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Factors associated with poor balance ability in older adults of nine high-altitude communities

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ABSTRACT

Introduction: Poor balance ability in older adults result in multiple complications. Poor balance ability has not been studied among older adults living at high altitudes. In this study, we analysed factors associated with poor balance ability by using the Functional Reach (FR) among older adults living in nine high-altitude communities.
Material and methods: Analytical cross-sectional study, carried out in inhabitants aged 60 or over from nine high-altitude Andean communities of Peru during 2013–2016. FR was divided according to the cut-off point of 8 inches (20.32 cm) and two groups were generated: poor balance ability (FR less or equal than 20.32 cm) and good balance ability (greater than 20.32 cm). Additionally, we collected socio-demographic, medical, functional and cognitive assessment information. Poisson regression models were constructed to identify factors associated with poor balance ability. Prevalence ratio (PR) with 95% confidence intervals (95CI%) are presented.
Results: A total of 365 older adults were studied. The average age was 73.0 ± 6.9 years (range: 60–91 years), and 180 (49.3%) participants had poor balance ability. In the adjusted Poisson regression analysis, the factors associated with poor balance ability were: alcohol consumption (PR = 1.35; 95%CI: 1.05–1.73), exhaustion (PR = 2.22; 95%CI: 1.49–3.31), gait speed (PR = 0.67; 95%CI: 0.50–0.90), having had at least one fall in the last year (PR = 2.03; 95%CI: 1.19–3.46), having at least one comorbidity (PR = 1.60; 95%CI: 1.10–2.35) and having two or more comorbidities (PR = 1.61; 95%CI: 1.07–2.42) compared to none.
Conclusions: Approximately a half of the older adults from these high-altitude communities had poor balance ability. Interventions need to be designed to target these balance issues and prevent adverse events from concurring to these individuals.

1. Introduction

Aging in high-altitude populations is a poorly explored phenomenon. There is little knowledge on whether geriatric syndromes present in the same way among older adults living in such conditions. It is known that lung function decreases with aging, altering oxygen absorption and ventilatory responses from partial carbon dioxide pressure and partial oxygen pressure; however, there is no evidence suggesting that older adults are more prone to altitude sicknesses compared to other age groups (Lipsitz, 2002; Rodway, Hoffman, & Sanders, 2004). Dizziness and vertigo are common among older adults and part of the Lake Louiśs diagnostic criteria of altitude sickness (Roach, Bartsch, Hackett, & Oelz, 1993). These criteria however, are not exclusive to older adults, and no connection has been identified between them and increased risk of adverse events such as falls or balance impairment (Carod-Artal, 2014).

Poor balance ability is also common in older adults and predict multiple complications such as falls, fractures, brain injury, disability and death (Ambrose, Paul, & Hausdorff, 2013; Okubo et al., 2015). The four-square step test, performing dual tasks and functional reach (FR) have all been used to assess balance among older populations (Ambrose et al., 2013; Duncan, Studenski, Chandler, & Prescott, 1992; Duncan,

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Weiner, Chandler, & Studenski, 1990; Gabbard & Cordova, 2013; Gobbo, Bergamin, Sieverdes, Ermolao, & Zaccaria, 2014; Whitney, Poole, & Cass, 1998). Unfortunately, only a few of these measures have demonstrated reliability, validity and sensitivity to change. Unlike other measures, the FR test uses a continuous scoring system, is simple to use and is easily performed in the clinical setting (Duncan et al., 1992). Despite these benefits, few authors have used it to evaluate poor balance ability in older populations living in high-altitude (Otsuka et al., 2005; Sakamoto et al., 2016). These authors have shown that among older adults climbing to high-altitude cities, chemoreceptors of the carotid body detect a decrease in PaO_2, and trigger balance-related symptoms such as dizziness or vertigo affecting the FR (Otsuka et al., 2005; Sakamoto et al., 2016). Some authors have therefore hypothesized there may be a pathophysiological relationship between high-altitude and balance problems among older adults (Carod-Artal, 2014).

Based on the reported impact poor balance ability have on mortality and disability in older adults (Kwan, Close, Wong, & Lord, 2011; Rubenstein, 2006) and the gap in knowledge identified among older adults living at high altitudes, we will explore the factors associated with poor balance ability among a group of older adults living in such conditions. The aim of this study was to evaluate the factors associated with poor balance ability by using the FR among older adults from nine high-altitude communities.

2. Material and methods

2.1. Design and population

Analytical cross-sectional study, carried out in inhabitants aged 60 or over from nine high-altitude (≥1500 m above sea level) Andean communities of Peru: *La Jalca, Leimebamba (Amazonas), Llupa, San Pedro de Chaná, Atipayan (Áncash), Pampamarca (Huánuco), Ayahuanco (Ayacucho), Paucarcolla (Puno) and Vilca (Huancavelica)* between 2013 and 2016.

2.2. Description of the study area

The National Statistics Institute of Peru (*Instituto Nacional de Estadística e Informática* – INEI) classifies communities with 100 houses not in a capital district, having more than 100 individuals, located in a dispersed way without forming blocks as rural communities (Sociales, 2008). Therefore, most of individuals included in this study are considered members of rural communities in Peru. The communities were located in the Peruvian highlands as follows: a) *La Jalca*: urban settlement located at 2800 masl (meters above sea level); B) *Leimebamba*: rural village located at 2158 masl; C) *Llupa*: rural village located at 3511 masl; D) *San Pedro de Chaná*: rural village located at 3413 masl; E) *Atipayán*: rural village located at 3364 masl; F) *Pampamarca*: urban village located at 3445 masl; G) *Ayahuanco*: rural village located at 3414 masl; H) *Paucarcolla*: urban village located at 3847 masl; I) *Vilca*: rural village located at 3275 masl.

2.3. Sample type, sample size and analysis unit

A non-probabilistic, census-type sampling was performed, registering all older adults in the highland communities previously described. We included all or most (approximately 95%) of the geriatric population of each community (urban/rural). The analysis unit was older person from high-altitude Andean communities (urban/rural). The final sample included 368 adults and they all signed informed consent.

2.4. Evaluation

Participants were visited in their homes for the interview. Data was collected on sociodemographic characteristics, medical background (falls, polypharmacy, comorbidities, tobacco, alcohol and coca leaf consumption), functional status (Barthel Index, Edmonton test, exhaustion), physical performance (gait speed), anthropometric measurements (height and weight) and cognitive status (Pfeiffer Questionnaire).

2.5. Measures

2.5.1. Outcome: poor balance ability

We used the FR test to assess the presence of poor balance ability in the participants. This test was performed on a flat surface and with a wall or a supporting point in which the participant, standing and using the arm closest to the wall stretched, leaned forward without moving the feet of the flat surface and without losing the balance; registering the maximum reach (in cm) of his fist from the wall. The FR was divided according to the cut-off point of 8 inches (20.32 cm) and two groups were generated: poor balance ability (FR less or equal than 20.32 cm) and good balance ability (greater than 20.32 cm) (Bradley, 2011; Murphy, Olson, Protas, & Overby, 2003; Scott, Votova, Scanlan, & Close, 2007; Wolf, 1999).

2.5.2. Other variables

2.5.2.1. Sociodemographic characteristics. The sociodemographic characteristics were included and evaluated by self-report: age (less than or equal to 70 years, 71 to 80 years, over 80 years), gender (male, female), educational level (no education/incomplete elemental school, complete elementary school, complete high school), marital status (single, married, widowed/divorced), work (yes or no), current occupation (agriculture, trading, others) and altitude (masl). The sociodemographic information was corroborated with the participant's national identity document (ID card).

2.5.2.2. Medical background. The following variables were evaluated by self-report: falls in the last year (none, at least 1), polypharmacy (5 drugs or more, of frequent use, under medical prescription) (Viktil, Blix, Moger, & Reikvam, 2007), tobacco consumption (yes or no), alcohol consumption (yes or no), coca leaf consumption (yes or no), high blood pressure (HBP) (yes or no), diabetes mellitus type 2 (DM2) (yes or no), chronic obstructive pulmonary disease (COPD) (yes or no) and low back pain (yes or no). Likewise, a variable of comorbidities (obesity defined according to body mass index (BMI) + HBP + COPD + DM2 + low back pain + urinary incontinence) was constructed. The medical background information was confirmed by the caregiver/family member at the time of data collection.

According to the body mass index (BMI), we categorized the population as: malnutrition (< 18.5 kg/m^2), normal (18.5-24.99 kg/m^2), overweight (25.0-29.99 kg/m^2) and obesity (> 30.0 kg/m^2) (Flegal, Carroll, Ogden, & Johnson, 2002).

2.5.2.3. Functional assessment. We included gait speed independently from the Short Physical Performance Battery (SPPB); this was considered as a continuous variable and divided by 4, because the speed recorded was during the 4 m to obtain gait speed per meter (m/s) (Guralnik et al., 1994).

We used the Barthel Index, a questionnaire about 10 basic activities of daily living (ADL) with a total score between 0 and 100. People not reaching the highest score (100) were classified as dependent (< 100) (Collin, Wade, Davies, & Horne, 1988).

Additionally, we use 2 items from the Edmonton test (Rolfson, Majumdar, Tsuyuki, Tahir, & Rockwood, 2006): 1) Social support: When you need help, do you have someone who meets your needs? (Always, sometimes/never); 2) Urinary Incontinence: Do you have trouble holding urine when you do not feel like urinating? (yes or no).

In the present study, we evaluated exhaustion, which was defined by 3 items that the patient must respond according to the way he felt during the last 2 weeks: a) Did you feel full of energy? (yes or no); B)