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Postural assessment of lumbar lordosis among adult female users and non-users of high heeled shoes in the Accra Metropolis

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Abstract

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Background: The use of high- heeled shoes has undoubted effects on posture and gait. High-heeled shoes have been suggested as the main explanation for excessive lumbar lordosis and consequent dominance of low back pain among corporate women. The habitual use of these shoes may be a plausible explanation for this. We aimed to compare the values of lumbar lordotic angles between habitual users and non-users of high heeled shoes.

Methods: A cross sectional study involving a one –time postural assessment of the lumbar spine in the sagittal plane among two groups (the user group who wore high heeled shoes (HHS) and the non-user group who do not wear high heeled shoes to and from work) of women. The flexible curved ruler was used to determine the lumbar lordosis angle. The values recorded were compared between the two groups. Pearson correlation was used to assess the relationship between lordotic angle and the duration of use and height of high-heeled shoes. One-way Analysis of Variance was used to compare the type of heel most frequently worn and lordotic angles while independent sample t-test was used to compare HHS-users and non-users and angle of lordosis.

Results: The mean angle for user and non-user groups were 33.08±4.00/Ø and 33.61±3.65/Ø respectively. The average duration of use of HHS was 2.55±1.66 years. Fifty-seven percent of the user group wore high-heeled shoes 3 times a week to work. Majority of the HHS users wore kitten type 12 (46%). There was no significant correlation (r=0.169, p=0.410) between lordotic angle and the duration of use of high-heeled shoes as well as between lordotic angle and the height of high-heeled shoes (r=-0.03, p=0.884). There was also no significant difference (p>0.05) among the type of high-heeled shoes most frequently worn and lordotic angle and no significant difference (p>0.05) between HHS users and non-users and lordotic angle.

Conclusion: Results of this study suggests that habitual use of high-heeled shoes does not have a significant effect on lumbar lordotic angle.

Keywords: *High-Heeled Shoes, Lumbar Lordosis, Corporate Women*

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INTRODUCTION

Two thirds of the human body mass are located in the upper two thirds of body height, so the body is an inherently unstable system that requires a controller [1]. Motor control is particularly complicated during common tasks like walking, where there is only one foot on the ground for parts of the step cycle but then both balance and propulsion are required [2]. Shoe choice is important in this regard and can potentially alter both force profiles and motor control [3].

Lumbar lordosis is the inward (ventral) curvature of the lumbar spine formed by the wedging of lumbar vertebral bodies and the intervertebral disks [4]. Lumbar lordosis is influenced by the shape of the vertebral bodies and the shape of the intervertebral discs, because each account for nearly 50% of the variability seen in lordotic angles of adults [5]. Dai et al [6] reported that wearing high-heeled shoes can lead to increased lumbar lordosis and an uneconomic body position.

High-heeled footwear (often shortened as ‘high heels’ or simply ‘heels’) is footwear that raises the heel of the wearer's foot significantly higher than the toes. According to high-fashion shoe websites like Jimmy Choo and Gucci, a low heel is considered less than 2.5 inches while heels between 2.5 and 3.5 inches are considered mid heels, and anything over that range is considered a high heel. The apparel industry appears to have a simpler view; the term high heels cover heels ranging from 2 to 5 inches or more. A high-heeled shoe is considered an important aspect of fashion world of women [7]. Different classifications of high-heeled shoes exist and may include cone, kitten wedge, prism and spool or Louis heels as well as Stiletto [8].

Research has suggested that high heels have the ability to change the normal posture and gait of the human body, thereby causing some health hazards” [9]. The Ogilvy Group [10] showed that 78% of British women wear high-heeled shoes on a daily basis. Wearing high-heeled shoes may produce deleterious effects on the musculoskeletal system and to the spine. In the context of high heel research, their effects on lumbar lordosis are perhaps the most debated and discussed [11]. Lee, Jeong and Freivalds [12] reported increased lordosis in five women aged between 20 and 30 when changing from standing to walking. In a study of 13–20-year-old girls, De Oliveira Pezzan et al [13], reported that lordosis decreased in inexperienced users of high heels but increased in experienced users. However, Iunes, et al [14], reported no significant difference for either regular or infrequent users of high heeled shoes. Ebrahimian and Ghaffarinejad [15], reported by means of a questionnaire and interview only on 60 women between the ages of 20 and 30 years that an association of increased lumbar lordosis correlated with increased heel heights. Matsuo, et al., [16], took measurements of participants who wore high-heeled shoes of various heights and reported that that wearing heeled shoes does not influence spinal curvature in the standing position.

Wearing high heels is said to be associated with chronic pain of the neck, lower back and knees howver, the mechanisms behind this are not fully understood [9]. It is widely believed that the use of high- heeled shoes causes an increase in the lumbar lordotic curvature. Han in 2015 [17], reported that high heels is not recommended for those who have pain or functional problems in the cervical and/or lumbar spine as it tends to exacerbate the condition.

For instance, in April 2017, the Canadian province of British Columbia amended workplace legislation to prevent employers from requiring women to wear high heels at work. British Columbia Premier at the time indicated that government was "changing this regulation to stop this unsafe and discriminatory practice".

The Centre for Disease Control and Prevention’s research in 2013, found that nearly a third of the female adult population suffered from low back pain, compared to a quarter of the male adult population as reported by Lee, Jeong and Freivalds [12]. In Ghana, even though there may not be empirical data backing the claim of using such footwear, it appears most corporate ladies wear high-heeled shoes on a regular basis.

Information on the long-term effects of wearing high-heeled shoes on the lumber spine curvature appears scanty and a bit diverse. However, very few studies have been conducted among the Ghanaian populace. Considering the fact that both low back pain and wearing of high-heeled shoes are common in women elsewhere, this is a scope of knowledge that needs further investigation. This study therefore sought to investigate the effects of habitual use of high-heeled shoes on the lumbar spine curvature among Ghanaian women.

MATERIALS AND METHODS

We conducted a cross-sectional study at selected law firms and Korle-Bu Teaching Hospital all in the Accra metropolis of Ghana. All measurements were taken at designated private rooms allocated for the study at the workplaces of the participants. Participants included two groups of women; a user group who wore high-heeled shoes to work on a regular basis and a non-user group who did not wear high-heeled shoes in their line of work. The user group included lawyers, clerks, secretaries and paralegals recruited from the selected law firms. The non-user group constituted rotation nurses, midwives and nursing students on clinical rotation recruited from the Korle-Bu Teaching Hospital. A one-time assessment was done over a period of two months (end of March to end of May 2017). For the purposes of this study, a high-heeled shoe is defined as having a heel height of 5cm or higher [18].

Five hundred and ninety-seven (597) female names were identified from the published list of the Ghana Bar Association from approximately 200 law firms registered and operating in the Accra Metropolis. The recruitment was piloted among ten law firms selected randomly to help assess the actual population size. Out of the ten law firms to which copies of the recruitment form was administered, only 3 women fit into the criteria. Five of those law firms had no woman employee. Three of the law firms had no woman who fit into the criteria. The other two law firms together had 3 employees who satisfied the criteria. This outcome was used to estimate the sample size of 52 participants.

Participants of this study were female adults between the ages of 19 and 60 years. The user group were those who have worn and continued to wear high-heeled shoes at least 3 times a week, 3 straight hours in a day and for a minimum of 1 year to work at the time of data collection. The non-user group were those who had never used high-heeled shoes for a minimum of 1 year to work at the time of data collection.

The exclusion criteria comprised of women who were pregnant at the time of the study, diagnosed with a spinal deformity such as scoliosis and kyphosis as well as women who had been diagnosed with limb length discrepancy.

Data collection tools

A recruitment form which was developed by the researchers was used to select and recruit women who met the criteria for selection. The form was used to elicit participants' use of high-heeled shoes, past medical history and whether or not they were pregnant at the time of recruitment. A close-ended questionnaire made up of five simple questions was designed by the researchers to obtain information about the types of high-heeled shoes used and to ascertain the durations and frequencies of use. Aside questions, the participants were asked to indicate, by means of various photographs, the shoes most similar to those they most often used.

The flexible curved ruler (flexi-curve or flexible curve) usually made from lead, which is wrapped in steel ribbons, and covered in plastic was used to assess the lordotic curvature of each participant. Its validity and reliability have been tested and proven to be a valid and reliable non-invasive method for the measurements of the spinal curvature. A skin pencil was used to mark bony prominences that served as landmarks for the measurement. Disposable examination gowns were provided for the participants to allow for easy access to the back without exposing other parts of the body not relevant for the study.

Procedure

Recruitment forms were distributed to the selected law firms and the various departments at Korle-Bu Teaching Hospital.

Copies of the questionnaire were administered to the user group only.

All participants' lordotic curvatures were assessed using the flexi-curve. Participants were requested to change into a disposable examination gown provided by the researchers and requested to leave brassieres unhooked to allow access to the paraspinal area. All examinations were done in designated private rooms at the participants' workplace to ensure their privacy. Participants were allowed to leave their pants or skirts on. The skin pencil was used to mark the T12 spinous process and the second sacral tubercle. Participants were asked to take off their shoes and stand barefooted or allowed to wear their stockings or socks during the measurements. Interestingly, most of the recruited women wore shoe size 35. The flexi-curve was used to take the back measurements twice by tracing the lordotic curvature. Participants were instructed to look on the wall, keep their gaze at eye height until the ruler was carefully removed from the back. Without a change in shape, the ruler was carefully placed on a graph sheet to reproduce the shape of the ruler and the spots corresponding to T12 and S2 marked.

To calculate lumbar lordosis angle, a straight line was drawn from the T12 to S2 points and a perpendicular line was drawn from the straight line. The lines were labelled L and H respectively. The angle was then obtained from the formula; $\theta=4$ Arc Tan $2H/L$. All measurements were taken by the researchers.

Data analysis

Pearson correlation was used to assess the relationship between lordotic angle and the duration of use and height of high-heeled shoes. One-way Analysis of Variance (ANOVA) was used to compare the type of heel most frequently worn and lordotic angles while independent sample t-test was used to compare HHS-users and non-users and angle of lordosis. Data was then analysed using SPSS version 23.0 at a significance level of $\alpha=0.05$.

RESULTS

Participant's Demographic Characteristics

Fifty-two (52) participants were recruited for this study, with equal representation of both the users of high-heeled shoes 26(50%) and non-users of high-heeled shoes 26 (50%) and their mean age almost similar. The mean age of the non-high heel users was 30.96±5.17 years while that of high heel users was 30.92±5.08 years. Furthermore, the duration of use of high-heeled shoes among the participants was approximately two and half years (2.55±1.66 years) (Table 1). Table 1 also shows the average lordotic angle for users and non-users of high-heeled shoes. Interestingly, 58% of the user group wore high-heeled shoes 3 times a week to work. In addition, the most frequent type of high heeled shoe worn by the user group was the kitten type (n= 12, 46%).

Table 1: socio-demographic characteristics of the participants (Users of HHS, n=26, Non-users of HHS, n=26)

Variable	Mean +SD	Minimum	Maximum
Age (yrs.)			
Users of HHS /years.	30.92±5.08	22	43
Non-users of HHS/years	30.92±5.08	22	43
Duration of use of HHS (years).	2.55±1.66	1	9
Height of heel/inches	3.31±0.93	2	6
Angle of lordosis/Ø			
Users of HHS	33.08±4.00	27.39	40.84
Non-users of HHS	33.61±3.65	28.44	42.79

There was no significant correlation (r=0.169, p=0.410) between lordotic angle and the duration of use of high-heeled shoes as well as between lordotic angle and the height of high-heeled shoes (r=-0.03, p=0.884) as presented in Table 2. There was no significant difference (p>0.05) among the type of high-heeled shoes most frequently worn and lordotic angle (Table 3) and no significant difference (p>0.05) between HHS users and non-users and lordotic angle (Table 4).

Table 2: Pearson correlation analysis of lordotic angle, duration of use and height of heel

Variables	N	r	p-value
Lordotic angle and duration of use	26	0.169	0.410
Lordotic angle and height of heel	26	-0.030	0.884

n= sample size,

r= Pearson correlation coefficients

Table 3: Analysis of variance comparison of type of heel and recorded lordotic angles

Type of heel	n	Mean±SD	F	DF	p-value
Kitten	8	34.10±4.79	0.266	25	0.849
Cone	4	33.23±5.30			
Prism	2	32.46±0.62			
Stiletto	12	32.44±4.00			

DF=Degree of freedom,

n= sample size

Table 4: Independent t-test analysis of users and non-users of HHS and recorded lordotic angles

	n	Mean±SD	t	DF	p-value
Users of HHS	26	33.08±4.00	-0.506	50	0.615
Non-users of HHS	26	33.61±3.65			

DF=Degree of freedom

n= sample size

DISCUSSION

The youngest participants of this study were 22 years old whereas the oldest was 43 years old. Most of the participants were however either in their late twenties to early thirties (26-33years). This implies that the vast majority of women who use high heeled shoes in corporate organizations are mainly the youth and this corroborates findings of Dai et al [6]. It could be inferred that for majority of the user group, they wore high-heeled shoes three times a week to work because this may be attributed to the fact that they probably do not attend court proceedings every day of the week. It could also be that kitten heels are quite comfortable since it was the most frequently worn by the user group next to the stiletto type of heel.

Lumbar lordotic angles were slightly larger in the non-user group as compared to the user group though not significant. This may be due to the fact that the sample size was not large enough to detect any significant difference in lumbar lordotic angles. Perhaps the non-user group used or use high-heeled shoes while they were not at work but rather to parties and other social gatherings. This may put them at the same level of usage as the user group depending on frequency. This finding is similar to reports of Russell, Muhlenkamp, Hoiriis et al. [11], who used the spinal mouse to measure lumbar lordosis in test participants barefooted and then

again with 3- or 4- inches high-heeled shoes after a 10-minute adaptation. Although the 10-minute time given for adaptation is probably too short, the method used for measurement showed good reliability. Its validity of measurements in the sagittal plane has not been, however, established.

Lee, Jeong and Freivalds [12], on the contrary, reported increased lumbar lordosis angles with the use of high-heeled shoes. The sample size of five women in their 20's for the study was probably rather small for any meaningful conclusions to be drawn. Lee, Jeong and Freivalds [12], used markers on the skin of the lateral trunk to derive angular measurements from photographs. The methods for selecting marker locations were not described and landmarks on lateral trunk may not represent lumbar curves. Iunes, Monte-Raso, Santos et al. [14], reported that there was no significant difference in lumbar lordosis angles for either regular or infrequent users of high heel shoes, which is similar to findings obtained in this study. Interestingly, most participants of this study used shoe size 35 which suggests that participants were mostly petite. Although there is currently no evidence that relatively small or short women would get a different result than relatively taller or heavier women, it might be informative to see a larger study that could compare older and younger women of which analysis could be done according to body mass indices.

There was no significant relationship between lordotic angles recorded and duration of use of high heeled shoes in this study, which is quite similar to findings by Russell, Muhlenkamp, Hoiriis *et al.* [11]. This implies that the duration of use of high-heeled shoes may not be associated with lumbar lordotic angles unless it is tallied with specific type of heel and frequency of usage. There may be a recall bias as participants were required to remember how long they had been wearing high-heeled shoes to work.

There was no significant difference between lordotic angles recorded and type of heel most frequently worn. A study on muscle activation of paraspinal muscles in different types of high heels during standing found that the muscle activation of the C6 paraspinal muscle in the standing position differed significantly with each type of heel [17]. The choice of most frequently worn type of heel was based solely on the ability of the participants to remember. Recall bias may have affected the outcome of this study. Furthermore, the type of heel worn must be tallied with equal duration and frequency of use to obtain a more accurate comparison.

There was no correlation between lordotic angle and height of heel most frequently used. Participants based their choice of height of heel most frequently used on the visual estimates. As such, the height of heel chosen may not be accurate. The choice of height most frequently used was also based on their ability to recall. Poor recall abilities will yield false results. This may account for the findings of this study. A study, found only as an abstract for a conference presentation, contradicts this study. It claims an association of increased lumbar lordosis correlated with increased heel heights [15].

In agreement to this study, a study by Matsuo, Murata, Miyazaki et al., [16], suggests that wearing heeled shoes does not influence spinal curvature in the standing position. Although the angles of lumbar lordosis changed with heel height, no significant differences were found. Measurements were taken while participants wore high-heeled shoes of various heights which was not the same for this study.

CONCLUSION

This study reveals that the use of high-heeled shoes did not yield significant differences in lumbar lordotic angles in comparison to the non-users and the number of years of use of high-heeled shoes did not affect lumbar lordotic angles. The height and type of heel used did not also affect lumbar lordotic angles.

However, further studies could be carried out with a larger sample size in different parts of Ghana including other professionals such as bankers to further validate the outcomes of this study. Future studies when conducted could relate findings to occurrence of low back pain and other musculoskeletal conditions.

DECLARATION

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Competing interests There were no competing interests from all authors in this study.

Contributing Authors EN, JQ, and SO contributed to the study design and data collection. EN, JQ, SO, SK and JA contributed towards data analysis. JQ, and SK wrote the draft manuscript. EN, JQ, SO, SK and JA reviewed the manuscript for important intellectual content, revised the draft and approved the final version of the manuscript for submission

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