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Correlation of hallux deviation angle with age, weight, height, and body mass index in adult Nigerians

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Abstract:

CONTEXT: Hallux deviation angle (HDA) is the angle between the axis of the hallux and axis of the first metatarsal bone.

AIMS: The aim was to determine whether there is any correlation between HDA and age, weight, height, and body mass index (BMI) in an adult Nigerian population.

SETTING AND DESIGN: This was a cross-sectional study.

MATERIALS AND METHODS: A total of 1033 individuals consisting of 548 males and 485 females were studied. Age range was 15–74 years. HDA was measured by the goniometric method.

STATISTICAL ANALYSIS USED: Analysis was done using Statistical Package for the Social Sciences version 21. Correlation of HDA with age, weight, height, and BMI was done using Pearson's correlation. Test of significance was done using Chi-square.

RESULTS: Mean age in years was 34.1 (±13.4) for males and 29.6 (±12.0) for females. Mean BMI in kg/m^2 was 25.8 (±7.5) for males and 26.1 (±5.5) for females. The mean HDA in degrees on the right and left feet, respectively, were 5 ± 6 and 7 ± 7 for males and 5 ± 6 and 6 ± 6 for females. In males, there was a positive but weak correlation of HDA with age on both feet. There was also weak correlation of HDA with BMI on the right feet, but there was no correlation of HDA with weight and height. In females, there was positive and weak correlation of HDA with height on both feet while but there was no correlation with age, weight, or BMI.

CONCLUSION: HDA did not correlate with age, weight, height and BMI in our environment.

Keywords:

Age, body mass index, hallux deviation angle, Nigeria

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Introduction

Hallux deviation angle (HDA) is the angle between the axis of the proximal phalanx of the hallux and the long axis of the first metatarsal bone, at the first metatarsophalangeal joint. It is important in the diagnosis, classification, and postoperative evaluation of hallux valgus (HV).

HV is a defect of the hallux, in which the HDA is >15° toward the lesser toes, with a medial bony prominence at the head of the first metatarsal bone (Dufour *et al.*, 2014). It is a common foot problem, especially found at the foot and ankle clinics (Vanore *et al.*, 2003). Pain is the leading complaint in patients with HV. Other complications may include footwear fitting problems, impaired gait patterns, poor balance, and falls in older adults (Menz and Lord, 2005).

The prevalence of HV varies from place to place. Owoeye *et al.* (2011) reported a prevalence of 15.4%, among a youth population in Lagos, Nigeria. A systematic review on the prevalence of HV in the

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general population by Nix *et al*. (2010) yielded a prevalence of 23% in adults aged 18–65 years.

HV is a complex forefoot defect for which a clearly identifiable cause is not yet known (Morales-Orcajo *et al*., 2015; Perera, Mason and Stephens, 2011). However, potential etiologic factors include high-heeled narrow shoes, genetic factor, race, sexual dimorphism, age, and body mass index (BMI).

There are conflicting reports of association of HV with age. Some researchers (Menz, 2015; Dufour *et al*., 2014; Roddy *et al*., 2008; Mafart, 2007; and Scott *et al*., 2007) agree while some others (Nguyen *et al*. 2010; Castro, Rebelatto and Aurichio, 2009; Cho *et al*., 2009; and Hardy and Clapham, 1951) did not agree on such observation. In the same way, some authors associated increase in the prevalence of HV with increase in BMI (Gay *et al*., 2014; Cho *et al*., 2009; and Coughlin and Jones, 2007) while some others (Butterworth *et al*., 2012; Perera, Mason and Stephens, 2011) did not agree on that association in their works.

The purpose of this study was to determine whether there exists any correlation between HDA and age, weight, height, and BMI in an adult Nigerian population, as the knowledge will help in the prevention of HV.

This study has not been reported in our environment, hence the need for this study.

Materials and Methods

The study was conducted among individuals who were resident in Anambra State of Nigeria. The study was a cross-sectional descriptive design, with the use of structured questionnaire. Recordings for the measurements of height, weight, and HDA were also documented in the questionnaire.

The population was apparently healthy male and female individuals who were drawn from several occupational groups which included farmers, traders, medical student, nursing student, road safety corps, the police, and the military. A total of 1033 individuals including 548 males and 485 females were studied. The age range was between 15 and 74 years.

Inclusion criteria included individuals who did not have obvious foot deformity and did not use support devices while exclusion criteria included severe foot trauma, rheumatoid arthritis, pregnancy, surgery of foot and/or foot deformity other than spread foot, HV, or lesser toe deformities.

Height was measured in centimeter with a wooden stadiometer, to which a calibrated steel tape (Liangjin® 5 m/16 ft, 36G-50) was attached. Measurement was taken according to the procedure described by Hall *et al*. (1995). Measurements of height were rounded up to the nearest 0.1 cm. Two measurements were taken and the mean was determined. If the difference between the measurements was >0.4 cm, a third measurement was taken and the mean of the closest two was taken as the height.

Weight was measured with a manual weighing scale (Harson Emperors, model: H89, China) in kilogram, to the nearest 0.1 kg. Individuals were asked to wear light clothing with no shoes. Then, he/she was asked to stand erect on the instrument which was mounted on a flat surface while the observer took the measurement. Two measurements were taken and the mean was recorded. BMI was calculated as weight (kg)/height^2 (m^2).

HDA was measured with clinical goniometer, by the method described by Janssen *et al*. (2014) [Figure 1]. It was measured in degrees and was accurate to 1°. Two measurements were taken, and the mean was determined. If the difference between the measurements exceeded 2°, a third measurement was taken and the mean of the closest two was determined.

Data were analyzed with Statistical Package for the Social Sciences version 21 (IBM Corp, Armonk, NY, USA). Mean values for age, weight, height, BMI, and HDA were analyzed with their corresponding standard deviations. Correlation of HDA with age, height, weight, and BMI was also analyzed.

Ethical approval

Ethical approval was obtained from the ethical committee of the Faculty of Basic Medical Sciences, Nnamdi Azikiwe University, Awka (NAU/CHS/NC/FBMS/172). Consent was obtained from all individuals.

Figure 1: Measurement of hallux deviation angle

Sampling technique

Simple random sampling was used to select occupational groups. Then, all the consenting individuals from the group were selected. One thousand and thirty-three individuals were examined as listed below:

- Police: 122
- Road safety: 119
- Nursing students: 200
- Military: 58
- Medical student: 141
- Traders: 228
- Farmers: 165.

Results

The mean age for the sample was 34.1 (±13.4) years for males and 29.6 (±12.0) years for females. Furthermore, the mean BMI was 25.8 (±7.5) kg/m^2 for males and 26.1 (±5.5) kg/m^2 for females [Table 1]. Correlation of HDA with age, weight, height, and BMI is shown in Table 2. In males, there was a positive and weak correlation of HDA with age on both feet and with BMI on the right foot only. There was no correlation of HDA with either weight or height in males. In females, there was a positive and weak correlation of HDA with height on both feet, but there was no correlation with age, weight, and BMI. Table 3 showed the mean HDA among the individuals. Table 4 shows the prevalence of HV among various occupational groups. The differences in the prevalence of HV among the various occupational groups were statistically significant ($P < 0.05$).

Table 1: Mean value of age, weight, height, and body mass index in males and females

Variable	Males	Females
Mean age (years)±SD	34.1±13.4	29.6±12.0
Mean weight (kg)±SD	76.4±12.6	69.1±15.0
Mean height (cm)±SD	172.9±6.9	162.7±6.8
Mean BMI (kg/m^2)±SD	25.8±7.5	26.1±5.5

SD - Standard deviation, BMI - Body mass index

Table 2: Correlation of age, height, weight, and body mass index with hallux deviation angle

Variable	Correlation coefficient *r*, *P*			
	Male (*n*=548)		Female (*n*=485)	
	HDA right foot	HDA left foot	HDA right foot	HDA left foot
Age	0.19, 0.00	0.17, 0.00	0.06, 0.16	−0.00, 0.99
Height	−0.05, 0.21	0.02, 0.63	0.11, 0.02	0.11, 0.02
Weight	0.07, 0.09	0.07, 0.09	−0.01, 0.82	−0.04, 0.35
BMI	0.11, 0.01	0.06, 0.19	−0.05, 0.29	−0.08, 0.09

BMI - Body mass index, HAD - Hallux deviation angle

Table 3: Mean hallux deviation angles among individuals

Variable	Males		Females	
	Right foot	Left foot	Right foot	Left foot
HDA (°)	5±6	7±7	5±6	6±6

HAD - Hallux deviation angle

Table 4: Prevalence of hallux valgus among various occupational groups

Occupational group	HV present (%)	HV absent (%)	Total (%)
Police	22 (18.0)	100 (82.0)	122 (100)
Road safety	17 (14.3)	102 (85.7)	119 (100)
Nursing students	21 (10.5)	179 (89.5)	200 (100)
Military	12 (20.7)	46 (79.3)	58 (100)
Medical students	14 (9.9)	127 (90.1)	141 (100)
Traders	19 (8.3)	209 (91.7)	228 (100)
Farmers	28 (17.0)	137 (83.0)	165 (100)
Total	133	900	1033 (100)

χ^2-15.017, *P* - 0.020. HV - Hallux valgus

Discussion

Summary of key findings

HDA is necessary in the diagnosis and treatment of HV. In our study, there seemed to be a relationship between HDA and some of the parameters in both males and females, but the magnitudes of the correlation coefficient were not strong enough to establish any meaningful correlation between HDA and the parameters in question.

Strengths and limitations of the study

Being a cross-sectional study, this study cannot be used to establish a causal relationship between HV and the variables under study, but it may be used to generate a hypothesis. In our study, HDA was determined by goniometric measurement, which is less objective as compared to the radiographic method which is often regarded as the gold standard for measuring HDA.

Interpretation and implications

The findings of our study showed that there was a positive and weak correlation of HDA with age in male individuals on both feet. However, there was no correlation between HDA and age in the female individuals. The reason for this gender-based difference was not obvious from our research work. A similar finding was reported by Castro *et al*. (2009) in a study conducted in Brazil. They reported a positive and weak correlation of HDA with age only on the right feet of the female individuals. In our study, the male group was 548, while the female group was 485 in number. There was male preponderance in the study sample and HDA correlated with age in males. In the work of Castro *et al*. (2009), there was female preponderance in the study sample (females – 227 and males – 172) and again HDA correlated with age. The disproportion in the number of male and female individuals may have affected the observed correlation of HDA and age among males and females. However, in the work of Castro *et al*. (2009), the correlation was not found on both feet of women but only on the right foot, the reason of which was not obvious.

The HDA measured by Castro *et al*. (2009) were 13.9° (±8.2) and 12.0° (±8.3) on the left and right feet, respectively, in women and 11.8° (±6.9) and 10.0° (±6.5) on the left and right feet, respectively, in men. These values were significantly larger than that of our study which were 5° (±6) and 6° (±6) in the left and right feet, respectively, in females and 7° (±7) and 5° (±6) in the left and right feet, respectively, in males [Table 3]. This difference may have resulted from difference in race. Barnicot and Hardy (1955) reported a significant difference in the HDA between individuals of European and West African origin.

In our study, there was a positive and weak correlation of HDA with BMI on the right feet of male individuals, whereas there was no correlation between HDA with BMI in females. It was not clear why there was difference in correlation between the right and left feet in males. This may suggest that some behavioral characteristics such as handedness, posture, and gait pattern may affect HDA. Nguyen *et al*. (2013) had associated handedness with HV. The correlation of HDA and BMI as observed in our work is not strong enough to establish association BMI with HDA.

Our finding was similar to a meta-analysis by Butterworth *et al*. (2012). They reviewed 25 papers in 2011 regarding the association of BMI with musculoskeletal foot disorders and found a strong relationship between BMI and nonspecific foot pain. However, evidence was inconclusive regarding the relation between BMI and HV. Our result did not support the findings of Cho *et al*. (2009) in a rural Korean population. They reported that high BMI was significantly associated with HV. The difference may be due to the method of measuring the HDA. While we used goniometric technique, they used radiographic method. Radiographic measurement of HDA is known to be more objective and reproducible than goniometric method (Janssen *et al*., 2014) However, it is not feasible for a field study and in resource-poor setting which was the case in our study. The Framingham study (Dufour *et al*., 2014) in Massachusetts which was carried out between 2002 and 2008 reported that BMI >30 kg/m^2 was inversely associated with HV in both sexes, reducing the odds by 33%–45%. This means that obese individuals were less likely to have HV. This inverse relationship between BMI and HV was also reported in women by the MOBILIZE Boston Study (Nguyen *et al*., 2010). The difference between the findings in the Framingham study and ours may be because the Framingham study was a cohort study while ours was a cross-sectional study. It may also be due to difference in the mean age. The mean age in their study was 66 years (±10.5) while the mean age for our study was 34.1 years (±13.4) for males and 29.6 years (±12.0) for females. Scott *et al*. (2007) reported the increased prevalence of HV among elderly persons as compared with younger persons.

There was a significant difference in the prevalence of HV in various occupational groups. Table 4 shows that there is higher prevalence among the military and police. This finding may be attributed to the thick boots worn by these uniform groups. Some studies had associated HV with shoe wearing (Dufour *et al*., 2014 and Nguyen *et al*., 2010).

In the present work, we studied to the individual effects of weight and height on the HDA. Our findings showed that there was no correlation between weight and HDA on both sexes. There was a positive but weak correlation of height with HDA on both feet in females.

Conclusion

There was a weak correlation of HDA with age and BMI in males, and there was also a weak correlation of HDA with height in females. However, these correlations were not strong enough to establish a real relationship between the HDA and the parameters studied.

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Conflicts of interest

There are no conflicts of interest.

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