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Effects of High-Intensity Interval Training in Older Adults: A Systematic Review of Randomized and Clinical Trials

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INTRODUCTION

Review question / Objective The systematic review aimed to answer the following question: in older adults and clinically relevant aging populations, what are the effects of high-intensity interval training or aerobic interval training, compared with moderate-intensity continuous training, usual care, and non-exercise control, or alternative exercise interventions, on cardiorespiratory, metabolic, functional, cognitive, psychological, and quality-of-life outcomes?

P (População): Adultos saudáveis que praticam CrossFit, treinamento funcional de alta intensidade ou programas de condicionamento físico funcional.
I (Intervenção): Exposição ao CrossFit ou outras estratégias de treinamento funcional de alta intensidade.
C (Comparison): No training, traditional training methods, or pre/post comparisons (depending on included studies).

Rationale This systematic review is based on the growing need to identify effective, safe, and feasible physical exercise strategies to address the challenges associated with population aging. Aging is frequently associated with a progressive decline in cardiorespiratory capacity, metabolic function, functional fitness, cognition, and quality of life, factors that contribute to increased morbidity, functional dependence, and healthcare costs.

In this context, high-intensity interval training (HIIT) and aerobic interval training (AIT) have emerged as promising interventions, as they appear to induce significant physiological adaptations in a shorter period of time than required by traditional moderate-intensity continuous training programs. This characteristic makes these modalities particularly attractive for older populations, in whom lack of time, low adherence, and functional limitations are frequent barriers to regular physical exercise.

Despite the growing volume of research in this area, the available evidence remained scattered and heterogeneous, encompassing different populations, intervention protocols, and outcome measures. Additionally, doubts persisted regarding the safety, tolerability, and magnitude of benefits of HIIT and AIT in older individuals and in aging clinical populations, especially when compared to conventional interventions or the absence of exercise.

Thus, a systematic synthesis of the literature became necessary to consolidate existing knowledge, identify gaps in scientific evidence, and provide well-founded guidelines for clinical practice and exercise prescription. By evaluating the effects of these training modalities on multiple health domains—including cardiorespiratory, metabolic, functional, cognitive, psychological, and quality of life parameters—this review seeks to contribute to the optimization of strategies for promoting healthy aging and to the development of evidence-based recommendations for elderly and clinically complex populations.

Condition being studied Aging is a complex biological process characterized by progressive changes in physiological systems that compromise functional capacity, cardiorespiratory fitness, metabolic health, and cognitive performance. These changes are frequently associated with an increased prevalence of chronic diseases, frailty, functional dependence, and reduced quality of life. Given the accelerated growth of the elderly population worldwide, identifying effective strategies to mitigate the adverse effects of aging has become a public health priority. In this context, physical exercise plays a central role in promoting healthy aging, with high-intensity interval training (HIIT) and aerobic interval training (AIT) being emerging approaches with the potential to produce significant benefits in multiple health domains. However, the evidence regarding their efficacy, safety, and applicability in elderly and clinically complex populations remains heterogeneous, justifying a systematic literature review to clarify their impact and guide evidence-based practice.

METHODS

Search strategy The search strategy was developed to maximize both sensitivity and specificity, combining controlled vocabulary terms and free-text keywords related to three conceptual domains: high-intensity interval training, older adult populations, and randomized or longitudinal clinical study designs. Boolean operators (“AND” and “OR”) were employed to combine search terms within and across domains, and the strategy was independently adapted to the indexing conventions and field-specific syntax of each database.

The PubMed search strategy was structured as follows:

("High-Intensity Interval Training"[MeSH] OR "high-intensity interval training"[tiab] OR HIIT[tiab] OR "high intensity interval training"[tiab] OR "high intensity interval exercise"[tiab] OR "aerobic interval training"[tiab]) AND ("Aged"[MeSH] OR "older adults"[tiab] OR elderly[tiab] OR aged[tiab] OR seniors[tiab] OR aging[tiab] OR "older people"[tiab]) AND ("Randomized Controlled Trial"[Publication Type] OR "Clinical Trial"[Publication Type] OR "randomized controlled trial"[tiab] OR "randomised controlled trial"[tiab] OR RCT[tiab] OR "clinical trial"[tiab])

Equivalent search strings were constructed for Scopus using TITLE-ABS-KEY field tags and for the Web of Science Core Collection using TS (Topic) field tags, with appropriate syntactic adaptations. Database-specific filters were applied where available, including restrictions to human studies, clinical and randomized controlled trial publication types, and English-language publications.

Participant or population The 34 studies included in the present review comprised a heterogeneous sample of apparently healthy older adults and clinically complex older populations presenting with a wide range of chronic cardiometabolic, neurological, pulmonary, and musculoskeletal conditions. Across studies, participants were predominantly middle-aged and older adults, with the majority of investigations recruiting individuals aged ≥60 years. However, studies involving populations characterized by premature pathological aging, particularly HIV-associated aging and intellectual disability cohorts, included participants aged ≥50 years in accordance with the accelerated biological aging profiles associated with these conditions.

Intervention The interventions evaluated in this review consisted of structured high-intensity interval training (HIIT) and aerobic interval training (AIT) programs applied to older adults and aging clinical populations. These interventions are characterized by alternating periods of high-intensity physical exertion with periods of active or passive recovery, differing from traditional continuous exercise by their intermittent nature and greater physiological demands.

Studies that implemented different exercise modalities, such as cycling, walking, running, treadmill training, ergometry, and aquatic or

resistance exercises, were included, provided they respected the fundamental principles of HIIT/AIT. The interventions varied in duration, weekly frequency, relative intensity, and interval structure, reflecting the diversity of protocols used in the literature.

Exercise intensity was defined based on objective and/or subjective parameters, including percentage of peak oxygen consumption, maximum or reserve heart rate, maximum power, maximum aerobic speed, and rating of perceived exertion scale. Only programs with structured intensity prescription or monitoring were considered.

The objective of this analysis was to evaluate the effects of these interventions on cardiorespiratory, metabolic, functional, cognitive, and psychological domains, as well as on quality of life in elderly and clinically complex populations, and to assess their safety and feasibility for application in these contexts.

Comparator Comparative interventions applied to the target population included continuous moderate-intensity training (CIT), standard medical care, no-exercise control groups, and other structured physical exercise modalities. CIT was defined as aerobic exercise performed continuously at a moderate and stable intensity, without intermittent load variations.

The standard care and no-exercise control groups corresponded to participants who received only usual clinical follow-up or who maintained their usual levels of physical activity and were used as a reference for evaluating the specific effects of interval training interventions.

Additionally, alternative structured exercise interventions were considered, allowing for comparison between different approaches to prescribing physical exercise in elderly and clinically aged populations.

Study designs to be included This systematic review will include different study designs in order to ensure a comprehensive and methodologically sound analysis of the scientific evidence on the effects of HIIT and multicomponent training in older adults. Priority will be given to randomized controlled trials (RCTs), as well as non-randomized trials, quasi-experimental studies, and longitudinal intervention studies, provided they present structured exercise programs and pre- and post-intervention assessments of variables related to physical fitness, functionality, body composition, or quality of life.

Eligibility criteria Eligible interventions comprised structured high-intensity interval training (HIIT) or aerobic interval training (AIT) protocols, defined by repeated bouts of vigorous-to-near-maximal effort interspersed with periods of active or passive recovery. Home-based, aquatic, resistance-based, and combined HIIT modalities were considered eligible provided the intervention design clearly adhered to the conceptual and operational characteristics of HIIT.
HIIT/AIT interventions were required to include repeated high-intensity exercise bouts prescribed or monitored using objective or subjective intensity markers, including percentage of peak oxygen uptake, maximal heart rate, heart-rate reserve, peak power output, maximal aerobic speed, workload, or rating of perceived exertion.

Information sources The database search identified a total of 2,370 records across PubMed (n = 614), Scopus (n = 1,382), and the Web of Science Core Collection (n = 374). Following duplicate removal, 1,326 unique records remained for title and abstract screening.
After the initial screening phase, studies that clearly failed to meet the predefined eligibility criteria were excluded. The remaining potentially eligible articles underwent full-text assessment for eligibility. Studies were excluded at this stage if they did not involve older adults or clinically relevant aging populations, lacked a clearly defined HIIT or AIT intervention, focused exclusively on acute exercise responses, or did not employ a longitudinal intervention design.
Of the 43 reports assessed for eligibility, 9 were excluded for the following reasons: acute-response study design (n = 3), ineligible population (n = 2), review or meta-analysis article (n = 1), case report design (n = 1), and protocol or non-eligible study design (n = 2).
A total of 34 studies met all eligibility criteria and were included in the final qualitative synthesis.

Main outcome(s) Physiological and Cardiorespiratory
Outcomes: Internal improvements in physiological and cardiorespiratory parameters represented the most consistently improved outcomes across the included studies….
Metabolic Outcomes
Improvements in insulin sensitivity and glycemic regulation were particularly pronounced among individuals with T2DM and metabolic compromise.
Metabolic adaptations following HIIT and AIT interventions were consistently documented

across studies encompassing older adults with cardiometabolic dysfunction, obesity, type 2 diabetes mellitus (T2DM), coronary artery disease, HIV-associated aging, and sedentary lifestyles.

Functional Outcomes

Functional performance outcomes represented one of the most consistently improved domains across the reviewed studies, particularly among individuals presenting with mobility limitations, impaired balance, reduced muscular strength, and exercise intolerance. Across both apparently healthy and clinically complex older adult populations, HIIT and AIT interventions were associated with meaningful improvements in gait performance, walking capacity, muscular strength, balance, mobility, and functional independence.

Enhancements in walking capacity and mobility were especially pronounced in cardiovascular, pulmonary, metabolic, and post-stroke populations. Improvements in six-minute walk distance (6MWD), Incremental Shuttle Walk Test (ISWT) performance, gait speed, and exercise tolerance were consistently observed following structured HIIT (Deka et al., 2022; Freyssin et al., 2012; Nilsson et al., 2008). Freyssin et al. (2012) and Nilsson et al. (2008) reported clinically meaningful gains in 6MWD among heart failure patients, while Deka et al. (2022) demonstrated substantial increases in ISWT performance following combined HIIT and resistance training in individuals with coronary artery disease. Marcotte-Chénard et al.

Quality of Life and Psychological Outcomes

Health-related quality of life (HRQoL) and psychological outcomes were favourably influenced by HIIT and AIT interventions across multiple included studies, particularly among individuals with cardiovascular disease, pulmonary conditions, post-stroke sequelae, and sedentary aging profiles.

Data management A systematic review was conducted in accordance with PRISMA 2020 guidelines. Electronic searches were performed in PubMed, Scopus, and Web of Science. Randomised controlled trials and longitudinal intervention studies investigating HIIT or AIT in older adults or populations characterised by accelerated biological aging were considered eligible. Studies focusing exclusively on acute exercise responses, observational designs, protocols, reviews, and non-human studies were excluded. Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) scale.

Quality assessment / Risk of bias analysis The methodological quality of the included randomized controlled trials was evaluated using the Physiotherapy Evidence Database (PEDro) scale, a validated and widely adopted instrument for appraising methodological rigor in exercise science, physiotherapy, and rehabilitation research (Maher et al., 2003). The PEDro scale assesses internal validity and statistical reporting adequacy across ten scorable criteria, encompassing random allocation, allocation concealment, baseline comparability, blinding of participants, therapists, and assessors, adequacy of follow-up, intention-to-treat analysis, and between-group statistical reporting.

Scores range from 0 to 10, with higher values reflecting superior methodological quality. In accordance with classification thresholds established in the literature, studies were categorized as excellent (scores of 9–10), good (6–8), fair (4–5), or poor (≤3) methodological quality.

The quality assessment was conducted by the primary reviewer, with uncertain or borderline classifications resolved through discussion with the supervisory team.

Strategy of data synthesis The methodological quality of the included randomized controlled trials was evaluated using the Physiotherapy Evidence Database (PEDro) scale, a validated and widely adopted instrument for appraising methodological rigor in exercise science, physiotherapy, and rehabilitation research (Maher et al., 2003). The PEDro scale assesses internal validity and statistical reporting adequacy across ten scorable criteria, encompassing random allocation, allocation concealment, baseline comparability, blinding of participants, therapists, and assessors, adequacy of follow-up, intention-to-treat analysis, and between-group statistical reporting.

Scores range from 0 to 10, with higher values reflecting superior methodological quality. In accordance with classification thresholds established in the literature, studies were categorized as excellent (scores of 9–10), good (6–8), fair (4–5), or poor (≤3) methodological quality.

The quality assessment was conducted by the primary reviewer, with uncertain or borderline classifications resolved through discussion with the supervisory team.

Subgroup analysis Subgroup analyses were considered based on participant and training characteristics that potentially influence physiological and biomechanical responses to CrossFit training, including training experience (beginner vs. experienced), sex (male vs. female), competitive level (recreational vs. competitive athletes), and training frequency or program duration (short-term vs. long-term interventions).

Due to heterogeneity in study designs, outcome measures, and the limited amount of information reported, a formal statistical subgroup analysis was not feasible; however, notable differences observed in each study were described qualitatively to explore possible moderating effects on performance and adaptation outcomes.

Sensitivity analysis A formal sensitivity analysis was not conducted due to the limited number of high-quality randomized controlled trials and the methodological heterogeneity across included studies. However, study quality scores (assessed via the PEDro and JBI tools) were considered during the interpretation of results to assess the robustness of findings. Studies with higher methodological quality were given greater interpretive weight in the narrative synthesis to minimize potential bias in conclusions.

Language restriction No.

Country(ies) involved Portugal (University of Trás-os-Montes and Alto Douro).

Keywords High-intensity interval training; aging; older adults; cardiorespiratory fitness; functional autonomy; healthy aging.

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