Repercussions on spinal posture before and after wearing high-heeled shoes in a sample of young women: cross-sectional study

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(translated version)

TYPE OF STUDY

Cross sectional study. Monocentric.

INTRODUCTION

Women who wear high-heeled shoes are considered more attractive, confident and elegant. However, some authors argue that women who often use high heels are at greater risk of back pain [Lee et al 2001].

There are numerous studies that have tried to give an explanation to the typical lumbar pain in women who wear this shoe: according to some authors (Han 2015) it is due to an increase in the activity of the spinal erector (recorded by surface electromyography) which occurs both by maintaining an upright posture and by walking.

In fact, the heel produces a displacement of the center of mass (COM) anteriorly and superiorly (Gerber et al., 2012), determining compensations implemented by our body including greater activation of the paraspinal muscles (recorded by electromyography).

At a postural level, many doctors, physiotherapists and chiropractors are convinced that lower back pain induced by heels is due to an increase in lumbar lordosis associated with an anterior pelvic tilt; this thought is even shared by the American Chiropractic Association and the American Physical Therapy Association (Russell, 2010).

Furthermore, in most of the websites consulted, even by non-experts, the reason for the onset of spinal pain is attributed to hyperlordosis and pelvic anteversion.

However, this thought is not entirely in agreement with other scientific publications. Therefore it is necessary to pay attention to online searches which often answer these questions without taking EBM into account.

Investigations into the role of high-heeled shoes in altering the spinopelvic profile have attempted to explore compensatory and adaptive structural changes as the cause of lower back pain. The conclusions of these studies, however, are controversial. Some studies [de Oliveira Pezzan et al 2011; Dai et al 2015] demonstrated that high-heeled shoes significantly increase lumbar lordosis (LL), and consequently mechanical loading and degenerative changes in soft tissue.

Other studies [Franklin et al 1995] show a reduction in LL and a compensatory increase in erector spinae muscle activity [Pezzan de Oliveira et al 2011]. The results of the study of Oliveira Pezzan et al. (2011) are indicative of an increase in pelvic anteversion and LL, but only in the group of subjects who frequently wore high heels, while in the other group there was a decrease in pelvic inclination and lordosis.

The results of other studies [de Lateur et al 1991; Lee et al. 2001; Kwon et al. 2015; Schroeder and Hollander 2018] showed that heel elevation did not significantly change the LL in the female subjects evaluated.

None of the studies reported above take into consideration the time factor. In fact, all the studies have evaluated the immediate changes induced by heel raising. Women who complain of lower back pain when wearing high-heeled shoes rarely experience pain as soon as they start wearing them.

The objective of the research arises from these considerations.

The aim of this study (primary outcome) is to investigate whether wearing high-heeled shoes for at least 2 hours modifies the spinopelvic parameters compared to the barefoot condition and as soon as the shoes are worn.

The secondary outcome will be to verify in the sample analyzed whether there are different behaviors between the subgroups of those who have complained in their anamnesis and those who have never complained of lower back pain when using high-heeled shoes for a few hours.

MATERIALS AND METHODS

Location of the study

Spine Center and OSCE (Osteopathic Spine Center Education), via della Liberazione 5, Bologna

Population

Students of the OSCE osteopathy school

Sample size

Not having found similar studies in the literature, we prefer to start as a pilot study with the recruitment of approximately 30 female subjects. This number represents a good compromise between the possibility of finding a normal distribution and the feasibility of the study.

Recruitment

Recruitment will be carried out by announcing on the bulletin board and presenting the study project in the classroom of the OSCE osteopathy school.

Following the ethical principles of the Declaration of Helsinki, a paper information will be provided where there will be an explanation of the intent and purpose of the study to all subjects before their participation; furthermore, together with the information, a paper consent will be provided on which to obtain consent written informed voluntary consent to participate in the study and consent to the use of data through privacy information.

Inclusion criteria

- female subjects aged between 20 and 40 years

- usual users of shoes with heels at least 7 cm high, with a frequency of at least twice a week and/or more than 3 hours/week as proposed by a previous study (de Oliveira Pezzan et al. 2011);

Exclusion criteria

- structural or neurological anomalies that may prevent from standing, for approximately 2 hours, with shoes having a heel (difference between the heel and the plateau) of at least 7 cm high;

Methods

A three-dimensional analysis of the posterior surface will be performed with the Formetric 4D® rasterstereographic device (Diers International GmbH, Schlangenbad, Germany). Participants will be asked to complete the informed consent form after reading the information. Furthermore, consent to the processing of data will be requested after reading the Privacy form, confirming their participation in the study.

Participants will be given a questionnaire which investigates:

• Age, weight, height of the participants;
• Any pain in the spine (measured by NPS) usually reported by subjects after using high-heeled shoes;
• Type of profession;
• Frequency with which the subjects wear the heeled shoe (how many hours per week);
• Heel height of the shoe with which they participate in the clinical study;
• Any spinal pain (measured by NPS) after wearing heeled footwear for the study period.

This last data will be filled in at the end of the evaluation.

For the evaluation of the secondary outcome, on the basis of the data from the medical history sheet, the sample will be divided into two groups:

1) The first group (group A, ASYMPTOMATIC) includes subjects who during daily life do not report spinal pain after wearing high-heeled shoes;

2) The second group (group S, SYMPTOMATIC) is made up of participants who usually complain of more or less intense pain after using the shoe.

Heel type

The subjects will be asked to bring their own pair of shoes with a heel that is at least 8.7 cm, the average height reported by the work of Schroeder and Hollander (2018), where average height means the difference between the height of the heel and the height of the raised part at the forefoot level (plateau). A particular heel width will not be required, because it seems that the height of the heel influences muscle activation, in particular the paravertebral muscles, while the width of the heel has no significant effects on them (Han 2015).

Conversely, amplitude has a greater influence on balance when standing and while walking.

Measurement method

Positioning with respect to the measurement system will be carried out according to the indications provided by the supplier.

To standardize the position the subjects will be prepared for the analysis as follows:

1. standing, back to the detection system, in a relaxed posture with knees fully extended with bare feet on the floor (neutral position)
2. bare torso with trousers and briefs lowered to mid-buttock;
3. in the case of long hair, it will be required to tie it with suitable means (cap, hair clips, hair ties, etc.) so that the neck is visible up to the hairline;
4. Rings, watches and necklaces will be removed to avoid any interference with the light lines (necklaces in particular increase this probability).

A three-dimensional analysis of the posterior surface is performed with the Formetric 4D® rasterstereographic device (Diers International GmbH, Schlangenbad, Germany) [9-15].

The device, already supplied at the Spine Center rehabilitation center in Bologna and made available free of charge for study, is non-invasive and non-dangerous. The analysis of the spine curve with rasterstereography is carried out with a purely optical modality.

The protocol

1) first evaluation in neutral position with bare feet (T0)

2) second evaluation in neutral position wearing shoes (T1);

3) third evaluation like the previous one but at least 2 hours apart, in which it will be required to remain standing still or walk (T2).

Parameters detected

1) Flexion of the antero-posterior trunk (trunk inclination – TI) measured as the angle between the vertical and the line that passes through the prominent cervical vertebra (VP) and the line that connects the two dimples (DM);

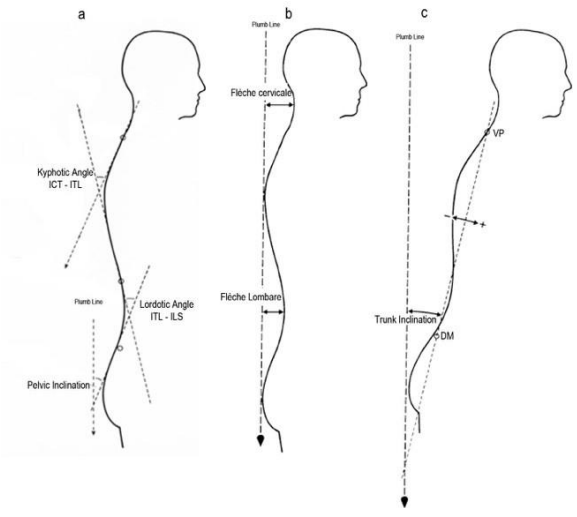
2) pelvic inclination angle (PI), i.e. the angle between the vertical and the tangent to the lumbosacral junction (ILS);

3) ITL-ILS lordotic angle, measured between the tangents of the thoracolumbar junction (ITL) and the lumbosacral junction (ILS);

4) ICT-ITL kyphotic angle, measured between the tangents of the cervicothoracic junction (ICT) and the thoracolumbar junction (ITL);

5) lumbar arrow (FL) (horizontal distance in millimeters of the lumbar spine from the virtual vertical line that passes through the kyphotic apex) ;

6) cervical arrow (FC) (horizontal distance in millimeters of the cervical spine from the virtual vertical line that passes through the kyphotic apex).



Statistic analysis

A descriptive analysis of the population will be performed to determine the mean values and standard deviations (SD) of both the combined group and the subgroups A and S. T-tests for independent data will be used to verify whether there are any significant differences between the two subgroups .

The distribution of the data will be verified using graphical representation. If the distribution is normal ($p < 0.05$) for the comparison between T1 vs T2 the t-test for paired data will be used and between the subgroups (T1S vs T1A and T2S vs T2A) t-test for independent data with statistical significance accepted for p values <0.05. ANOVA will be used to simultaneously compare the pre and post of both groups.

If the data does not have a normal distribution ($p > 0.05$) the Wilcoxon test will be used for the comparison between the T1 vs T2 data of the total group and the Mann-Whitney U test for the comparison between subgroups (T1S vs T1A and T2S vs T2A). The Friedman test will be used to simultaneously compare the pre and post of both groups.

Risks

The risks are quite limited given that the shoes worn are those owned by the tested subject, therefore it is assumed that they are used to wearing them, and they are not asked to perform movements at risk of sprains or falls.

Benefits

Being able to identify the spino-pelvic parameters that predispose to spinal symptoms, when wearing high heels, could help prevent the related pathology/symptoms through postural re-education or muscle strengthening exercises.

Costs

The use of the Formetric will be given free of charge and any related expenses (paper, color cartridges, etc.) will be borne by the Spine Center.

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