guidelines for this type of training in adults. This is not the case with older adults. This makes it difficult to draw up a scientifically based program for this type of training in geriatric rehabilitation. This review is a first step in the development of recommendations for physical fitness training for older adults.

Participants/population

The included review must present results of at least a subgroup of older adults aged 65 and older. There are no other criteria with regard to the population.

Intervention(s), exposure(s)

Physical fitness training aimed at improving or maintaining cardiorespiratory fitness.

Comparator(s)/control

The studies included in the included systematic reviews may be either randomised, quasi-randomised, non-randomised, or without a control intervention.

Context

Inclusion criteria:

- We will include systematic reviews of intervention studies. Reviews will be classified as systematic if they at least fulfill the following criteria: description of a search strategy and in- and exclusion criteria. The studies included in the included systematic reviews may be either randomised, quasi-randomised, non-randomised, or without a control intervention.Cardiorespiratory fitness is measured at least before and after the intervention

- The intervention is a physical training that is expected to improve cardiorespiratory fitness

- The description of the intervention must contain at least one of the following: Frequency, Intensity, Time or Type of exercise

Exclusion criteria:

- Systematic review does not report an intervention

- Insufficient description of the intervention in the systematic review

- No cardiorespiratory outcomes

Main outcome(s)

The outcome numbers correspond with the research questions.

1. The described outcomes are focused on fitness and have been measured at least twice so that they actually show the effect of the training on fitness. Think of:

a. Cardiorespiratory function:

i. Heart rate response

ii. VO2 max

iii. VO2 peak

iv. Muscle fatigue

b. Performance:

i. 2/4/6 Minute Walking Test

ii. Endurance capacity

iii. Exercise tolerance

c. Any other outcome measure that describes cardiorespiratory fitness

2. Training characteristics will be described using Frequency, Intensity, Time and Type of exercise (FITT-criteria).

Measures of effect

None

Additional outcome(s)

Quality of the reviews

Measures of effect

Not applicable

Data extraction (selection and coding)

1. Two reviewers (DV, EBS) independently screen titles and abstracts of the full list and agreement has to be reached before the article will be subjected to a full-text assessment. In case, an article is only selected by one reviewer a discussion will take place between the two reviewers to determine whether the study should be selected for a full-text analysis. In the case that consensus cannot be reached than the article will be included for full text analysis.

2. Next, both reviewers independently assess the full text of the selected articles. In case, an article is only selected by one reviewer a discussion will take place between the two reviewers to determine whether the

study should be included in the review. A third reviewer (HLG) will be consulted in case that the two reviewers cannot reach consensus on inclusion. .

3. The two reviewers independently assess the review quality and extract the data from each included review. The results of the quality assessment and data extraction will be compared and discrepancies will be resolved through discussion.

4. The methodological quality of the reviews will be determined by A MeaSurement Tool to Assess systematic Reviews (AMSTAR 2)?

5. The validated JBI Data Extraction Form for Systematic Reviews and Research Syntheses* will be used for data extraction. Two authors will independently undertake this process. Characteristics of studies will be tabulated as:

a. Review characteristics: author/year, objectives, participants (characteristics/total number), setting/context, interventions of interest, number of databases/sources searched, date range of included studies, number of total studies included, detailed description of the included primary studies related to healthy eating promotion (number/type of studies/country of origin), appraisal instrument and rating, method of analysis and outcomes assessed; and

b. Review Results:

i. Effect of training on cardiorespiratory fitness

ii. Training characteristics using the FITT-criteria

*Aromataris E, Munn Z (Editors). Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute, 2017. Available from https://reviewersmanual.joannabriggs.org/

Risk of bias (quality) assessment

A MeaSurement Tool to Assess systematic Reviews 2 (AMSTAR 2)*.

*Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, Moher D, Tugwell P, Welch V, Kristjansson E, Henry DA. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ. 2017 Sep 21;358:j4008.

Strategy for data synthesis

No meta-analysis will be performed. Due to the expected large differences between the different groups of elderly people and the different types of physical fitness training, these will not be sufficiently comparable. Therefore we will use a narrative synthesis to describe the results of the included reviews on the effect of training and the training characteristics including FITT-criteria (see question #26). The results of the quality assessment will also be reported in this synthesis. There are no limitations to the data synthesis, this mean that there will not be a minimal number of systematic reviews as well as number of studies in the included reviews. Furthermore, data synthesis will include studies of all quality levels, however the risk of bias and its impact on the data synthesis will be reported.

Analysis of subgroups or subsets

If sufficient articles are found, the results may be broken down by patient group (for example stroke patients or patients after an orthopedic procedure). The results will be described in the same way as stated under the heading data extraction, only per patient group.

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Type and method of review

Intervention, Narrative synthesis, Review of reviews, Systematic review

Anticipated or actual start date

08 May 2019

Anticipated completion date

08 May 2020

Funding sources/sponsors

ZonMw (national funding body for medical research)

Postbus 93245

2509 AE Den Haag

Projectnumber: 839120007

Gerion (educational institute for the training of elderly care physicians)

Postbus 7057

1007 MB Amsterdam

Conflicts of interest

None known

Language

English

Country

Netherlands

Stage of review

Review Ongoing

Subject index terms status

Subject indexing assigned by CRD

Subject index terms

Adult; Cardiorespiratory Fitness; Exercise; Humans; Physical Fitness

Date of registration in PROSPERO

13 March 2020

Date of first submission

12 July 2019

Stage of review at time of this submission

Stage	Started	Completed
Preliminary searches	Yes	No
Piloting of the study selection process	Yes	No
Formal screening of search results against eligibility criteria	No	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

The record owner confirms that the information they have supplied for this submission is accurate and complete and they understand that deliberate provision of inaccurate information or omission of data may be construed as scientific misconduct.

The record owner confirms that they will update the status of the review when it is completed and will add publication details in due course.

Versions

13 March 2020

SUPPLEMENTARY FILE B. SEARCH STRATEGY IN PUBMED

#1 Frail elderly
"Aged"[Mesh] OR "Geriatric Psychiatry"[Mesh] OR "Geriatric Nursing"[Mesh] OR "Health Services for the Aged"[Mesh] OR "Geriatric Assessment"[Mesh] OR "Alzheimer Disease"[Mesh] OR "Dementia"[Mesh] OR frail*[tiab] OR elder*[tiab] OR eldest[tiab] OR geriatri*[tiab] OR old age*[tiab] OR oldest old*[tiab] OR senior*[tiab] OR senium[tiab] OR very old*[tiab] OR septuagenarian*[tiab] OR octagenarian*[tiab] OR octogenarian*[tiab] OR nonagenarian*[tiab] OR centarian*[tiab] OR centenarian*[tiab] OR supercentenarian*[tiab] OR older people[tiab] OR older subject*[tiab] OR older patient*[tiab] OR older age*[tiab] OR older adult*[tiab] OR older man[tiab] OR older men[tiab] OR older male*[tiab] OR older woman[tiab] OR older women[tiab] OR older female*[tiab] OR older population*[tiab] OR older person*[tiab] OR ageing[tiab] OR community dwelling[tiab] OR "mini mental state"[tiab] OR alzheimer[tiab] OR alzheimer's[tiab] OR alzheimers[tiab] OR mmse[tiab] OR gds[tiab] OR dementia[tiab] OR demented[tiab] OR psychogeriatrics[tiab]

OR

Setting: Hospital, nursing home, homecare etc.
"Hospitals"[Mesh] OR "Nursing Homes"[Mesh] OR "Home Care Services"[Mesh] OR "Housing for the Elderly"[Mesh] OR "Senior Centers"[Mesh] OR "Ambulatory Care"[Mesh] OR "Institutionalization"[Mesh] OR "Long-Term Care"[Mesh] OR "Hospitalization"[Mesh] OR hospital*[tiab] OR home[tiab] OR homes[tiab] OR housing[tiab] OR Community Health Service*[tiab] OR communit*[tiab] OR senior center*[tiab] OR senior centre*[tiab] OR outpatient*[tiab] OR ambulatory[tiab] OR Institution*[tiab] OR "Long-Term Care"[tiab] OR Hospitalization[tiab] OR Hospitalisation[tiab]

#2 Physical fitness
"Gymnastics"[Mesh] OR "Physical Conditioning, Human"[Mesh] OR "Running"[Mesh] OR "Swimming"[Mesh] OR "Walking"[Mesh] OR "Sports"[Mesh] OR "Physical Exertion"[Mesh] OR "Exercise Therapy"[Mesh] OR "Exercise Movement Techniques"[Mesh] OR Motor Activit*[tiab] OR Physical Activit*[tiab] OR Locomotor Activit*[tiab] OR Exercis*[tiab] OR Physical Exercis*[tiab] OR Aerobic Exercis*[tiab] OR training[tiab] OR Physical Condition*[tiab] OR Physical fitness[tiab] OR Physical endurance[tiab] OR movement therap*[tiab] OR fitness training[tiab] OR Weight-Bearing[tiab] OR running[tiab] OR jogging[tiab] OR walk*[tiab] OR bicycle[tiab] OR cycle[tiab] OR bicycling[tiab] OR cycling[tiab] OR rowing[tiab] OR swim*[tiab] OR ambulation[tiab] OR step[tiab] OR steps[tiab] OR treadmill[tiab] OR skate*[tiab] OR skating[tiab] OR handbike*[tiab]

#3 Outcome (muscle strength, cardiovascular fitness, endurance etc.)
"Muscle Fatigue"[Mesh] OR "Physical Endurance"[Mesh] OR “Physical Fitness”[Mesh] OR "muscle fatigue"[tiab] OR "muscular fatigue" [tiab] OR “muscle morphology”[tiab] OR Physical Endurance*[tiab] OR Anaerobic Threshold*[tiab] OR "exercise tolerance"[tiab] OR “muscle fatigue”[tiab] OR “physical Endurance”[tiab] OR “fatigue resistance”[tiab] OR “physical fitness”[tiab] OR “aerobic capacity”[tiab] OR “VO2peak”[tiab] OR “VO2max”[tiab] OR “HR responses”[tiab] OR

Visser D, *et al. BMJ Open* 2022; 12:e058056. doi: 10.1136/bmjopen-2021-058056

“heart rate response”[tiab] OR “aerobic fitness”[tiab] OR “endurance”[tiab] OR “cardiovascular function”[tiab] OR “cardiovascular fitness”[tiab] OR “cardiorespiratory function”[tiab] OR “cardiorespiratory fitness”[tiab] OR “2 min walk test”[tiab] OR “4 min walk test”[tiab] OR “6 min walk test”[tiab]

#4 Review humans/ humans
(("Review Literature as Topic"[Mesh] OR "Review"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR review[tiab] OR meta-analys*[tiab] OR "Meta-Analysis "[Publication Type] OR systematic[sb]) NOT ("Letter"[Publication Type] OR "Editorial"[Publication Type] OR "Comment"[Publication Type]))

NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms])

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SUPPLEMENTARY FILE C: CHARACTERISTICS OF ALL INCLUDED REVIEWS

Article author year	Objective	No. of databases/ sources searched Date range of included studies	Participants	Intervention of interest Control Conditions	No. of included studies/total no. of studies in the review Method of analysis Outcome measure(s) Appraisal instrument
Ada 2010	To examine the beneficial and harmful effects of mechanically assisted walking with body weight support in subacute, non-ambulatory patients after stroke in the short and the long term. Cardiorespiratory fitness is a secondary outcome.	n=4 2006 - 2010	Stroke patients in inpatient rehabilitation n=348 Mean age range 63 to 73	F: 5 sessions/week I: - T: 20 to 60 minutes/session T: Any type of mechanically assisted walking and assisted overground walking Total duration: 4 to 6 weeks or until discharge from inpatient rehabilitation Control conditions: Not-AT	3/6 Meta-analysis, 6MWT PEDro scores
Angevaren 2008	To assess the effectiveness of physical activity, aimed at improving cardiorespiratory fitness, on cognitive function in older people without known cognitive impairment. Cardiorespiratory fitness is a secondary outcome.	n=6 1989 - 2002	Frail older adults with age related illnesses, not cognitively impaired, and not recovering from surgical treatment n=667 Age range 55-91	F: 2 to 7 sessions/week I: 70% HRmax, HR at VT, HR of 95 to 125, 50 to 75% VO2 max, 50 to 65% HRR or 85% HRR T: 8 to 60 minutes/session T: Aerobic exercise programs (walking, cycling, jogging, running, mixed exercise) Total duration: 8 to 26 weeks Control conditions: UC, No-Ex, Not-AT/RT	11/11 Narrative analysis VO2max CLEAR NPT

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Anthony 2013	To examine the beneficial and harmful effects of exercise programmes performed primarily in the seated position for frail older people who are unable to perform standard evidence-based exercise programmes. Cardiorespiratory fitness is a primary outcome.	n=10 1997 - 2005	Frail older adults in various settings n=82 Mean age 80,5	F: 2 sessions/week I: - T: - T: Chair based exercise Total duration: 3 months Control conditions: UC, No-Ex, Not-AT	1/6 Narrative analysis 6 MWD Jaded scale
Baker 2007	To systematically review all health outcomes to concurrent strength, aerobic, and balance training in older adults to assess the current level of evidence regarding the feasibility and efficacy of current guidelines. Cardiorespiratory fitness is a primary outcome.	n=8 1993 - 2007	Community living frail older adults n=479 Mean age range 67 to 84	F: 3 sessions/week I: 13 to 16 on BORG scale, 70% HRmax, 70% HRR, 65-70% VO2peak T: 8.3 to 45 minutes/session T: Walking, cycling ergometer training, rowing ergometer training Total duration: 12 weeks - 6 months Control conditions: No-Ex	4/15 Narrative synthesis 6 MWD, VO2peak Modified from Delphi list (Verhagen et al)
Blankevoort 2010	To investigate whether physical activity can improve mobility, lower-extremity strength, balance, walking endurance and BADL in elderly individuals with dementia. Cardiorespiratory fitness is a primary outcome.	n=6 1995 - 2009	Older adults with dementia n=253 Mean age range 78.8 to 87.1	F: 2 to 3 sessions/week I: start at 30% VO2 max up to 60% VO2max T: 30 to 60 minutes/session T: Walking, strength, balance aerobic exercises, functional skills Total duration: 12 weeks to 2 years Control conditions: UC, No-Ex	5/16 Meta-analysis 2 MWT, 6 MWT, 2-min step test Downs and Black checklist and Sackett et al checklist.

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Bouaziz 2015	To assess the health benefits of endurance training alone or combined with diet for obese people aged over 60. Cardiorespiratory fitness is a primary outcome.	n=8 1995-2014	Obese older adults n=832 Mean age range 61 to 76.2	F: 3 to 7 sessions/week I: 40 to 85% HRR, 50 to 75% VO2max, 60 to 85% HRmax T: 12 to 90 minutes/session T: Cycling on ergometer, walking, treadmill walking Total duration: 12 to 36 weeks Control conditions: UC, No-Ex, AT	26/26 Narrative VO2max (23 studies) Not reported
Bouaziz 2016	To assess the potential health benefits of multicomponent training for adults aged 65 years or over. Cardiorespiratory fitness is a primary outcome.	n=8 2000-2015	Older adults n=NOT REPORTED Mean age range 70 to 83	F: 3 sessions/week I: - T: 90 minutes/session T: Combination of endurance, strength, balance and flexibility training (2 non-RCTs) or combination of endurance, strength, balance, flexibility and coordination training (1 RCT) Total duration: 10 to 36 weeks Control conditions: NOT REPORTED	3/27 Narrative synthesis VO2peak Not specified
Bouaziz 2018	To estimate to what extent the exact benefits of aerobic training are in terms of VO2peak among healthy and unhealthy seniors aged 70 years or older. Cardiorespiratory fitness is a primary outcome.	n=6 1989 -2013	Older adults, both healthy and with chronic health conditions n=348 Mean age range 70 to 79	F: 3 to 4 sessions/week I: 50% to 85% of VO2peak, 40 to 80% of HRR, 50% to 95% of HRmax T: 15 to 60 minutes/session T: Walking, cycling on ergometer, treadmill walking and walking/running on a mini-trampoline Total duration: 12 to 26 weeks Control conditions: UC, Not-AT	10/10 Meta-analysis VO2peak Cochrane Collaboration risk of bias assessment

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Bruns 2016	To assess the effects of prehabilitation in patients aged over 60 years undergoing colorectal surgery. Cardiorespiratory fitness is a secondary outcome.	n=4 2010-2015	Patients undergoing elective colorectal surgery n=353 Mean age range 60 to 72	F: 3 to 7 sessions/week I: 40 to 80% peak HR T: 20 to 30 minutes/session T: Cardiopulmonary aerobic exercise Total duration: 24 to 38 days Control conditions: UC, No-Ex, Not-AT	5/5 Narrative VO2 at VT, 6MWT Cochrane risk of bias tool
Bueno de Souza 2018	To examine evidence from RCTs to determine the effects of mat Pilates on measures of physical functional performance in the older persons. Cardiorespiratory fitness is a primary outcome.	n=5 2011-2017	Healthy older adults in various settings n=156 Mean age 65.8	F: 2 to 3 sessions/week I: - T: 60 minutes/sessions T: Pilates Total duration: 8 to 24 weeks Control conditions: No-Ex	3/9 Meta-analysis 6MWT, VO2max PEDro score
Bullo 2018	To summarize and analyse the effectiveness of Nordic walking interventions on the physical fitness, the body composition, and the quality of life in the elderly population. Cardiorespiratory fitness is a primary outcome.	n=6 2013-2017	Older adults with various health conditions n=536 Mean age 60 to 92	F: 2 to 3 sessions/week I: 60 to 70% max ability, progressive intensity up to 12 to 14 RPE, 50 to 60% HRmax, moderate intensity (12 to 14 RPE), moderate to high intensity (HR 100 to 120 bpm), comfortable pace T: 20 to 80 minutes/session T: Nordic walking Total duration: 6 to 35 weeks Control conditions: No-Ex	9/15 Meta-analysis 6 MWT, 12 MWT, 5mWT, 2minST , VO2max Cochrane Collaboration Back review Group.

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Cugusi 2017	To appraise the available evidence on the health effects and clinical relevance of Nordic walking in individuals with established cardiovascular diseases and, to determine a precise estimate of Nordic walking-induced changes on outcomes in individuals diagnosed with cardiovascular diseases. Cardiorespiratory fitness is a primary outcome.	n=5 2002-2016	Older adults with various cardiovascular diseases: coronary artery disease, peripheral arterial disease, hart failure, post stroke survivors. n=766 Age range 40-80	F: 2 to 5 sessions/week I: - T: 30 to 60 minutes/session or 2.5 to 3km T: Nordic walking Total duration: 3 to 24 weeks Control conditions: UC, No-Ex, AT	15/15 Meta-analysis 6 MWT, VO2peak PEDro score
Dale 2015	To assess the effects of exercise training on exercise capacity, health-related quality of life and levels of physical activity in people with non-malignant dust-related respiratory diseases compared with control, placebo or another non-exercise intervention. Cardiorespiratory fitness is a primary outcome.	n=7 2008-2014	Older adults with non-malignant dust-related respiratory diseases n=39 Mean age range 67 to 72	F: 2 to 3 sessions/week I: 80% of walking speed on initial 6MWT and progressed weekly, initial intensity of 60% peak work at baseline incremental cycle test and progressed weekly T: 15 to 30 minutes/session T: Cycling, walking Total duration: 8 weeks Control conditions: No-Ex	2/2 Meta-analysis 6 MWT, peak work rate. Cochrane Risk of Bias and GRADE.
Doyle 2019	To assess the clinical outcomes of aerobic exercise commenced within two weeks of cardiac surgery. Cardiorespiratory fitness is a primary outcome.	n=5 1984-2016	Older adults undergoing cardiac surgery n=2175 Mean age 66	F: 1 to 14 sessions/week I: 3 to 7 RPE (10pt scale), 10 to 13 RPE, 65 to 75% max HR, anaerobic threshold T: 3 to 60 minutes/session T: Walking, stationary cycling or both Total duration: length of hospital stay to 6 months Control conditions: UC	18/18 Meta-analysis 6MWT, VO2peak Not reported

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Fukuta 2016	To determine the effects of cardiovascular drug or exercise intervention on exercise capacity and quality of life in patients with heart failure with preserved ejection fraction. Cardiorespiratory fitness is a primary outcome.	n=2 2003-2013	Older adults with heart failure with preserved of >40% ejection fraction. n=245 Mean age 67.6	F: 2 to 3 sessions/week I: - T: 20 to 60 minutes/session T: Walking, walking and cycling, cycling and cycling and resistance training Total duration: 12 to 24 weeks Control conditions: UC, No-Ex	5/13 Meta-analysis, 6 MWD, VO2peak Not reported
Gardner 2014	To provide a comprehensive and up-to-date summary of the effects of exercise on treatment-related adverse effects for patients with prostate cancer receiving androgen-deprivation therapy. Cardiorespiratory fitness is a primary outcome.	n=6 2003-2012	Older adults with prostate cancer n=565 Mean age range 63 to 72	F: 1 to 5 sessions/week I: 55% to 85% HRmax, 11 to 15 RPE, 50% to 75% peak oxygen uptake T: 15 to 60 minutes/session T: Walking, aerobic exercises Total duration: 12-24 weeks Control conditions: NOT REPORTED	10/10 Narrative synthesis 6MWT, 400m walk, time to reach RPE15 in treadmill protocol. Downs and Black checklist.
Golledge 2019	To summarize evidence from randomized controlled trials of the efficacy of structured home exercise programmes, in comparison to controls not receiving an exercise programme, in improving walking performance and objectively measured physical activity in patients with peripheral artery disease Cardiorespiratory fitness is a secondary outcome.	n=5 1966-2018	Older adults with peripheral arterial disease n=524 Mean age range 57 to 70	F: 3 to 5 sessions/week I: until severe leg discomfort experienced, a speed that evokes strong claudication pain, severe discomfort (12–14 on Borg rating), a brisk pace that elicits pain within 3–5minutes T: 10 to 50 minutes/session T: Walking Total duration: 6 to 36 weeks Control conditions: No-Ex	11/11 Meta-analysis 6 MWT Cochrane collaboration tool for assessing risk of bias

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Gomes-Neto 2019	To determine the effects of whole-body vibration training on metabolic abnormalities, mobility, balance and aerobic capacity in older adult patients with type 2 diabetes and to provide information concerning the vibration exercise regimens that may be most suitable for improving health in this population. Cardiorespiratory fitness is a primary outcome.	n=5 2011-2017	Patients with type 2 diabetes n=59 Age range 45 to 80	F: 3 sessions/week I: - T: 12 to 24 minutes/session T: Whole to body vibration training alone or in combination with exercises on the spot Total duration: 8 to 12 weeks Control conditions: NOT REPORTED	2/7 Meta-analysis 6 MWT PEDro score
Halloway 2015	To examine the effect of prehabilitation randomized clinical trial interventions on physical activity behaviour and dimensions of physical fitness in older adults. Cardiorespiratory fitness is a primary outcome.	n=5 1996-2014	Frail older adults scheduled for total hip arthroplasty n=30 Mean age range 67	F: 2 to 4 sessions/week I: - T: 30 minutes/session T: Walking, individual exercises Total duration: 3 to 6 weeks Control conditions: UC	1/7 Meta-analysis 6 MWT Not reported
Hernandez 2015	To identify and characterize the scientific literature regarding the effects of exercise on Alzheimer's Disease. Cardiorespiratory fitness is a secondary outcome.	n=5 2003-2013	Patients with Alzheimer's disease n=131 Age not reported, but likely>65	F: 3 to 5 sessions/week I: moderate to intensive (subjective inability to speak a sentence) T: 15 to 45 minutes/session T: Walking, multimodal exercise, cycling Total duration: 2 to 6 months Control conditions: No-Ex, No control	5/14 Narrative synthesis 6 MWT, SWT, VO2 Own criteria

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Heyn 2008	To compare endurance and strength outcomes of cognitively impaired and cognitively intact older adults who participate in similar randomized exercise trials, and to provide a quantitative answer concerning the relative benefits of exercise for impaired and non-impaired elderly. Cardiorespiratory fitness is a primary outcome.	n=13 1974-2004	Older adults with and without cognitive impairment n=1057 Mean age range 74 to 91	F: 2 to 5 sessions/week I: - T: 30 to 90 minutes/session T: Aerobic training, variable-intensity group exercise program, multicomponent functional fitness training, endurance exercises Total duration: 2 to 40 weeks Control conditions: No-Ex	15/41 Meta-analysis 1 mile walk, 6MWT, 2 MWT, max Walking Time, 6 min aerobics, Walking endurance. UTMB/TLC Interventions Trial Quality Form
Howes 2017	To update and extend the available evidence for the physical and cognitive effects of active computer gaming in older adults. Cardiorespiratory fitness is a primary outcome.	n=4 2003-2015	Healthy and frail older adults n=427 Mean age range 71 to 85	F: 1-4 sessions/week I: - T: 45 to 90 minutes/session T: Active computer gaming Total duration: 4 weeks to 6 months Control conditions: No-Ex, Not-AT, AT	8/25 Meta-analysis 6 MWT Cochrane Risk of Bias and GRADE.
Huang 2002	To determine the effects of controlled endurance or aerobic exercise training on physiological changes in cardiovascular function and pulmonary function among older adults aged 60 years and over. Cardiorespiratory fitness is a primary outcome.	n=4 1983-2001	Sedentary healthy older adults n=2102 Mean age range 67 to 67	F: 1 to 5.2 sessions/week I: 60 to 85% HRmax, 52 to 82% VO2max, 35 to 80% HRR, 100.4 to 129 bpm as absolute number of HRmax T: 18,7 to 60 minutes/session T: Walking, jogging, cycling, aerobic dance and aerobic games Total duration: 8 to 52 weeks Control conditions: UC	41/41 Meta-analysis VO2max Not reported

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Huang 2005	To determine the effects and direction of endurance training programs on VO2max in sedentary older adults, to quantify the magnitude of observed changes, and to examine the influence of certain variables, such as study design, individual physical characteristics, and characteristics of training programs on the changes. Cardiorespiratory fitness is a primary outcome.	n=6 1983-2000	Sedentary healthy older adults n=2102 Mean age range 67 to 68	F: 1 to 4.9 sessions/week I: 60% to 85% HRmax, 50% to 82% VO2max, 35% to 80% HRR, 107 to 129 bpm HRmax T: 20 to 60 minutes/session T: Walking, jogging, cycling, stair to climbing, aerobic dance, tai chi chuan, outdoor performance or aerobic games Total duration: 8 to 52 weeks (22.7±12.1 weeks) Control conditions: UC	41/41 Meta-analysis VO2max Jadad scale
Huang 2016	To qualify the dose–response relationship between different training regimens and the induced VO2max improvements. Cardiorespiratory fitness is a primary outcome.	n=not reported, hand searching 1983-2000	Sedentary healthy older adults n=2102 Mean age range 67 to 69	F: 2.9 to 4.9 sessions/week I: exercise intensity varied and was expressed as percent maximum heart rate (% HRmax), percent VO2max reserve (%VO2R) % VO2max, % VO2R, % HRR, or HRmax T: 20 to 60 minutes/session T: Walking, jogging, running, cycling, stair climbing, aerobic dancing, outdoor aerobic performance, and aerobic games Total duration: 8 to 52 weeks Control conditions: UC	41/41 Meta-analysis VO2max Instrument not reported

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Hurst 2019	To systematically review and meta-analyse the effects of same session combined exercise training on measures of fitness in adults aged over 50 years, while also exploring the modifying effects of study and subject characteristics. Cardiorespiratory fitness is a primary outcome.	n=5 1991-2018	Healthy community-dwelling older adults n=1131 Mean age 70.1	F: 2 to 3 sessions/week I: 50 to 75% HRmax, 60 to 80% HRR, 80% HRVT2 or RPE 12 to 14 T: 30 to 90 minutes/session T: Combined (strength and endurance) training and endurance training ((Treadmill) walking, running, cycling, cross-trainer, stationary cycling, dance) Total duration: 6 to 52 weeks Control conditions: UC, AT, RT	24/27 Meta-analysis VO2peak, 6MWT Cochrane Collaboration's tool for assessing risk of bias
Hwang 2015	To examine the effectiveness of dance programs in improving the physical health of all older adults, both those with health conditions and those considered healthy. Cardiorespiratory fitness is a primary outcome.	n=1 2004-2013	n=97 Mean age range 52	F: 2 sessions/week I: - T: 50 minutes/session T: Dance Total duration: 12 weeks Control conditions: UC	1/18 Narrative analysis VO2max Criteria provided by Sackett and Megens and Harris
Kanach 2018	To examine the effects of structured exercise (defined as aerobic walking, with or without complementary modes of exercise) on performance measures, mobility, functional status, healthcare utilization and Quality of Life, in older adults hospitalized for acute medical illness. Cardiorespiratory fitness is a primary outcome.	n=3 2000-2014	Older adults who were hospitalized for an acute medical episode: chronic respiratory disease, COPD, diabetes mellitus. n=556 Mean age range 60 to 78	F: 5 to 35 sessions/week I: 125% of best 6 MWD, 85% predicted VO2max T: 10 to 60 minutes/session T: Aerobic walking, combined training with aerobic component Total duration: hospital length of stay to 18 months Control conditions: UC, No-Ex	4/11 Narrative analysis VO2max, 6 MWD, endurance shuttle walk Cochrane Risk of Bias assessment

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Keogh 2012	To systematically review the literature for the chronic benefits of exercise in reducing symptoms and improving quality of life in prostate cancer patients. Cardiorespiratory fitness is a primary outcome.	n=3 2003-2010	Patient with prostate cancer n=289 Mean age range 66 to 72	F: 2 to 7 sessions/week I: - T: - T: Aerobics training or aerobics training combined with either strength or eccentric training Total duration: 8 to 26 weeks Control conditions: NOT REPORTED	12/12 Narrative analysis 400 m walk, 6 MWT, SWT, METS, VO2max An adaptation of Sackett reported by Megens and Harris.
Kuijlaars 2019	To systematically review RCTs on the short- (4mo) and long-term (>4mo) effectiveness after hospitalization on body functions, activities, and participation (conform the ICF) of supervised home-based exercise therapy in older patients (65y) after hip fracture compared with a control intervention (including usual care). Cardiorespiratory fitness is a secondary outcome.	n=3 1997-2014	Older adults after hip fracture n=67 Mean age 79.3	F: 1 to 2 sessions/week I: 65 to 75% predicted HRmax T: 30 to 40 minutes/session T: Walking and stair walking Total duration: 3 months Control conditions: No-Ex	2/9 Meta-analysis 6MWT PEDro scale.
Lam 2018	To examine the effects and characteristics of physical exercise training on physical function and quality of life in people with cognitive impairment and dementia and to examine the effect of subject characteristics on training efficacy. Cardiorespiratory fitness is a secondary outcome.	n=5 1994-2016	Older adults with cognitive impairment dementia n=402 Mean age 82.0	F: 2 to 4 sessions/week I: 30 to 60% VO2max,62 or 40% of heart rate reserve that gradually progressed to 85% T: 30 to 90 minutes/session T: Aerobic training, walking exercise, or multimodal exercise Total duration: 9 weeks to 12 months Control conditions: UC, No-Ex	7/43 Meta-analysis 6MWT PEDro scale.

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SUPPLEMENTARY FILE C: CHARACTERISTICS OF ALL INCLUDED REVIEWS

Article author year	Objective	No. of databases/ sources searched Date range of included studies	Participants	Intervention of interest Control Conditions	No. of included studies/total no. of studies in the review Method of analysis Outcome measure(s) Appraisal instrument
Lee 2017	To systematically review the effects of Pulmonary Rehabilitation or Exercise Training in non-Cystic Fibrosis bronchiectasis on (1) measures of exercise capacity and muscle strength; (2) health related quality of life; (3) symptoms; and (4) frequency of exacerbations and mortality. Cardiorespiratory fitness is a primary outcome.	n=6 2005-2014	Older adults with non-cystic fibrosis bronchiectasis n=164 Mean age range 57.3 to 71.2	F: 2 to 7 sessions/week I: 80% peak HR achieved on initial incremental exercise test, 75 to 85% of VO2max, 60% max of 6MWT T: 30 to 45 minutes/session T: (Treadmill) walking, cycling, stair climbing, ski machine Total duration: 8 weeks Control conditions: Not-AT, Ex-Adv	4/4 Meta-analysis 6MWD, SWT, endurance exercise capacity (set at 85% VO2peak uptake of maximal incremental treadmill test) Cochrane Risk of Bias.
Leggio 2019	To analyse the effects of the exercise training on cardiovascular outcomes in patients with heart failure with preserved ejection fraction Cardiorespiratory fitness is a secondary outcome.	n=8 2010-2017	Older adults with heart failure with preserved ejection fraction. n=348 Mean age range 61.9 to 70.1	F: 2-3 sessions/week I: - T: 20-40 to 60 minutes T: Aerobic exercise training, walking, and treadmill and bicycle ergometer Total duration: 4 to 16 weeks Control conditions: No-Ex	9/9 Narrative analysis VO2peak, 6 MWD. Downs and Black Quality Index.
Li 2019	To explore the comprehensive effect of resistance training on the various types of exercise capacities of COPD patients. Cardiorespiratory fitness is a secondary outcome.	n=5 2004-2018	Older adults with moderate to severe COPD n=405 Mean age range 58.3 to 70.3	F: 3-5 sessions/week I: 40-80% of 1RM T: 40 minutes/session T: resistance training Total duration: 6-12 weeks Control conditions: No-Ex, Not-AT	11/11 Meta-analysis 6MWD, 6min-peg-and-ring test, constant work rate, UULEX, CPET. PEDro scale.

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Article author year	Objective	No. of databases/ sources searched Date range of included studies	Participants	Intervention of interest Control Conditions	No. of included studies/total no. of studies in the review Method of analysis Outcome measure(s) Appraisal instrument
Liao 2015	To investigate the effects of resistance training alone or combined with endurance training on clinically relevant rehabilitation outcomes in advanced COPD, Cardiorespiratory fitness is a primary outcome.	n=7 1992-2014	Older adults with moderate to severe COPD n=333 Mean age range 67,7	F: 2 to 3 sessions/week I: 60% work rate, 1 level below the maximum level achieved on the unsupported arm test, intensity increased according to breathlessness and perceived arm exertion, 50% maximum work capacity, 3 metabolic equivalents, 60% peak VO2 T: 20 to 60 minutes/session T: Treadmill walking, cycle ergometer, arm cranking Total duration: 8 to 12 weeks Control conditions: No-Ex, AT	10/18 Meta-analysis 6MWD, 6min peg-and-ring test, max workload, VO2max. Modified Jadad scale.
Paneroni 2017	To evaluate, in patients with very severe but stable COPD, the effectiveness of exercise training defined as a change in functional capacity and health related quality of life. Cardiorespiratory fitness is a primary outcome.	n=4 1999-2014	Older adults with severe COPD n=396 Mean age 65.6 for all 10 studies	F: 1 to 5 sessions/week I: high intensity ranging from 70% to 90% of the maximum load or velocity reached during incremental tests in three studies T: 15 to 30 minutes/session T: Cycling, (treadmill) walking or a combination Total duration: 4 to 52 weeks Control conditions: UC, No-Ex	8/10 Meta-analysis 6MWT Cochrane collaboration tool modified by the Jadad Scale score.

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Article author year	Objective	No. of databases/ sources searched Date range of included studies	Participants	Intervention of interest Control Conditions	No. of included studies/total no. of studies in the review Method of analysis Outcome measure(s) Appraisal instrument
Parmenter 2013	To identify whether any mode of structured exercise improves physical fitness, or performance-based tests of function, and to identify if improvements in physical fitness measures. Cardiorespiratory fitness is a primary outcome.	n=9 1974-2011	Older adults with intermittent claudication n=924 Mean age range 59 to 76	F: 2 to 5 sessions/week I: intensity focussed on moderate to maximum pain or 60 to 90% VO2peak T: 16 to 60 minutes/session T: (Treadmill) walking, lower limb aerobics, pole striding, arm cranking Total duration: 6 to 76 weeks Control conditions: UC, No-Ex, Ex-Adv	24/24 Narrative analysis 6MW-ICD, 6MW-TWD, SWT-ICD, SWT-TWD,VO2peak. Modified PEDro scale
Patel 2012	To review systematically the comparative effectiveness of yoga, compared with other exercise interventions, for older adults as shown on measures of health and physical functioning. Cardiorespiratory fitness is a primary outcome.	n=5 1989-2009	Healthy older adults in various settings n=265 Mean age range 67 to 72	F: 1 (+home exercise) to 2 sessions/week I: - T: 60 to 90 minutes/session T: (Supervised) aerobic exercise, resistance training Total duration: 16 to 26 weeks Control conditions: UC, AT	4/11 Meta-analysis VO2max 10-item quality checklist by Chalmers et al.
Pengelly 2019	To identify exercise parameters and outcome measures used in cardiac rehabilitation programs following median sternotomy, in the elderly cardiac population. Cardiorespiratory fitness is a secondary outcome.	n=5 1997-2015	Older patients after coronary artery bypass graft, valve surgery or both. n=246 Mean age range 73 to 87	F: 5 to 7 sessions/week I: 60% 1RM (1 set 8-12 repetitions) , RPE 13/20, starting at 50% max power output T: 60-90 minutes/session T: aerobic strength and balance exercises, calisthenics Total duration: 3 to 4 weeks Control conditions: UC	9/11 Meta-analysis 6MWT, max. power output, VO2peak. Downs & Black tool.

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Article author year	Objective	No. of databases/ sources searched Date range of included studies	Participants	Intervention of interest Control Conditions	No. of included studies/total no. of studies in the review Method of analysis Outcome measure(s) Appraisal instrument
Puhan 2016	To assess effects of pulmonary rehabilitation after COPD exacerbations on hospital admissions (primary outcome) and other patient-important outcomes (mortality, health related quality of life and exercise capacity). Cardiorespiratory fitness is a secondary outcome.	n=6 1998-2016	Older adults with COPD after acute exacerbation n=1368 Mean age range 58 to 78	F: 2 to 35 sessions/week I: - T: 10 to 120 minutes/session T: Supervised and unsupervised inpatient and/or outpatient pulmonary rehabilitation (treadmill walking, walking, cycling, stair climbing, aerobic activities, endurance training) Total duration: 4 days to 6 months Control conditions: UC, No-Ex	18/22 Meta-analysis 6MWT, SWT, 3MWT. Cochrane Risk of Bias.
Rezende Barbosa 2018	To gather information in the literature regarding the influence of functional training on cardiorespiratory parameters. Cardiorespiratory fitness is a primary outcome.	n=5 2002-2016	Community living older adults n=227 Mean age range 69 to 83	F: - I: 65-70%VO2peak (15 min) T: 10 to 60 minutes/session T: Multimodal exercise programmes Total duration: 12 weeks to 11 months Control conditions: UC, AT	3/5 Meta-analysis VO2peak PEDro scale and GRADE.
Ribeiro 2017	To summarise the evidence on the impact of a cardiac rehabilitation program on functional capacity, exercise tolerance and health-related quality of life in aortic stenonis patients after intervention either by sAVR or TAVI. Cardiorespiratory fitness is a primary outcome.	n=7 2014-2015	Older adults after heart surgery (sAVr or TAVI). n=1797 Mean age range 68 to 86	F: 1 to 18 sessions/week I: intensity low to medium, 70% of HRmax predict or 14 RPE on Borg- scale T: 30 minutes/session T: Aerobic exercise, cycling or cycle ergometer, treadmill or outdoor walking, (group) gymnastics Total duration: 2 to 3 weeks Control conditions: No controls	5/5 Meta-analysis 6MWD PEDro scale.

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Rodrigues-Krause 2016	To verify the level of evidence regarding the adaptations of dance interventions on cardiovascular risk factors in older adults. The primary outcome was cardiorespiratory fitness.. Cardiorespiratory fitness is a primary outcome.	n=4 1990-2015	Older adults with various health conditions n=237 Mean age range 59 to 70	F: 1 to 3 sessions/week I: 70% VO2peak, 100-120 bpm, 13-14RPE T: 40 to 60 minutes/session T: Dance, aerobic training (cycle ergometer, treadmill or both) Total duration: 8 to 24 weeks Control conditions: No-Ex, AT, combi AT Not-AT	4/7 Meta-analysis VO2peak Downs & Black criteria.
Rodrigues-Krause 2019	To review the literature on the use of dance as a form of intervention to promote functional and metabolic health in older adults. Cardiorespiratory fitness is a primary outcome.	n=4 1984-2016	Older adults with various health conditions n=893 Age range 59 to 94	F: 1 to 3 sessions/week I: 50 to 75% VO2peak, 11 to 14 Borg scale (specifications unclear), 50 to 70% HRmax, 50 to 120 bpm music (salsa goes up to 180 bpm), 50 to 70% HRR, 4.0 to 7.5 METs/hour or low to moderate intensity (unspecified) T: 30 to 90 minutes/session T: Dance (folk dance, aerobic dance, Argentine tango, waltz, foxtrot). Aerobic training (cycle ergometer, treadmill or both). Total duration: 6 to 104 weeks Control conditions: No-Ex, AT, combi AT Not-AT	12/49 Narrative analysis VO2max, 6MWT, half mile walking test, 2minST. Own criteria

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Rosero 2019	To assess the different modalities or combinations of preoperative physical exercise interventions on the outcomes of functional capacity, mental wellness, and medical care in patients with non-small-cell lung cancer after surgery. Cardiorespiratory fitness is a secondary outcome.	n=6 2011-2017	Hospital patients with non-small-cell lung cancer. n=648 Mean age 65	F: 3 to 14 sessions/week I: 60 to 80% peak work capacity T: 20 to 60 minutes/session T: Aerobic training, multicomponent training (aerobic exercise combined with IMT and/or strength training) Total duration: 1 to 4 weeks Control conditions: NOT REPORTED	9/10 Meta-analysis 6MWD, VO2peak PEDro scale.
Rydwik 2004	To describe the effect of physical training on physical performance in institutionalised multiple diagnoses older adults. Cardiorespiratory fitness is a primary outcome.	n=5 1989-2000	Institutionalised multiple diagnoses older adults n=554 Mean age range 84.6	F: 2 to 3 sessions/week I: 50 to 65% progressively, >70% or 80% (units of measurement unclear) T: 2 to 20 minutes/session T: Aerobic training Total duration: 9 to 52 weeks Control conditions: NOT REPORTED	4/16 Narrative analysis VO2max, heart rate, walking/wheelchair endurance (average speed). Modified SBU form.
Ryrso 2018	To investigate the effect of a supervised early pulmonary rehabilitation program, initiated during or within 4 weeks, in patients hospitalized with a COPD exacerbation compared with usual care. Cardiorespiratory fitness is a secondary outcome.	n=10 1998-2018	Older adults with COPD after acute exacerbation n=723 Mean age range 59 to 75	F: 2 to 7 sessions/week I: 60 to 80% of max work load , >75% of max walking distance, 60-70% VO2max or HRmax, Borg breathlessness score 3-4 T: 30 to 40 minutes/session T: (Treadmill) walking, cycling and/or tailored aerobic activities/exercise (supervised and unsupervised) Total duration: 10 days to 6 months Control conditions: UC, No-Ex	11/13 Meta-analysis 6MWT, SWT. Cochrane Risk of Bias and Grade criteria.

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Article author year	Objective	No. of databases/ sources searched Date range of included studies	Participants	Intervention of interest Control Conditions	No. of included studies/total no. of studies in the review Method of analysis Outcome measure(s) Appraisal instrument
Scheerman 2018	To identify the effect of physical interventions on physical performance and physical activity in older patients during hospitalization. Additionally, we aimed to compare the effect of patient tailored physical interventions e.g. continuously adapted to the capabilities of the patient to the effect of non-patient tailored interventions. Cardiorespiratory fitness is a primary outcome.	n=5 2006-2017	Older adults hospitalized with various diagnoses n=260 Mean age 79.2	F: 3 to 18 sessions/week I: - T: 1 to 45 minutes/session T: tai chi principles, muscle strengthening exercises, electrical stimulation, walking (backward and forward). Total duration: 1 to 6 weeks Control conditions: UC	3/15 Narrative analysis 6 MWT. PEDro scale.
Slimani 2018	To establish the effects of physical training on quality of life, aerobic capacity, and left ventricular ejection fraction in older heart failure patients, and to quantify dose-response relationships according to training modalities and program variables. Cardiorespiratory fitness is a primary outcome.	n=3 1999-2017	Older adults with heart failure n=2624 Age not reported (inclusion criteria 50+ for African population and 65+ for populations from developed countries)	F: 1 to 13 sessions/week I: - T: 25 to 60 minutes/session T: Aerobic training, resistance training or a combination of both Total duration: 6 to 54 weeks Control conditions:	11/25 Meta-analysis 6MWT Not reported

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Vieira 2010	To assess the benefits of home-based pulmonary rehabilitation in patients with COPD for exercise capacity, and to assess the risks of home-based pulmonary rehabilitation and whether findings are consistent across populations of COPD, supervision and exercise training program variation. Cardiorespiratory fitness is a primary outcome.	n=4 1977-2007	Older adults with severe COPD n=728 Mean age range 38 to 78 N 728 -% men	F: 4 to 14 sessions/week I: 70% max SWT T: 15 to 45 minutes/session T: Walking, stair climbing, cycling or a combination Total duration: 3 to 52 weeks Control conditions: UC	12/12 Narrative analysis 4-min, 6-min or 12-min walk test, the shuttle walk test, work rate, VO2max. The PEDro scale
Wee 2018	To assess the impact of preoperative exercise in abdominal aortic aneurysm patients, including those who are not indicated for surgery. Cardiorespiratory fitness is a primary outcome.	n=3 2008-2017	Patients with abdominal aortic aneurysm. n=227 Mean age range 69 to 73	F: 2 to 3 sessions/week I: moderate to high T: 22 to 45 minutes/session T: continuous exercise, high intensity training Total duration: 4 to 12 weeks Control conditions: UC, Ex-Adv	4/4 Narrative analysis VO2peak, aerobic threshold, ventilatory threshold PEDro scale.

Appendix 2: Characteristics of all included reviews

n=number; *sAVR*: surgical aortic valve replacement; *TAVI*: trans catheter aortic valve implantation; *COPD*: chronic obstructive pulmonary disease

Intervention of interest and control conditions:
FITT-characteristics: Frequency, Intensity, Time per session, Type of exercise
HR: heart rate; *HRmax*: maximum heart rate; *HRR*: heart rate reserve; *HRVT2*: heart rate at the second ventilatory threshold; *VT*: ventilatory threshold;;
VO2max / *VO2peak*: maximum oxygen consumption; *VO2R*: maximum oxygen consumption reserve; *RPE*: rate of perceived exertion; *bpm*: beats per minute; *MET*: metabolic equivalent;

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AT: aerobic fitness training; *No-Ex*: intervention other than exercise, e.g. wait list, social acitivity, education, stress management, mental training, nutritional advise, breathing exercise; *UC*: no intervention, e.g. usual care, usual daily activities, usual exercise program, waiting list; *Not-AT*: exercise intervention other than aerobic training, e.g. stretching and toning, yoga, balance training, resistance training; *Ex-Adv*: Exercise advise.

Outcome measures
2minST: 2 minute step test; *3MWT*: 3 minute walking test; *5mWT*: 5 meter walking test; *6MWT*: 6 minute walking test; *6MWD*: 6 minute walking distance; *12MWT*: 12 minute walking test; *CPET*: cardio pulmonary exercise test; *ICD*: initial claudication distance; *SWT*: shuttle walk test; *TWD*: total walking distance; *UULEX*: Unsupported Upper Limb Exercise.

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Supplementary File D Interventions and summary of the evidence of all included reviews.
Reviews with complete FITT-criteria AND risk of bias analysis highlighted in in italic

Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Ada 2010	3 RCT n=348 Cardiovascular disease	F: 5 session/week I: NOT REPORTED T: 20 to 60 minutes/session T: Any type of mechanically assisted walking and assisted overground walking Total duration: 4 to 6 weeks or until discharge from inpatient rehabilitation	The short-term effect (after 4 weeks training) of additional mechanically assisted walking on walking capacity in patients after stroke (6MWT) is not statistically significant (35 m; 95%CI –13 to 84). The quality of the underlying studies was high.	MA: not statistically significant result
Angevaren 2008	*11 RCT n=667 Frail older adults*	*F: 2 to 7 session/week I: 70% HRmax, HR at VT, HR of 95 to 125, 50 to 75% $\dot{V}O_2$ max, 50 to 65% HRR or 85% HRR T: 8 to 60 minutes/session T: Aerobic exercise programs (walking, cycling, jogging, running, mixed exercise) Total duration: 8 to 26 weeks*	*Eight out of 11 studies reported that aerobic exercise interventions in older people with known cognitive impairment resulted in increased aerobic capacity in the intervention group (increase in $\dot{V}O_2$max of 14%) 10/11 of the underlying studies had an unclear risk of bias.*	*NAn: positive result for >75% of all studies*
Anthony 2013	1 RCT n=82 Frail older adults	F: 2 session/week I: NOT REPORTED T: NOT REPORTED T: Chair based exercise Total duration: 3 months	The effect of chair based exercise in frail older persons on aerobic performance (6MWT) is not statistically significant (2.1 % increase, p=0.23). The quality of the underlying study is low, and allocation was not concealed	NAn: not statistically significant result
Baker 2007	4 RCT n=479 Frail older adults	F: 3 session/week I: 13 to 16 RPE on Borg scale, 70% HRmax, 70% HRR, 65 to 70% $\dot{V}O_2$peak T: 8.3 to 45 minutes/session T: Walking, cycling ergometer training, rowing ergometer training Total duration: 12 weeks to 6 months	Multimodal exercise training in frail older people has a statistically significant effect on aerobic performance (6MWT) in only one out of three studies, and a statistically significant increase in aerobic capacity in the one study ($\dot{V}O_2$peak increase ES 0.84). The effect of risk of bias was not evaluated.	NAn: inconclusive

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Blankevoort 2010	*4 RCT, 1 nonRCT n=255 Cognitive impairment*	*F: 2 to 3 session/week I: start at 30% V̇O₂max up to 60% V̇O₂max T: 30 to 60 minutes/session T: Walking, strength, balance & aerobic exercises, functional skills Total duration: 12 weeks to 2 years*	*Physical exercise in older people with dementia has a statistically significant effect on aerobic performance in 5 out of 5 studies (several walking tests, mean ES 1.08; 95%CI 0.31 to 3.79), with longer duration showing larger effects. Four out of 5 studies were high quality RCT's, 1 study was a case series. Risk of bias was moderate to high (1 to 5 /7 points, with 7 points = low risk of bias.*	*NAn: <u>positive</u> result for all studies*
Bouaziz 2015	15 RCT, 11 nonRCT n=832 Metabolic diseases	F: 3 to 7 session/week I: 40 to 85% HRR, 50 to 75% V̇O₂max, 60 to 85% HRmax T: 12 to 90 minutes/session T: Cycling on ergometer, walking, treadmill walking Total duration: 12 to 36 weeks	Exercise therapy in obese people has a statistically significant effect on aerobic capacity (increase V̇O₂max 11 to 34%) in 7 out of 8 studies. Exercise therapy combined with diet has a statistically significant effect on aerobic capacity (increase V̇O₂max 1 to 25%), larger than diet alone. The type of diet does not affect the effect. The quality of the underlying studies was not assessed.	NAn: <u>positive</u> result for >75% of all studies
Bouaziz 2016	1 RCT, 1 nonRCT n=NOT REPORTED (Healthy) older adults	F: 3 session/week I: NOT REPORTED T: 90 minutes/session T: Combination of endurance, strength, balance and flexibility training or combination of endurance, strength, balance, flexibility and coordination training. Total duration: 10 to 36 weeks	Multicomponent training in older adults shows positive effects on cardiorespiratory capacity (Increase in V̇O₂max 10 to 20%) compared to baseline (2/2 studies) or to controls (1/1 study) The quality and risk of bias of the underlying studies was not assessed.	NAn: <u>positive</u> result for all studies

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Bouaziz 2018	10 RCT n=348 Mixed	F: 3 to 4 session/week I: 50% to 85% of $\dot{V}O_2$peak, 40 to 80% of HRR, 50% to 95% of HRmax T: 15 to 60 minutes/session T: Walking, cycling on ergometer, treadmill walking and walking / running on a mini-trampoline Total duration: 12 to 26 weeks	Aerobic training in older adults has a statistically significant positive effect on aerobic capacity in 9/10 studies (increase in $\dot{V}O_2$max 6.5 to 30%). Pooled analyses of all studies, and adjusted to health status all showed positive results. Statistically significant heterogeneity was detected in all analyses. Greater gain was measured when subjects trained at 40 (sedentary) to 85% of $\dot{V}O_2$peak, and after 16 weeks training (average) and 24 to 26 weeks for sedentary individuals. None of the included studies was at high risk of bias.	MA: <u>positive</u> result for all comparisons
Bruns 2016	*3 RCT, 2nonRCT* *n=353* *Oncologic disease*	*F: 3 to 7 session/week* *I: 40 to 80% peak HR* *T: 20 to 30 minutes/session* *T: Cardiopulmonary aerobic exercise* *Total duration: 24 to 38 days*	*Physical prehabilitation in older colectoral surgery patients has a positive effect on aerobic capacity ($\dot{V}O_2$ at ventilatory threshold, 2.9 ml/kg/min increase) in one study, in aerobic performance (6MWT, 42, (p<0.01)) in 2 out of 3 studies. Inconclusive results were found in one study with several outcome measures.* *Studies had a moderate risk of bias.*	*NAn:* *<u>inconclusive</u>*
Bueno de Souza 2018	3 RCT n=156 (Healthy) older adults	F: 2 to 3 session/week I: NOT REPORTED T: 60 minutes/sessions T: Pilates Total duration: 8 to 24 weeks	Pilates in older people has a statistically significant effect on aerobic performance (6MWT increase of 30 to 130m, SMD 2.00; 95%CI 1.44 to 2.56) and no effect on aerobic capacity ($\dot{V}O_2$max). The evidence for aerobic performance is rated "moderate", the evidence for aerobic capacity "limited".	MA: <u>positive</u> result for all comparisons

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Article author year	Number/ type of relevant studies, Number (n) of participants, Group	Characteristics of the intervention	Summary of the evidence	Conclusion
Bullo 2018	5 RCT, 4nonRCT n=536 Mixed	F: 2 to 3 session/week I: 60 to 70% max ability, progressive intensity up to 12 to 14 RPE, 50 to 60% HRmax, moderate intensity (12 to 14 RPE), moderate to high intensity (HR 100 to 120 bpm), comfortable pace T: 20 to 80 minutes/session T: Nordic walking Total duration: 6 to 35 weeks	Nordic walking (NW) in older people has a statistically significant effect on aerobic performance in 8 out of 9 studies (6MWT, 12MWT, 2 min step test, 5m WT: increase of 9 to 22%). NW showed a large effect compared to sedentary(ES 0.91; 95%CI 0.56 to 1.28) and resistance training (ES 0.75; 95%CI 0.03 to 1.47) controls, but walking therapy was more effective (ES -0.21; 95%CI -.64 to 0.21). The effect on aerobic capacity is also statistically significant ($\dot{V}O_2$max increase of 2.4 to 13.6%). The studies were rated low quality and heterogeneous.	MA: positive result, only for comparisons with non-exercise controls

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Cugusi 2017	15 RCT n=766 Cardiovascular disease	F: 2 to 5 session/week I: NOT REPORTED T: 30 to 60 minutes/session or 2.5 to 3km T: Nordic walking Total duration: 3 to 24 weeks	Nordic Walking (NW) additional to conventional cardiovascular rehabilitation (CCVR) in individuals with coronary artery disease has a positive effect on exercise capacity (METs: SMD 0.49; 95%CI 0.04 to 0.93) and no effect on aerobic performance (6MWT: SMD 0.12; 95% CI -0.32 to 0.56). For peripheral artery disease patients NW has a statistically significant effect compared to non-exercise controls on aerobic capacity (exercise duration: SMD 0.93; 95%CI 0.52 to 1.34; $\dot{V}O_2max$: SMD 0.64; 95%CI 0.23 to 1.04). But compared to traditional walking (TW), NW is less effective (TW vs NW ES 0.1 to 0.6 for exercise duration and $\dot{V}O_2max$). For patients with heart failure NW showed positive but not always statistically significant results compared to CCVR and usual care. In a meta-analysis these findings were not established ($\dot{V}O_2max$ SMD 0.29; 95%CI -0.10 to 0.68; 6MWT 0.29; 95%CI -.0.04 to 0.62). For post-stroke survivors NW-treadmill training showed positive results compared to traditional treadmill training (SMD: 0.80; 95%CI 0.08 to 1.52). Due to the overall low to moderate quality of the studies included in the present review (median PEDro score: 5), cautious interpretation of the studies' findings is recommended.	MA: <u>positive</u> result, only for comparisons with non-exercise controls
Dale 2015	*2 RCT n=39 Respiratory disease*	*F: 2 to 3 session/week I: 80% of walking speed on initial 6MWT and progressed weekly, initial intensity of 60% peak work at baseline incremental cycle test and progressed weekly T: 15 to 30 minutes/session T: Cycling, walking Total duration: 8 weeks*	*For patients with non-malignant dust-related respiratory diseases exercise training has a positive effect on aerobic performance (6MWT increase of 54m; 95%CI 34 to 73) and no effect in maximal exercise capacity (peak work rate increase of 10 watts; 95%CI -0.4 to 4.4). The quality of this evidence is rated very low, although the risk of bias is judged very low.*	*MA: <u>inconclusive</u>*

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Doyle 2019	11 RCT, 7 nonRCT n=2175 Cardiovascular disease	F: 1 to 14 session/week I: 3 to 7 RPE (10pt scale), 10 to 13 RPE, 65 to 75% max HR, anaerobic threshold T: 3 to 60 minutes/session T: Walking, stationary cycling or both Total duration: length of hospital stay to 6 months	Aerobic exercise early after cardiac surgery has a positive effect on aerobic fitness, both when started immediate postoperative (6MWT mean difference 69.5m; 95%CI 39.2 to 99.7) and when started early postoperative ($\dot{V}O_2$peak mean difference 3.20ml/kg/min; 95%CI 1.45 to 4.95). However, for the early started aerobic exercise for 6MWT the number of patients was too small, and controls tend to improve a little more.	MA: <u>positive</u> result for all comparisons
Fukuta 2016	5 RCT n=245 Cardiovascular disease	F: 2 to 3 session/week I: NOT REPORTED T: 20 to 60 minutes/session T: Walking, walking and cycling, cycling and cycling and resistance training Total duration: 12 to 24 weeks	Exercise training in patients with heart failure with preserved ejection fraction has a positive effect on aerobic capacity ($\dot{V}O_2$peak: weighted mean difference 2.283 ml/kg/min; 95%CI 1.318 to 3.248) and on aerobic performance (6MWD: weighted mean difference 30.275; 95%CI 4.315 to 56.234)	MA: <u>positive</u> result for all comparisons
Gardner 2014	*5 RCT, 5 nonRCT* *n=565* *Oncologic disease*	*F: 1 to 5 session/week* *I: 55% to 85% HRmax, 11 to 15 RPE, 50% to 75% peak oxygen uptake* *T: 15 to 60 minutes/session* *T: Walking, aerobic exercises* *Total duration: 12-24 weeks*	*Exercise training in patients with prostate cancer receiving androgen-deprivation therapy has inconclusive effects on aerobic capacity ($\dot{V}O_2$max: a positive effect in 1 study and not statistically significant in 3 studies), and in exercise performance (6MWT: positive in 2 studies, not statistically significant in 1 study; 400m walk: positive in 2 studies, not statistically significant in 1 study; Time to reach rate of perceived exertion of 15 in treadmill protocol: 1 positive study). Rik of bias scores are of the underlying studies are low to moderate (scores 4 to 6 out of 7), due to the fact that not all underlying studies were RCTs and participants and therapists were not blinded.*	*NAn:* <u>*inconclusive*</u>

Supplementary File D Interventions and summary of the evidence of all included reviews.
Reviews with complete FITT-criteria AND risk of bias analysis highlighted in in italic

Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Golledge 2019	*11 RCT n=524 Cardiovascular disease*	*F: 3 to 5 session/week I: until severe leg discomfort experienced, a speed that evokes strong claudication pain, severe discomfort (12–14 on Borg rating), a brisk pace that elicits pain within 3–5minutes T: 10 to 50 minutes/session T: Walking Total duration: 6 to 36 weeks*	*Structured home based exercise programs in patients with peripheral artery disease has a positive effect on aerobic performance (6MWT: SMD 0.28; 95%CI 0.09 to 0.47; walking distance treadmill SMD 0.32; 95%CI 0.15 to 0.50; claudication onset distance on treadmill SMD 0.45; 95%CI 0.27 to 0.62) compared to non-exercise controls. The majority of the underlying studies did not report on blinding of the assessors.*	*MA: <u>positive</u> result for all comparisons*
Gomes-Neto 2019	2 RCT n=59 Metabolic diseases	F: 3 session/week I: NOT REPORTED T: 12 to 24 minutes/session T: Whole to body vibration training alone or in combination with exercises on the spot Total duration: 8 to 12 weeks	Whole body vibration in older patients with diabetes type 2 has a positive effect on aerobic performance (6MWT/1 mile track walk: SMD 0.73; 95%CI 0,20 to 1.27) compared to not-descried controls. The included studies scored 2/10 and 5/10 on Pedro scale.	MA: <u>positive</u> result for all comparisons
Halloway 2015	1 RCT n=30 Frail older adults	F: 2 to 4 session/week I: NOT REPORTED T: 30 minutes/session T: Walking, individual exercises Total duration: 3 to 6 weeks	Prehabilitation prior to elective total hip surgery in frail patients has a positive effect on aerobic performance in 1 out of 1 study (6MWT: Effect Size (d) 0.37) compared to controls that received usual care. Risk of bias of the underlying study was not assessed.	NAn: <u>positive</u> result for all studies
Hernandez 2015	5 RCT n=131 Cognitive impairment	F: 3 to 5 session/week I: moderate to intensive (subjective inability to speak a sentence) T: 15 to 45 minutes/session T: Walking, multimodal exercise, cycling Total duration: 2 to 6 months	Exercise programs (both multimodal and aerobic programs) in patients with Alzheimer's disease (AD) show positive effects in aerobic capacity in 1 out of 1 study ($\dot{V}O_2$ at cycle ergometer test) and aerobic performance in 3 out of 3 studies(shuttle walk (1/1), 6MWT (2/2)) in all studies. One study showed different effects for moderate and for severe AD, with negative results for severe AD. Other studies showed a positive effect for severe AD. 2/5 studies had no control group. In the other 3 studies assessors AND participants were blinded in 1 of 3.	NAn: <u>positive</u> result for all studies

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Heyn 2008	14RCT, 1 nonRCT n=1057 Mixed	F: 2 to 5 session/week I: NOT REPORTED T: 30 to 90 minutes/session T: Aerobic training, variable-intensity group exercise program, multicomponent functional fitness training, endurance exercises Total duration: 2 to 40 weeks	Exercise programs in cognitively intact older adults had a statistically significant positive effect on aerobic performance in 4 out of 6 studies (6MWT or other walking endurance test, ES 0.047 to 2.169). In cognitively impaired older adults 2 out of 9 studies showed positive results on aerobic performance (6MWT or other walking endurance test, ES 0,230 to 0.555). A quality assessment was performed but not used in the interpretation of results.	MA: <u>positive</u> result for all comparisons
Howes 2017	8 RCT n=427 Mixed	F: 1 to 4 session/week I: NOT REPORTED T: 45 to 90 minutes/session T: Active computer gaming Total duration: 4 weeks to 6 months	Active computer gaming in older adults shows a small positive effect on aerobic performance (6MWT and other walking distance test: SMD 0.29; 95%CI 0.04 to 0.55). Subgroup analyses on types of control (active – no exercise) showed no effect in either group. Sensitivity analyses showed a dose-effect relation: a moderate effect for >120 minutes per week , and a large effect for studies >150 minutes per week. This evidence was graded as very low quality	MA: <u>positive</u> result for all comparisons
Huang 2002, 2005, 2016	23 RCT, 18 nonRCT n=2102 (Healthy) older adults	F: 1 to 4.9 session/week I: 60% to 85% HRmax, 50% to 82% $\dot{V}O_2$max, 35% to 80% HRR, 107 to 129 bpm HRmax T: 20 to 60 minutes/session T: Walking, jogging, cycling, stair to climbing, aerobic dance, tai chi chuan, outdoor performance or aerobic games Total duration: 8 to 52 weeks	Aerobic exercise in sedentary older adults shows a positive effect on aerobic capacity ($\dot{V}O_2$max: Standardized ES: 0,64; 95%CI 0,56 to 0,73, i.e. an increase of 3,50 ml/kg/min; 95%CI 1,83 to 5,17). A greater increase was seen in studies with a longer duration (>20/24/32 weeks), intensity 60 to 65% of $\dot{V}O_2$max, time>30 min. The quality of the underlying studies was variable, but the risk of bias was not included in the interpretation of the results.	MA: <u>positive</u> result for all comparisons

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Hurst 2019	*20 RCT, 4 nonRCT n=1131 (Healthy) older adults*	*F: 2 to 3 session/week I: 50 to 75% HRmax, 60 to 80% HRR, 80% HRVT₂ or RPE 12 to 14 T: 30 to 90 minutes/session T: Combined (strength and endurance) training and endurance training ((Treadmill) walking, running, cycling, cross-trainer, stationary cycling, dance) Total duration: 6 to 52 weeks*	*Combined aerobic and strength training in healthy olde2r adults shows a positive effect on aerobic capacity ($\dot{V}O_2$peak: increase of 3.6 ml/kg/min; 95%CI 2.8 to 4.4) and on aerobic performance (6MWT: increase of 29.6m; 95%CI 9.1 to 50.1) compared to non-exercise controls. There was a not statistically significant effect on aerobic capacity ($\dot{V}O_2$peak) compared to aerobic training alone and a not statistically significant effect on aerobic endurance (6MWT) compared to strength training alone. The risk of bias in underlying studies was low or unclear, and authors mentioned a possible bias due to the exclusion of studies with other outcome measures than the predefined ($\dot{V}O_2$peak and 6MWT)*	*MA: <u>positive</u> result, only for comparisons with non-exercise controls*
Hwang 2015	1 nonRCT n=97 (Healthy) older adults	F: 2 session/week I: NOT REPORTED T: 50 minutes/session T: Dance Total duration: 12 weeks	Dancing interventions older adults improve aerobic capacity ($\dot{V}O_2$max) in 1 out of 1 study. No specific outcome measure was reported. The quality of the study was moderate, the design was quasi-experimental.	NAn: <u>positive</u> result for all studies
Kanach 2018	*4 RCT n=556 Older adults, hospitalized for acute medical illness*	*F: 5 to 35 session/week I: 125% of best 6 MWD, 85% predicted $\dot{V}O_2$max T: 10 to 60 minutes/session T: Aerobic walking, combined training with aerobic component Total duration: hospital length of stay to 18 months*	*Structured exercise Interventions for older adults hospitalized with acute medical illness shows positive results on aerobic capacity ($\dot{V}O_2$max) in one single study, and on aerobic performance (6MWT and shuttle walk test) in 3 out of 4 studies, all compared to non-exercise controls. The evidence is of low quality.*	*NAn: <u>positive</u> result for >75% of all studies*

Supplementary File D Interventions and summary of the evidence of all included reviews.
Reviews with complete FITT-criteria AND risk of bias analysis highlighted in in italic

Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Keogh 2012	8 RCT, 4 nonRCT n=289 Oncologic disease	F: 2 to 7 session/week I: NOT REPORTED T: NOT REPORTED T: Aerobics training or aerobics training combined with either strength or eccentric training Total duration: 8 to 26 weeks	Group based exercise in prostate cancer patients shows positive results for aerobic capacity in 2 out of 3 studies (increase in V̇O₂max 9%, in METs 47%), and for aerobic performance in 2 out of 4 studies (increase in 6MWT 9%, in 400m walk 11%). Homebased exercise in this group shows positive results for aerobic endurance in 2 out of 4 studies (increase in 6MWT 11%, shuttle walk 13%). The evidence for group based exercise is judged as grade A, and the evidence for home based evidence is judged as grade B.	NAn: inconclusive
Kuijlaars 2019	*2 RCT* *n=67* *Trauma*	*F: 1 to 2 session/week* *I: 65 to 75% predicted HRmax* *T: 30 to 40 minutes/session* *T: Walking and stair walking* *Total duration: 3 months*	*Supervised home-based exercise therapy in patients after hip fracture shows no statistically significant results for aerobic performance (6MWT).* *The evidence was of moderate quality, risk of bias of the underlying studies was moderate to due to the lack of allocation concealment, blinding of participants and therapists, and in one study blinding of assessors.*	*NAn: not statistically significant result*
Lam 2018	*7 RCT* *n=402* *Cognitive impairment*	*F: 2 to 4 session/week* *I: 30 to 60% V̇O₂max,62 or 40% of heart rate reserve that gradually progressed to 85%* *T: 30 to 90 minutes/session* *T: Aerobic training, walking exercise, or multimodal exercise* *Total duration: 9 weeks to 12 months*	*Physical exercise in older people with cognitive impairment shows a positive effect on aerobic performance (increase in 6MWT 50m; 95%CI 18 to 81) compared to non-exercise controls. In institutionalized programs these results could not be established. Trials that reported positive findings adopted either specific aerobic training, walking exercise, or multimodal exercise, with a training duration ranging from 30 to 90 minutes/session, 2 to 4 session/week, for a total of 9 weeks to 12 months. Reported effective training intensity was 30 to 60% V̇O₂max, or 40% of heart rate reserve that gradually progressed to 85%.* *Publication bias was present in this analysis. The quality of the evidence is moderate, risk of bias was low.*	*MA: positive result for all comparisons*

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Lee 2017	*4 RCT n=164 Respiratory disease*	*F: 2 to 7 session/week* *I: 80% peak HR achieved on initial incremental exercise test, 75 to 85% of $\dot{V}O_2$max, 60% max of 6MWT* *T: 30 to 45 minutes/session* *T: (Treadmill) walking, cycling, stair climbing, ski machine* *Total duration: 8 weeks*	*Exercise training in patients with non-cystic fibrosis bronchiectasis shows no effect on aerobic capacity ($\dot{V}O_2$max) in 1 single study, and a positive effect on aerobic performance (shuttle walk test: MD 66.62m; 95%CI 51.57 to 81.68; 6MWD: increase of 32m (1 study)).* *Risk of bias in the underlying studies was low or unclear.*	*MA: positive result for all comparisons*
Leggio 2019	9 RCT n=348 Cardiovascular disease	F: 2 to 3 session/week I: NOT REPORTED T: 20-40 to 60 minutes T: Aerobic exercise training, walking, and treadmill and bicycle ergometer Total duration: 4 to 16 weeks	Exercise training in patients with heart failure with preserved ejection fraction has a positive effect on aerobic capacity ($\dot{V}O_2$peak) in 6 out of 6 studies, on aerobic performance (6MWD) in 2 out of 2 studies and on ventilatory threshold in 2 out of 2 studies. Risk of bias was moderate in all underlying studies.	NAn: positive result for all studies
Li 2019	*11 RCT n=405 Respiratory disease*	*F: 3 to 5 session/week* *I: 40 to 80% of 1RM* *T: 40 minutes/session* *T: resistance training* *Total duration: 6 to12 weeks*	*Resistance training in elderly patients with COPD shows a positive effect on aerobic performance in two out of three measures (6MWD WMD 54.52; 95%CI 25.47 to 83.56; 6min peg-and-ring test: WMD 25.17; 95%CI 10.17 to 40.16; no statistically significant effect in constant work rate endurance test) and on aerobic capacity in 1 out of 2 measures (UULEX: SMD 0.41 95%CI 0.03 to 0.79; no statistically significant effect in CPET).* *Risk of bias in the underlying studies was moderate to high.*	*MA: inconclusive*

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Liao 2015	*10 RCT n=333 Respiratory disease*	*F: 2 to 3 session/week I: 60% work rate, 1 level below the maximum level achieved on the unsupported arm test, intensity increased according to breathlessness and perceived arm exertion, 50% maximum work capacity, 3 metabolic equivalents, 60% V̇O₂peak T: 20 to 60 minutes/session T: Treadmill walking, cycle ergometer, arm cranking Total duration: 8 to 12 weeks*	*Resistance training in elderly patients with COPD shows no effect on aerobic performance (6MWD; 6 minute peg-and-ring test; max workload) and on aerobic capacity (V̇O₂max). Risk of bias of the underlying studies was high, especially because in most studies no intention to treat analysis was performed.*	*NAn: not statistically significant result*
Paneroni 2017	*8 RCT n=396 Respiratory disease*	*F: 1 to 5 session/week I: high intensity ranging from 70% to 90% of the maximum load or velocity reached during incremental tests in three studies T: 15 to 30 minutes/session T: Cycling, (treadmill) walking or a combination Total duration: 4 to 52 weeks*	*Aerobic training in patients with very severe COPD shows a positive effect on aerobic performance (6MWT: WMD 67.1m; 95%CI 37.9 to 98.9). Risk of bias of the underlying studies was high.*	*MA: positive result for all comparisons*

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Article author year	Number/ type of relevant studies, Number (n) of participants, Group	Characteristics of the intervention	Summary of the evidence	Conclusion
Parmenter 2013	*24 RCT n=924 Cardiovascular disease*	*F: 2 to 5 session/week I: intensity focussed on moderate to maximum pain or 60 to 90% V̇O₂peak T: 16 to 60 minutes/session T: (Treadmill) walking, lower limb aerobics, pole striding, arm cranking Total duration: 6 to 76 weeks*	*Exercise in patients with intermittent claudication has a positive effect on aerobic performance in 10 out of 16 studies (6MWT-ICD 3/5 studies; 6 MWT-TWD 4/7 studies; shuttle walk-ICD: 1/2 studies; shuttle walk-TWD: 2/2 studies) and on aerobic capacity in 9 out of 24 studies (V̇O₂peak 9/24 studies) compared to non-exercise controls. It has a positive effect on aerobic performance in 0 out of 9 studies (6MWT-ICD 0/2 studies; 6 MWT-TWD 0/3 studies; shuttle walk-ICD: 0/2 studies; shuttle walk-TWD: 0/2 studies) and on aerobic capacity (V̇O₂peak) in 0 out of 14 studies compared to exercise controls. The risk of bias is high due to the fact that assessors were not blinded.*	*NAn: <u>inconclusive</u>*
Patel 2012	4 RCT n=265 (Healthy) older adults	F: 1 (+home exercise) to 2 session/week I: NOT REPORTED T: 60 to 90 minutes/session T: (Supervised) aerobic exercise, resistance training Total duration: 16 to 26 weeks	Yoga in older adults shows a positive effect on aerobic capacity (V̇O₂max SMD 0.54; 95%CI 0.08 to 1.00) compared to aerobic exercise. Risk of bias in the underlying studies is not clear.	MA: <u>positive</u> result for all comparisons
Pengelly 2019	*2 RCT, 7 nonRCT n=246 Cardiovascular disease*	*F: 5 to 7 session/week I: 60% 1RM (1 set 8 to 12 repetitions) , RPE 13 20, starting at 50% max power output T: 60 to 90 minutes/session T: aerobic strength and balance exercises, callisthenics Total duration: 3 to 4 weeks*	*Additional training (duration 60 to 90 minutes, and additional resistance training and balance training) in cardiac rehabilitation in patients following median sternotomy has a positive effect on aerobic performance (6MWT increase of 27m; 95%CI 7 to 47) an no effect on aerobic capacity (V̇O₂max and maximal power output) compared to standard care consisting of aerobic and callisthenic exercises alone. Risk of bias of the studies not properly reported for the two relevant studies, study quality was fair to good.*	*MA: <u>inconclusive</u>*

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Puhan 2016	18 RCT n=1368 Respiratory disease	F: 2 to 35 session/week I: NOT REPORTED T: 10 to 120 minutes/session T: Supervised and unsupervised inpatient and/ or outpatient pulmonary rehabilitation (treadmill walking, walking, cycling, stair climbing, aerobic activities, endurance training) Total duration: 4 days to 6 months	Pulmonary rehabilitation following exacerbation of COPD shows a positive effect on aerobic performance (6MWT increase 62m; 95%CI 38 to 86; I2=87% (13 studies), 3MWT no statistically significant increase (1 study)). The evidence was rated high quality, and was not downgraded for statistical heterogeneity because the pooled effect is large and well above MIC (i.e. 30m).	MA: positive result for all comparisons
Rezende Barbosa 2018	3 RTC n=227 (Healthy) older adults	F: NOT REPORTED I: 65 to 70%V̇O₂peak (15 min) T: 10 to 60 minutes/session T: Multimodal exercise programmes Total duration: 12 weeks to 11 months	Functional training in different populations has no effect on aerobic capacity (V̇O₂max difference -1.0; 95%CI -5.4 to 3.3). Risk of bias in the studies was high.	NAn: not statistically significant result
Ribeiro 2017	*5 RCT* *n=1797* *Cardiovascular disease*	*F: 1 to 18 session/week* *I: intensity low to medium, 70% of HRmax predict or 14 RPE on Borgscale* *T: 30 minutes/session* *T: Aerobic exercise, cycling or cycle ergometer, treadmill or outdoor walking, (group) gymnastics* *Total duration: 2 to 3 weeks*	*Cardiac rehabilitation programme after transcatheter aortic valve implantation (TAVI) and surgical aortic valve replacement (sAVR) has a positive effect on aerobic performance (6MWT increase of 71m (38%; SMD 0.69; 95%CI 0.47 to 0.91) post-TAVI, and an increase of 87m (38%, SMD 0.79; 95%CI 0.43 to 1.15) post-sAVR) compared to at the start of the programme.* *Due to the fact that the studies had no control groups the risk of bias is high.*	*MA: positive result for all comparisons*

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Article author year	Number/ type of relevant studies, Number (n) of participants, Group	Characteristics of the intervention	Summary of the evidence	Conclusion
Rodrigues-Krause 2016	3RCT, 1 nonRCT n=237 Mixed	F: 1 to 3 session/week I: 70% V̇O_2peak, 100 to 120 bpm, 13 to 14RPE T: 40 to 60 minutes/session T: Dance, aerobic training (cycle ergometer, treadmill or both) Total duration: 8 to 24 weeks	Dance interventions in older adults show an positive effect on aerobic capacity (V̇O_2peak increase of 3.4ml/kg/min; 95%CI 1.08 to 7.78) compared to non-exercise controls, and no effect on aerobic capacity (V̇O_2peak) compared to other exercises. Risk of bias was considered serious, due to lack of blinded assessment of the outcome, lack of intention to treat principle for data analysis and considerable heterogeneity among studies.	MA: positive result, only for comparisons with non-exercise controls
Rodrigues-Krause/2019	10 RCT, 2 nonRCT n=893 Mixed	F: 1 to 3 session/week I: 50 to 75% V̇O_2peak, 11 to 14 Borg scale (specifications unclear), 50 to 70% HRmax, 50 to 120 bpm music (salsa goes up to 180 bpm), 50 to 70% HRR, 4.0 to 7.5 METs/hour or low to moderate intensity (unspecified) T: 30 to 90 minutes/session T: Dance (folk dance, aerobic dance, Argentine tango, waltz, foxtrot). Aerobic training (cycle ergometer, treadmill or both). Total duration: 6 to 104 weeks	Dancing in older adults shows a positive effect compared to non-exercise controls on aerobic capacity (V̇O_2peak) in 4 out of 6 studies, and on aerobic endurance (6MWT) in all 8 studies. There were no effects on aerobic capacity compared to other exercise interventions (2 studies), although in one study the intensity of dance was higher than walking. Risk of bias in the majority of studies was high, due to a lack of appropriate description of the generation of randomized sequences and of the methods of allocation concealment.	NAn: positive result for >75% of all studies
Rosero 2019	*9 RCT* *n=648* *Oncologic disease*	*F: 3 to 14 session/week* *I: 60 to 80% peak work capacity* *T: 20 to 60 minutes/session* *T: Aerobic training, multicomponent training (aerobic exercise combined with IMT and or strength training)* *Total duration: 1 to 4 weeks*	*Preoperative physical exercise interventions in patients with non-small-cell lung cancer has a positive effect on aerobic performance (6MWT SMD 0.27; 95%CI 0.11 to 0.44) and on aerobic capacity (V̇O_2peak SMD 0.78; 95%CI 0.35 to 1.12) compared to controls.* *Risk of bias was moderate in the majority of the studies although participants and therapists could not be blinded.*	*MA: positive result for all comparisons*

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Rydwik 2004	*4 RCT n=554 Frail older adults*	*F: 2 to 3 session/week I: 50 to 65% progressively, >70% or 80% (units of measurement unclear) T: 2 to 20 minutes/session T: Aerobic training Total duration: 9 to 52 weeks*	*Physical training in institutionalized elder persons had a positive effect on 'endurance' in 2 out of 4 studies. The evidence was judged low to high, and risk of bias was also low to high*	*NAn: <u>inconclusive</u>*
Ryrso 2018	*11 RCT n=723 Respiratory disease*	*F: 2 to 7 session/week I: 60 to 80% of max work load , >75% of max walking distance, 60 to 70% $\dot{V}O_2$max or HRmax, Borg breathlessness score 3 to 4 T: 30 to 40 minutes/session T: (Treadmill) walking, cycling and/or tailored aerobic activities / exercise (supervised and unsupervised) Total duration: 10 days to 6 months*	*Early supervised pulmonary rehabilitation (PR) following COPD-exacerbations shows a positive effect on aerobic performance (6MWT increase 76.89m; 95%CI 21.34 to 132.45; SWT increase 54.70m; 95%CI 30.83 to 78.57) at the end of treatment compared to usual care. The subgroup analysis showed no difference in the effect between PR initiated during admission and after discharge. Rik of bias was serious, due to unclear sequence generation, allocation concealment and blinding of assessors.*	*MA: <u>positive</u> result for all comparisons*
Scheerman 2018	3 RCT n=260 Older adults, hospitalized for acute medical illness	F: 3 to 18 session/week I: NOT REPORTED T: 1 to 45 minutes/session T: tai chi principles, muscle strengthening exercises, electrical stimulation, walking (backward and forward). Total duration: 1 to 6 weeks	Physical interventions in older patients during hospitalization showed a positive effect on aerobic performance (6MWT) in 1 out of 3 studies. Risk of bias was moderate, due to the fact that blinding of therapists and patients is not possible. Assessors were blinded in all studies.	NAn: <u>inconclusive</u>

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Article author year	**Number/ type of relevant studies, Number (n) of participants, Group**	**Characteristics of the intervention**	**Summary of the evidence**	**Conclusion**
Slimani 2018	11 RCT n=2624 Cardiovascular disease	F: 1 to 13 session/week I: NOT REPORTED T: 25 to 60 minutes/session T: Aerobic training, resistance training or a combination of both Total duration: 6 to 54 weeks	Physical Training in Older Patients With Heart Failure has a positive effect on aerobic performance (6MWT ES 0.43; 95%CI 0.15 to 0.71) compared to controls with unknown conditions. Resistance training had a larger effect (ES = 1.71; 95%CI 1.03 to 2.39), aerobic training had a smaller effect (ES = 0.51; 95%CI 0.30 to 0.72). Combined aerobic and resistance training had no statistically significant effect (ES = 0.15;95%CI −0.24 to 0.53). Dose–response analyses showed that none of the training variables predicted changes in aerobic capacity or cardiac function. Risk of bias of the underlying studies was not assessed.	MA: <u>positive</u> result for all comparisons
Vieira 2010	*12 RCT n=728 Respiratory disease*	*F: 4 to 14 session/week I: 70% max SWT T: 15 to 45 minutes/session T: Walking, stair climbing, cycling or a combination Total duration: 3 to 52 weeks*	*Home-based pulmonary rehabilitation in COPD-patients shows an increase in aerobic performance (diverse walking tests 8/9 increase in intervention group vs 2/9 in controls) and aerobic capacity (work rate and $\dot{V}O_2$max: 2/5 positive in intervention vs (0/5 increase AND 2/5 decrease in controls)). Compared to hospital-based rehabilitation no differences were found. Risk of bias was high in the majority of studies due to lack of concealed allocation and of blinding of assessors.*	*NAn: <u>positive</u> result, only for all studies with non-exercise controls*
Wee 2018	*4 RCT n=227 Cardiovascular disease*	*F: 2 to 3 session/week I: moderate to high T: 22 to 45 minutes/session T: continuous exercise, high intensity training (HIT) Total duration: 4 to 12 weeks*	*Preoperative exercise for patients with abdominal aortic aneurysm has a positive effect on $\dot{V}O_2$peak and in anaerobic threshold in 1 out of 2 studies. For patients without an indication for surgery no increase in $\dot{V}O_2$peak was found (0/2), but a positive effect on anaerobic (1/1) en ventilatory threshold (1/2). Risk of bias was high, due to lack of blinding of the assessors in the majority of studies.*	*NAn: <u>inconclusive</u>*

Appendix 3 Interventions and summary of the evidence of all included reviews.

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Reviews with complete FITT-criteria AND with risk of bias analysis are hightlighted *in italics*: these reviews are included in the subgroup analyses on categories with specific health status or diagnoses:

Type of relevant studies: *RCT*: Randomized controlled trial; *nonRCT*: other design than Randomized controlled trial

Characteristics of the intervention: Frequency, Intensity, Time and Type of exercise. *1RM*: 1 repetion maximum; *6MWD*: 6 minute walking distance; *6MWT*: 6 minute walking test; bpm: beats per minute; *HRmax*: Maximum heart rate; *HRR*: Heart rate reserve; *HRVT2*: Heart rate at the second ventilatory threshold; *MET*: metabolic equivalent; *RPE*: rate of perceived exertion; *VT*: ventilatory threshold; *$\dot{V}O_2max$:* maximum oxygen consumption; *$\dot{V}O_2peak$:* peak oxygen consumption

Summary of the evidence: *1RM*: one repetition maximum; *6MWD*: 6 minute walking distance; *6MWT*: 6 minute walking test; *CI*: confidential interval; *COPD*: chronic obstructive pulmonary disease; *CPET*: Cardio Pulmonary Exercise testing; *ES*: Effect size; *ICD*: initial claudication distance; *MD*: Mean difference; *MET*: metabolic equivalent; *sAVR*: Surgical aortic valve replacement; *SMD*: standardized mean difference; *SWT*: Shuttle walk test; *TAVI*: Transcatheter aortic valve implantation; *TWD*: total walking distance; *UULEX*: Unsupported Upper Limb Exercise test; *$\dot{V}O_2max$:* maximum oxygen consumption; *$\dot{V}O_2peak$:* peak oxygen consumption; *WMD*: weighted mean difference;

Conclusion*: MA:* Meta-*analysis*; *NAn:* Narrative analysis

Supplementary File E. List of excluded reviews

Review	Reason for exclusion
Aamann, 2018[1]	Age of participants <65
Al-Jundi, 2013[2]	Not a systematic review and no cardiorespiratory outcomes
Baschung Pfister, 2015[3]	No cardiorespiratory outcomes
Bennett, 2019[4]	Age of participants <65
Bullo, 2015[5]	No cardiorespiratory outcomes
Burton, 2019[6]	Intervention not aimed at cardiorespiratory fitness and no cardiorespiratory outcomes
Cardim, 2016[7]	Intervention not aimed at cardiorespiratory fitness
Heyn, 2004[8]	No cardiorespiratory outcomes
Keysor, 2001[9]	No cardiorespiratory outcomes
Knips, 2019[10]	Age of participants <65
van der Bij, 2002[11]	No cardiorespiratory outcomes

1. Aamann L, Dam G, Rinnov AR, Vilstrup H, Gluud LL. Physical exercise for people with cirrhosis. *Cochrane Database Syst Rev.* 2018;12:CD012678.
2. Al-Jundi W, Madbak K, Beard JD, Nawaz S, Tew GA. Systematic review of home-based exercise programmes for individuals with intermittent claudication. *Eur J Vasc Endovasc Surg.* 2013;46(6):690-706.
3. Baschung Pfister P, de Bruin ED, Tobler-Ammann BC, Maurer B, Knols RH. The relevance of applying exercise training principles when designing therapeutic interventions for patients with inflammatory myopathies: a systematic review. *Rheumatol Int.* 2015;35(10):1641-1654.
4. Bennett H, Slattery F. Effects of Blood Flow Restriction Training on Aerobic Capacity and Performance: A Systematic Review. *J Strength Cond Res.* 2019;33(2):572-583.
5. Bullo V, Bergamin M, Gobbo S, et al. The effects of Pilates exercise training on physical fitness and wellbeing in the elderly: A systematic review for future exercise prescription. *Prev Med.* 2015;75:1-11.
6. Burton E, Farrier K, Galvin R, et al. Physical activity programs for older people in the community receiving home care services: systematic review and meta-analysis. *Clin Interv Aging.* 2019;14:1045-1064.
7. Cardim AB, Marinho PE, Nascimento JF, Jr., Fuzari HK, Dornelas de Andrade A. Does Whole-Body Vibration Improve the Functional Exercise Capacity of Subjects With COPD? A Meta-Analysis. *Respir Care.* 2016;61(11):1552-1559.
8. Heyn P, Abreu BC, Ottenbacher KJ. The effects of exercise training on elderly persons with cognitive impairment and dementia: a meta-analysis. *Arch Phys Med Rehabil.* 2004;85(10):1694-1704.
9. Keysor JJ, Jette AM. Have we oversold the benefit of late-life exercise? *J Gerontol A Biol Sci Med Sci.* 2001;56(7):M412-423.
10. Knips L, Bergenthal N, Streckmann F, Monsef I, Elter T, Skoetz N. Aerobic physical exercise for adult patients with haematological malignancies. *Cochrane Database Syst Rev.* 2019;1:CD009075.
11. van der Bij AK, Laurant MG, Wensing M. Effectiveness of physical activity interventions for older adults: a review. *Am J Prev Med.* 2002;22(2):120-133.

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Supplementary File F. Results of AMSTAR 2 review quality assessment.

Review	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9 RCT	Item 9 NRSI	Item 10	Item 11 RCT	Item 11 NRSI	Item 12	Item 13	Item 14	Item 15	Item 16
Ada, 2010	+	-	+	+/-	-	+	+	+/-	+	NA*	-	+	NA**	+	+	+	-	-
Angevaren, 2008	+	+	-	+	+	+	+	+	+	NA*	-	+	NA**	+	+	+	+	+
Anthony, 2013	-	-	-	+/-	-	-	-	-	+	NA*	-	NA**	NA**	NA**	-	-	NA**	-
Baker, 2007	-	-	-	-	+	+	+	+	+	NA*	-	NA**	NA**	NA**	-	+	-	+
Blankevoort, 2010	-	-	+	-	+	-	-	+/-	+	+	-	-	-	-	-	-	-	+
Bouaziz, 2015	+	-	-	-	+	-	-	+/-	-	-	-	NA**	NA**	NA**	-	-	NA**	+
Bouaziz, 2016	-	-	-	-	+	-	-	-	-	-	-	NA**	NA**	NA**	-	+	NA**	+
Bouaziz, 2018	+	-	-	-	+	-	-	+/-	+	NA*	-	+	NA**	-	-	+	+	+
Bruns, 2016	-	+/-	-	-	+	+	-	+/-	+	+	-	NA**	NA**	NA**	-	+	NA**	+
Bueno- de Souza, 2018	+	-	-	-	+	-	-	+	+	NA*	-	+	NA**	-	+	-	-	+
Bullo, 2018	+	-	-	-	+	-	-	+/-	+	-	-	-	-	-	-	+	-	+
Cugusi, 2017	-	-	-	+/-	+	+	+	+/-	+	NA*	-	+	NA**	-	-	+	+	-
Dale, 2015	+	+	-	+	+	+	+	+	+	NA*	+	+	NA**	+	+	+	+	+
Doyle, 2019	+	-	-	-	+	+	-	+/-	-	-	-	+	-	-	-	+	-	+
Fukuta, 2016	+	-	-	+/-	+	-	-	+/-	-	NA*	-	+	NA**	-	-	+	+	+
Gardner, 2014	+	-	-	-	+	+	-	+/-	+	+	-	NA**	NA**	NA**	-	+	NA**	+
Golledge, 2019	+	-	-	+/-	+	+	-	+/-	+	NA*	-	+	NA**	-	-	-	+	+
Gomes-Neto, 2019	-	-	-	+/-	+	+	-	-	+	NA*	-	+	NA**	-	-	+	-	+
Halloway, 2015	-	-	+	-	-	+	-	+	-	NA*	-	NA**	NA**	NA**	-	+	NA**	+
Hernandez, 2015	-	+/-	-	-	+	-	-	-	-	-	-	NA**	NA**	NA**	-	-	NA**	-
Heyn, 2008	+	-	-	-	-	-	-	+/-	-	NA*	-	-	NA**	-	-	-	-	-
Howes, 2017	-	+	-	-	-	+	-	+/-	+	NA*	-	+	NA**	-	-	+	+	+
Huang, 2002, 2005, 2016	+	-	-	-	-	+	+/-	+/-	-	-	-	+	-	-	+	+	+	+
Hurst, 2019	+	+/-	-	-	+	+	-	+/-	+	-	-	+	-	-	-	+	+	+
Hwang, 2015	-	-	-	-	-	-	-	+/-	-	-	-	NA**	NA**	NA**	-	-	NA**	-
Kanach, 2018	+	-	-	+/-	+	+	-	+/-	+	-	-	NA**	NA**	NA**	-	+	NA**	-

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Supplementary File F. Results of AMSTAR 2 review quality assessment.

Review	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9 RCT	Item 9 NRSI	Item 10	Item 11 RCT	Item 11 NRSI	Item 12	Item 13	Item 14	Item 15	Item 16
Keogh, 2012	-	-	-	+/-	-	-	-	-	-	-	-	NA**	NA**	NA**	-	-	NA**	+
Kuijlaars, 2019	+	+/-	-	+/-	+	+	-	+	+	NA*	-	+	NA**	-	-	+	-	+
Lam, 2018	+	-	-	-	+	-	-	+	+	NA*	-	+	NA**	+	+	+	+	+
Lee, 2017	+	+/-	-	+/-	+	+	-	+	+	NA*	-	+	NA**	+	-	+	-	+
Leggio, 2019	+	-	-	-	+	-	-	-	+	NA*	-	NA**	NA**	NA**	-	+	NA**	+
Li, 2019	+	-	-	-	+	-	-	+/-	+	NA*	-	+	NA**	+	+	+	-	+
Liao, 2015	+	-	-	-	-	+	-	+/-	+/-	NA*	-	+	NA**	-	-	+	-	+
Paneroni, 2017	+	-	-	+/-	+	+	-	+	+	NA*	-	+	NA**	-	-	+	+	+
Parmenter, 2013	+	-	-	+/-	-	-	-	+/-	+	NA*	-	NA**	NA**	NA**	-	+	NA**	+
Patel, 2012	+	-	-	-	+	+	-	+	-	NA*	+	+	NA**	-	-	-	-	+
Pengelly, 2019	+	+/-	-	-	-	+	-	+/-	+/-	+	-	+	-	-	-	+	-	+
Puhan, 2016	+	+	-	+	+	+	+	+	+	NA*	+	+	NA**	+	+	+	+	+
Rezende Barbosa, 2018	-	+/-	-	+/-	-	+	-	-	+	NA*	-	+	NA**	+	+	-	+	+
Ribeiro, 2017	+	+/-	-	-	+	+	-	-	+	-	-	-	-	-	-	+	+	+
Rodrigues-Krause, 2016	+	+/-	+	-	+	+	-	+/-	+	+	-	+	-	-	-	+	+	+
Rodrigues-Krause, 2019	+	-	+	-	-	-	-	+	+	-	-	NA**	NA**	NA**	-	-	NA**	+
Rosero, 2019	+	-	-	-	+	+	+	+/-	+	NA*	-	+	NA**	-	-	+	+	+
Rydwik, 2004	+	-	-	-	-	-	-	+/-	+	NA*	-	NA**	NA**	NA**	+	+	NA**	-
Ryrso, 2018	+	-	-	-	+	+	-	+	+	NA*	-	+	NA**	+	+	+	-	+
Scheerman, 2018	+	-	-	-	+	+	-	+/-	+	NA*	-	NA**	NA**	NA**	+	+	NA**	+
Slimani, 2018	+	-	-	+/-	-	+	-	-	-	NA*	-	+	NA**	-	-	+	+	+
Vieira, 2010	+	-	-	-	-	+	-	+	+	NA*	-	NA**	NA**	NA**	-	-	NA**	+
Wee, 2019	+	+	-	+/-	+	+	-	+/-	+/-	-	-	NA**	NA**	NA**	-	-	NA**	+

Appendix 5 Results of AMSTAR 2 review quality assessment.

Supplementary File F. Results of AMSTAR 2 review quality assessment.

Legend: *RCT*: randomized controlled trials; *NRSI*: non-randomized studies of interventions; *"+":* yes; "-": no; *"+/-"*: partial yes; *NA**: Includes only RCT's; *NA**:* No meta-analysis conducted

Item 1 Did the research questions and inclusion criteria for the review include the components of **PICO**?; *Item 2* Did the report of the review contain an explicit statement that the **review methods were established prior to** conduct of the review and did the report justify any significant deviations from the protocol?; *Item 3* Did the review authors **explain their selection of the study designs** for inclusion in the review?; *Item 4* Did the review authors use a **comprehensive literature search strategy**?; *Item 5* Did the review authors perform **study selection in duplicate**?; *Item 6* Did the review authors perform **data extraction in duplicate**?; *Item 7* Did the review authors provide **a list of excluded studies** and justify the exclusions?; *Item 8* Did the review authors **describe the included studies in adequate detail**?; *Item 9* Did the review authors use a **satisfactory technique for assessing the risk of bias (RoB)** in individual studies that were included in the review?; *Item 10* Did the review authors **report on the sources of funding** for the studies included in the review?; *Item 11* If meta-analysis was justified did the review authors use **appropriate methods** for statistical combination of results? (Only complete this item if meta-analysis of other data synthesis techniques were reported); *Item 12* If meta-analysis was performed did the review authors **assess the potential impact of RoB** in individual studies on the results of the meta-analysis or other evidence synthesis?; *Item 13* Did the review authors **account for RoB in individual studies when interpreting/ discussing the results** of the review?; *Item 14* Did the review authors provide a satisfactory **explanation for, and discussion of, any heterogeneity observed** in the results of the review?; *Item 15* If they performed quantitative synthesis did the review authors carry out an adequate **investigation of publication bias** (small study bias) and discuss its likely impact on the results of the review?; *Item 16* Did the review authors report any **potential sources of conflict of interest**, including any funding they received for conducting the review?;

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