Human Movement Science 31 (2012) 1247–1252

Contents lists available at SciVerse ScienceDirect

Human Movement Science

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

Interference of high-heeled shoes in static balance among young women

Susana Bacelete Gerber [a], Rafael Vital Costa [a], Luanda André Collange Grecco [a], Hugo Pasini [a], Nádia Fernanda Marconi [b], Claudia Santos Oliveira [a,*]

[a] Nove de Julho University, São Paulo, SP, Brazil
[b] Paulista University, São Paulo, SP, Brazil

ARTICLE INFO

Article history:
Available online 27 June 2012

PsycINFO classification:
2330

Keywords:
High-heeled shoes
Static balance
Force plate

ABSTRACT

The aim of the present study was to assess the effect of the use of high-heeled shoes on static balance in young adult women. Fifty-three women between 18 and 30 years of age and accustomed to wearing high-heeled shoes participated in the study. None of the participants had any orthopedic or neurologic alterations. Static balance was assessed using a force plate. Oscillations from the center of pressure in the mediolateral and anteroposterior directions were measured both when barefoot and when wearing high-heeled shoes [7 centimeters (cm) in height and 1 cm in diameter] under the conditions of eyes open and eyes closed. Two-way analysis of variance was employed for the statistical analysis, with the level of significance set at 5% ($p < .05$). The results revealed statistically significant differences between tests when barefoot and when wearing high-heeled shoes as well as with eyes open and eyes closed ($p < .01$). With the use of high-heeled shoes, there was a significant increase in mediolateral oscillation with eyes closed ($p < .01$). The present study demonstrates that the use of seven-cm high heels altered static balance in the healthy young women analyzed, increasing the oscillation of the center of pressure, regardless of visual restriction.

* Corresponding author. Address: Endereço para Correspondência – Rua Itapicuru, 380, apart. 111 – Perdizes, CEP 05006-000, São Paulo, SP, Brazil. Tel./fax: +55 11 3868 1681.

E-mail addresses: s.gerber@yahoo.com.br (S.B. Gerber), vitalcorafa@hotmail.com (R.V. Costa), luandacollange@terra.com.br (L.A.C. Grecco), hugopneto@yahoo.com.br (H. Pasini), nadiamarconi@uninove.br (N.F. Marconi), csantos@uninove.br (C.S. Oliveira).

0167-9457/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.humov.2012.02.005

1. Introduction

From the mid 20th century to the current day, human behavior has undergone considerable changes. In various regions of the world, the social behavior of women and their representativity in society are reflected in changes in habits and ways of dressing, with a particular emphasis on footwear, especially high-heeled shoes, considered to characterize beauty, self-assurance and elegance. However, maintaining the body on a support base that has been modified in physical terms (diameter and height) presupposes changes in the sensory information necessary for the maintenance of postural control (Barela, 2000; Duarte, 2000; Thompson & Coughlin, 1994; Winter, 1995).

Postural control is defined as the process by which the central nervous system produces muscle activity patterns necessary to the relationship between the center of mass and support base. The visual, vestibular and proprioceptive systems are involved in sending information to the postural control system (balance), thereby forming an afferent mechanism. Vision is the most important sensory information system and can compensate for a lack or non-reliability of other sensory stimuli (Bugnariu & Fung, 2007; Cenciarini & Peterka, 2006; Mochizuki & Amadio, 2006).

The nervous system has the capacity to repair maladjustments, allowing dynamic postural efficacy (Schmid, Bottaro, Sozzi, & Schieppati, 2011). Despite maintaining an apparently immobile orthostatic posture, an individual constantly oscillates in the anteroposterior and mediolateral directions. These oscillations are the result of hip and ankle motor strategies performed to maintain static balance. The ankle strategy requires a small range of motion and considerable ankle muscle strength, which are fundamental when the disturbance to balance is slight and the support base is firm (Horak, Nashner, & Diener, 1990; Nashner, 1977; Runge, Shupert, Horak, & Zajac, 1999).

The reason for undertaking the present study was based on the fact that the use of high-heeled shoes alters variables that affect the stability of the body, such as friction on the ground, the form of the support base, the center of pressure (COP) of the feet on the ground and the height of the center of gravity in relation to the support base (Ko et al., 2009; Pezzan, Sacco, & João, 2009). As these elements contribute toward maintaining the body in static equilibrium, a change in any one of them consequently leads to a change in the balance of the body in bipedal stance (Cho & Choi, 2005; Hansen & Childress, 2004; Iunes, Monte-Raso, Santos, Castro, & Salgado, 2008; Joyce, 2000).

The aim of the present study was to assess the effect of the use of high-heeled shoes on the static balance of young adult women, comparing the degree of anteroposterior and mediolateral oscillation when barefoot and when wearing these shoes, and to analyze the interference of visual restriction.

2. Methods

The present study received approval from the Human Research Ethics Committee of the *Universidade Nove de Julho* (Brazil) under process number 201862/2008, in compliance with the guidelines of Resolution 196/96 of the Brazilian Health Board. Written informed consent was obtained from all participants.

A non-controlled, cross-sectional study was carried out involving 53 women between 18 and 30 years of age. The eligibility criteria were the ability to remain in an orthostatic position without support, experience of at least three weeks in wearing high-heeled shoes seven centimeters (cm) in height and an absence of orthopedic or neurologic alterations that might compromise balance. Obese women (based on the classification of the World Health Organization), those with uncorrected visual impairment and those with inner-ear conditions were excluded from the study.

The participants were assessed on a single day. Anthropometric measurements were taken. The assessment of static balance in the orthostatic position was assessed using a force plate (OR-6 model, Advanced Mechanical Technology, Inc) at a frequency of 1000 Hz. The force plate has a series of force sensors arranged to measure the three force components (Fx, Fy and Fz) and three torque components (Mx, My and Mz). This device measures movements in the anteroposterior (x), mediolateral (y) and vertical (z) directions. The Fz moments in relation to the x and y axes were calculated using equations 1 (Mx = Fz $*$ COPy) and 2 (My = Fz $*$ COPx).