Archives of Gerontology and Geriatrics 64 (2016) 138–145

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Review

Does physical exercise improve obstacle negotiation in the elderly? A systematic review

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ARTICLE INFO

Article history:
Received 30 May 2015
Received in revised form 29 January 2016
Accepted 9 February 2016
Available online 11 February 2016

Keywords:
Aging
Gait
Obstacle negotiation
Training

ABSTRACT

Background: Physical exercise improves walking in the elderly but much less is known about its effect on more challenged gait, such as obstacle negotiation. We conducted a systematic review to discuss the effects of regular physical exercise on kinematics and kinetics of obstacle negotiation in the elderly.
Methods: A comprehensive literature search revealed 859 citations for review, whereof 206 studies entered the full-text analysis. After application of inclusion and exclusion criteria, 13 studies were included in this systematic review.
Findings: Most of them presented a reasonable quality (average 0.68) but none of them reached the level of a randomized control trial. Interventions were heterogeneous, with training periods lasting from 5 days to 10 months. Studies assessed obstacle negotiation basically considering 3 types of testing paradigm, namely a walkway with either a single obstacle crossing, or with multiple obstacles, or else a treadmill with an obstacle avoidance task under time pressure.
Interpretation: In general, longer training programs had better results and very short ones were not effective. A weekly frequency of 2–3 times was the most common among the studies showing positive effects. Regardless of exercises types performed, most of them were effective and so far, there is no consensus about the best exercise for improving obstacle negotiation. A lack of studies on this topic still is evident. Including a record of fall score can further help in deciding which programs are to be preferred.

Contents

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http://dx.doi.org/10.1016/j.archger.2016.02.008
0167-4943/

1. Introduction

The regular participation of the elderly in programs of physical exercise benefits gait performance (Newell, Shead, & Sloane, 2012; Persch, Ugrinowitsch, Pereira, & Rodacki, 2009), by promoting improvements in strength (Landi, Marzetti, Martone, Bernabei, & Onder, 2014), brain health (Benedict et al., 2013), and motor coordination (Williams & Stewart, 2009). To test the latter during walking, the presence of an obstacle is used to challenge gait, and this has been considered an important paradigm to assess risk of falling in the elderly (Lim & Yoon, 2014a). Literature suggests that poor motor performance in obstacle negotiation increases the risk of tripping and falls in the elderly. Higher risk of falling has been related to lower toe clearances (Soma et al., 2010) and lower horizontal obstacle-toe and heel distances (Weerdesteyn, Nienhuis, & Duysens, 2005), which increases risk of obstacle contacts.

The effects of physical exercise on the performance of obstacle negotiation have been studied to determine to what extent exercise-based interventions benefit elderly locomotion in the daily life context (Kovacs & Williams, 2004; Lamoureux, Sparrow, Murphy, & Newton, 2003; Lim & Yoon, 2014b; Weerdesteyn, Nienhuis, & Duysens, 2008). Different interventions performed in these studies had different setups (e.g., frequency, volume, and types of exercises) and different gait parameters have been evaluated. Such diversity contributes to the divergence of results and makes it difficult to fully understand which components of exercise are important to improve obstacle negotiation in the elderly. In this context, a detailed analysis of the recent literature could significantly contribute to the design of future studies aiming at this question.

It is possible to find some recent reviews addressing aged gait (Barrett, Mills, & Begg, 2010; Galna, Peters, Murphy, & Morris, 2009). However, Galna et al. (2009) did not address the role of physical training in the elderly when they conclude that older adults are at greater risk of contacting obstacles for time-constrained conditions. Furthermore, Barrett et al. (2010) considered adults and older adults with different classifications regarding fall history and concluded that greater minimum foot clearance variability is found in older compared to younger adults and older fallers compared to older non-fallers, without considerations to differences in the physical training status. Therefore, these reviews bring different contributions to the field. Considering that physical exercise has been suggested as an effective strategy to minimize fall risks in the elderly, in our review, we consider independent elderly engaged in different exercise programs with the main purpose of discuss the characteristics that should be included in an exercise program designed to minimize falling risk related to obstacle crossing in the elderly. It is expected that the results of this review can be extrapolated to the general elderly population. Because most of falls in the elderly occurs after tripping or slipping (Berg, Alessio, Mills, & Tong, 1997), investigating the specific influence of exercise interventions on variables related to obstacle negotiation, can give an important insight on ways to reduce the risk of falls and also help in the clinical practice aiming at fall prevention.

Therefore, here we conducted a systematic review of studies addressing the effects of physical exercise on obstacle negotiation in the independent elderly. Through this review we tried to gather the literature of current exercises programs that aimed to improve obstacle negotiation and to present their main results and characteristics.

2. Methods

2.1. Search strategy

This systematic review was performed considering original articles published in the English language by scientific journals indexed in the Web of Science, Medline, Scopus and The Cochrane Library databases. Papers published from January 2003 to December 2014 were considered in order to clearly include a time window representative of 10 years of research in the topic. Furthermore, references lists from the included articles were searched to find related studies. These articles, as the others, underwent the exclusion/inclusion criteria application. The search strategy utilized aimed to identify all articles related to obstacle crossing in the elderly submitted to physical exercise programs. Mesh terms and keywords related to aging (elderly; aging; aged and older); gait (gait and walking); exercise (physical activity; exercise; physically active; inactivity; sedentary lifestyle; training and performance) and obstacle negotiation (obstacle) were used in the searches; combined through the Booleans operators "AND" and "OR". Two independent authors performed searches and inclusion/exclusion criteria application. A third author solved eventual discrepancies.

2.2. Inclusion and exclusion criteria

Original articles that investigated the effects of systematic physical exercise on at least one kinematics or kinetics variable of lower extremity during overground or treadmill gait with obstacles were included in this review. Participants should be aged 65 years old or more. Cross-sectional studies were considered if they compared a trained group with at least one paired control or trained group. Longitudinal studies were included if describing an intervention program based on physical exercises. Studies should include at least a brief description of the type of exercises performed. Studies including participants with some pathology related to motor and/or neurological impairments (e.g., Parkinson disease) that significantly impairs gait or limit exercise practice, case-control studies and those not detailing the participants were not included in this systematic review.

2.3. Study selection

All processes of search, selection and review of the papers were conducted by at least two independent authors. First of all, studies were selected considering the titles and abstracts. In this phase, concordance between reviewers was not mandatory. Afterwards, overlapping papers from different bases were excluded. Inclusion and exclusion criteria were applied for the rest of the papers, and those that fulfilled the criteria aforementioned were included. When reading the abstract did not permit to fully decide by inclusion or exclusion of the paper, the full text was checked. A third author solved any discrepancy between the two independent reviewers.

2.4. Quality assessment

Quality assessment of the articles included in the final yield was performed independently by three authors based on the tool used by Galna et al. (2009) and Barrett et al. (2010) with some adaptations to the present study (Supplemental file 1). This tool