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REVIEW: NARRATIVE REVIEW

The contribution of postural balance analysis in older adult fallers: A narrative review

L. Pizzigalli, PhD [a,*], M. Micheletti Cremasco, PhD [b], A. Mulasso, MSc [c], A. Rainoldi, PhD [a]

[a] Motor Science Research Center, School of Exercise & Sport Sciences, SUISM, Department of Medical Sciences, University of Torino, Torino, Italy
[b] Department of Life Sciences and Systems Biology, University of Torino, Torino, Italy
[c] Department of Psychology, University of Torino, Torino, Italy

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Summary *Objective:* Falls are a serious health problem for older adults. Several studies have identified the decline of postural balance as one of the main risk factors for falls. Contrary to what may be believed, the capability of force platform measurements to predict falls remains uncertain. The focus of this narrative review is the identification of postural characteristics of older adults at risk of falling using both static and dynamic postural balance assessments.
Methods: The literature analysis was conducted on Medline/PubMed. The search ended in May 2015.
Results: Centre of pressure (CoP) path length, CoP velocity and sway in medial lateral and anterior-posterior are the variables that distinguish older adult fallers from non-fallers.
Discussion: Recommendations to medical personnel on how to provide efficient balance training for older adults are offered, discussing the relevance and limitations of postural stability on static and dynamic board in falling risk prevention.

Introduction

Falls are a serious health problem for older adults (Tinetti, 1994; Guideline for the prevention of falls in older persons, 2001); in fact decreasing balance with age is one of the major risk factors for falling (Piirtola and Era, 2006). A great number of falls in older adults are caused by wrong and inadequate (ipometric: reduced/small sway responses and ipermetric: excessive/large sway responses) responses to the perturbations in the sagittal and frontal plane (Maki et al., 1994); moreover, it is well documented that the

* Corresponding author. Motor Science Research Center, School of Exercise & Sport Sciences, SUISM, Department of Medical Sciences, University of Torino, P.za Bernini 12, 10143 Torino, Italy. Tel.: +39 0117764708; fax: +39 011748251.
E-mail address: luisa.pizzigalli@unito.it (L. Pizzigalli).

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quantification of the centre of pressure (CoP) movements during lateral perturbation could predict subsequent falls (Piirtola and Era, 2006). Older adults are unaware that their performance impairments, such as their physical activity (muscular strength and resistance) and sensorial reflex capacity (increase of reaction time and sensorial deficits), determine a general decline of their motor system and autonomy (Brach and VanSwearingen, 2002; Maki et al., 1994; Prudham and Evans, 1981). The difficulty in recognizing these physical deficits limits seniors in an adequate postural reaction to protect themselves by the impact of falling.

Objective

This review intends to offer an overview of experimental works providing a basis for the comprehension and prevention of falls and fall-related injuries in older adults. It has two goals: i) to describe the methods and equipment commonly used in measuring static and dynamic postural balance and to report their capacities to distinguish between fallers and non-fallers, ii) to detail some specific characteristics of older fallers, such as muscular strength, frailty, sensorimotor aspects, usually related in literature, to postural balance field.

Methods

Design

The manuscript's starting point is a joint biomechanical, physiological and functional approach, and introduces some basic concepts which constitute a background for the topic of balance measurement (static and dynamic balance assessments) in older adults. Then the relevance and limitations of postural stability on static and dynamic boards in prevention of falling risk in older adults are discussed. Finally, distinguishing characteristics of older "fallers" and "non-fallers" are assessed.

Setting

The literature analysis was conducted on Medline/PubMed. The search ended in March 2015 and is limited to works published between 1970 and 2015. The language was limited to English. The following primary search terms were entered: static balance, dynamic balance, static board, dynamic board, static platform, moving platform, older adults, aging, risk of falling, proprioception, postural control, postural coordination, postural strategy, fallers, non-fallers, dynamic posture training, fall prediction index, clinical measures of dynamic balance, clinical measures of static balance and reliability.

Articles were collected on the basis of the following criteria, studies that evaluate risk of falling and used balance platform assessment. Only studies conducted on community-dwelling healthy male and female subjects aged 65 and over were considered. Studies of institutionalized subjects were excluded. Participants with medical factors affecting balance were excluded. The scientific quality of selected papers relied on Medline and PubMed criteria.

Among the eligible studies, the papers that did not treat or report parameters in static or dynamic balance were excluded. Published abstracts, conference presentations, dissertation materials were not considered in this review.

Background

Balance measurements

Posturography, which literally refers to the description of posture, is an approach to the assessment of postural balance utilizing force platforms providing a number of parameters reflecting postural stability. Computerized balance platforms offer objective measurements of sway under different conditions in clinical settings (Grabiner et al., 1993; Jarnlo and Thorngren, 1993).

Essentially there are two types of clinical posturography static platform and dynamic platform posturography (Di Fabio, 1995). Data thus obtained need to be generalized to provide reproducible results performing the assessment in a standardized way on reliable equipment. Few studies (Lafond et al., 2004) evaluate the reliability of CoP measures in older adults during quiet standing. Moreover, results on repeatability are often incomplete or unsatisfactory, and mostly concern test-retest, inter-tester reliability (Ageberg et al., 1998; Mattacola et al., 1995) only of the centre of pressure minus centre of mass (CoP−CoM) measure and of the time of CoP maintenance (Corriveau et al., 2000; King and Zatsiorsky, 2002; Lafond et al., 2004).

Recently some authors investigated postural balance in older adults using classical stabilometric measures extracted from CoP analysis in association to dynamic measures that the quantities describing the temporal structure of CoP trajectories, underlying their importance as postural signatures in this kind of population (Tallon et al., 2013).

Static balance assessment

Static platform posturography involves stance or tandem stance on a fixed platform with eyes open or closed (Black and Wall, 1981; Norre and Forrez, 1986). This procedure is based on the Romberg tests and the outcome is quantified with respect to changes in CoP sway area, path length, or velocity (Di Fabio, 1995).

In the tradition of Romberg (1853), a subject has to stay in upright position on a footboard in different stance positions (double limb, tandem or single limb) and visual condition (eyes open, eyes closed). A reduced postural sway about the central equilibrium point shows less movement, hence, greater stability control (relative to her/his age-matched peers). Optimal postural control in quiet standing therefore, is characterized by small CoP oscillations in amplitude, relatively unconstrained and irregular. Usually during balance tests the time that subjects are able to maintain a particular equilibrium position is recorded (Bogle Thorbahn and Newton, 1996; Graybel and Fregly, 1966) as further information for classification.

Control of posture is connected to attention and to the instructional set, therefore these parameters should be considered in testing protocols of postural control (Nishiwaki et al., 2000). These authors evaluated the