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Perceived fatigability and metabolic and energetic responses to 6-minute walk test in older women

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Abstract

Objective To determine the relationship between perceived fatigability and oxygen consumption, carbon dioxide production, respiratory exchange ratio and the energy cost of walking in older women.
Design Observational, cross-sectional study.
Participants Forty-eight community-dwelling older women were recruited from senior centres in Natal, Rio Grande do Norte, Brazil.
Main outcome measures Participants were evaluated in two different sessions. In the first session, sociodemographic and clinical factors were assessed and accelerometers were delivered. In the second session, the 6-minute walking test (6MWT) was performed and expired gases were analysed. Self-reported levels of fatigue were evaluated on a numerical scale from 1 ('extremely energetic') to 7 ('extremely tired'). Severity scores for perceived and performance fatigability were calculated as the ratio of change in performance and fatigue, respectively, with walking distance. The O_2 cost of walking was based on the oxygen consumption rate and the 6MWT walking speed.
Results No correlation was found between the severity of perceived fatigability and metabolic measures. However, the severity of perceived fatigability was significantly correlated with greater O_2 cost ($r = 0.579$, $P < 0.01$), physical activity ($r = -0.654$, $P < 0.01$), walking distance ($r = -0.712$, $P < 0.01$) and severity of performance fatigability ($r = 0.690$, $P < 0.01$).
Conclusion Perceived fatigability was not directly associated with metabolic measures; however, greater severity of perceived fatigability was associated with an increase in the O_2 cost of walking. Important relationships were also found between greater severity of perceived fatigability and poor functional fitness, high level of energy expenditure and lower level of physical activity.

Keywords: Fatigue; Energy metabolism; Ageing; Physical activity

Introduction

Perceived fatigue, defined as lack of subjective physical and/or mental energy, is a common complaint in older adults. Fatigue is associated with worse physical function [1], functional limitations [2,3] and mortality [4]. Prevalence rates range widely across published studies, from 5% to 68% [4,5]. Methods for measuring fatigue generally ask individuals to self-report their overall feelings of tiredness, irrespective of the specific context [6]. Older adults reduce their levels of physical activity, aiming to keep their fatigue threshold within an acceptable range [5,6]. Thus, focusing on fatigue without understanding the activity context in which the fatigue occurs may lead to misleading conclusions.

Fatigability is a new construct that describes how fatigued an individual gets in relation to defined activities [5]. This

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construct offers a more objective approach that measures the change in fatigue level as a function of the change in intensity, duration or frequency of activity. Fatigability has two components: perceived fatigue (change in the feeling of self-reported fatigue) and fatigue performance (decline in physical performance) [5]. Both components must consider the sum of energy expenditure or work done [7].

As a new concept, assessment of fatigability is still not uniform. Evaluations have ranged from task-specific scales to an ecological momentary assessment to a Borg rating of perceived exertion [8–10]. In two recent studies that evaluated perceived fatigability in older adults, a simple numeric scale was used to rate the level of tiredness before and after the performed activity [7,11].

Measuring metabolic variables of oxygen and carbon dioxide content of expired air during exercise is vital to the assessment of cardiovascular function and the prediction of energy expenditure [12]. The age-associated decrease in maximal oxygen consumption (VO_{2max}) results in greater oxygen consumption required to perform activities of daily living [13]. However, little is known about the relationship between physiological aspects linked to fatigue, such as metabolic and energetic requirements, and measures of perceived fatigability.

As such, this study aimed to determine the correlation between perceived fatigue and VO_2, carbon dioxide production (VCO_2), respiratory exchange ratio (RER) and energy cost (O_2 cost, ml O_2/kg/m) of walking in older women. A secondary objective was to identify which variables could better explain the process of greater perceived fatigability.

Methods

Sample and study design

This was an observational, cross-sectional study. Study participants were recruited as a convenience sample from senior centres in Natal, Rio Grande do Norte, Brazil. Forty-eight older women agreed to participate after being informed about the nature and purpose of this study. Inclusion criteria were: female sex; age 65 years or more; good cognitive function (as assessed by the Prueba Cognitiva de Leganés) [14]; able to sign the consent form and walk independently; willing to use the accelerometer for 7 consecutive days; and free of any neurological or cardiorespiratory conditions that may interfere with the outcome assessments performed in the study. All participants gave written informed consent for participation in the study. This research was approved by the Ethics and Research Committee of the Universidade Federal Rio Grande do Norte, Brazil (Ref. No. 223.952).

Procedures

The subjects were evaluated in two sessions on different days. The first session was composed of a general assessment for evaluation of sociodemographic characteristics such as age, marital status and educational level. In the same session, the participants also underwent a clinical assessment and received an accelerometer in order to evaluate their level of physical activity. All steps of this study were undertaken by trained physiotherapists.

Clinical assessment

Cognitive function was measured using the Prueba Cognitiva Leganés, a cognitive screening test for dementia in populations with a low level of education, which has been validated for older Brazilian adults [14]. Scores $\leq$22 indicate cognitive decline. Depressive symptoms were assessed using the Brazilian version of the Center for Epidemiologic Studies Depression Scale [15]. Participants with a score $\geq$16 were considered to have depressive symptoms.

Chronic non-communicable diseases, such as arthritis, stroke, angina, diabetes, chronic lung disease, asthma, depression and hypertension, were assessed by the participant's answers to questions such as 'Have you ever been diagnosed with diabetes (high blood sugar)?'. Self-rated health was measured by asking participants whether they would rate their health as good, fair or poor.

Frailty syndrome was defined on the basis of five dimensions of phenotype described by Fried *et al*. [16]: slow gait speed, weak grip strength, low energy expenditure, self-reported exhaustion and weight loss. Frailty was identified by the presence of three or more of these criteria. Gait speed was assessed using a 4-m course at usual walking speed from a standing position. Muscle strength was assessed by grip strength using a hand-held dynamometer (Jamar hydraulic hand dynamometer, Bolingbrook, USA). Energy expenditure was measured using the Brazilian version of the International Physical Activity Questionnaire. Exhaustion was defined using two questions of the Center for Epidemiological Studies Depression Scale. Weight loss was defined as self-reported unintentional loss of >4.5 kg in the previous year.

Height (cm) was measured to the nearest 0.1 cm with a wall measure. Body weight (kg) was assessed using a calibrated scale with participants wearing light indoor clothes and no shoes. Body mass index was calculated using weight and height^2 (kg/m^2).

Physical activity

Usual levels of physical activity were assessed using a triaxial accelerometer (Actigraph GT3X, Pensacola, FL, USA), worn on the waist, for 7 consecutive days [17]. Device activation and data download were performed using ActiLife Lifestyle Desktop software.

Actigraph measures and records acceleration were conducted in three orthogonal planes using 'counts' as the raw output [18]. Thus, accelerometry provides an indication of the intensity of physical activity associated with locomotion [19]. To interpret counts, some researchers use cut-off points to characterise activities by intensity, which include sedentary, light, moderate or vigorous activity [20]. However, for