Original Article

Hallux Valgus in Riyadh, Saudi Arabia: Prevalence, Characteristics, and its Associations

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Abstract

Objectives: Hallux valgus (HV) is a common forefoot deformity encountered in orthopedic clinics. Little is known about the condition in Saudi Arabia due to the deficiency of studies investigating its characteristics in the general population. Epidemiological studies documenting HV prevalence are of paramount importance. This study aimed to estimate the prevalence of HV and identify its characteristics among the Saudi population residing in the capital city, Riyadh. **Methods:** An interview-based and self-reported cross-sectional study was conducted at four commercial centers and three universities in Riyadh, Saudi Arabia. Data were collected between December 2017 and February 2018. For estimation of the prevalence of HV, the Manchester scale was used. Multivariate logistic regression was used to test the relationship between HV and possible risk factors. Bivariate analysis, using cross-tabulation, was used to identify the odds ratios (ORs) of HV and Chi-square to calculate statistical significance. **Results:** A total of 420 participants (140 males and 280 females) were included in the study. The overall prevalence of HV for all participants was 43% ($n = 181$). The prevalence of HV in males and females was 30.7% ($n = 43$) and 49.2% ($n = 138$), respectively. Severe degree of HV was noted in 0.95% of the participants. The incidence of HV was more prevalent in participants who reported a positive family history (OR = 2.144; $P = 0.001$), big toe pain (OR = 2.97; $P = 0.001$), and female gender (OR = 2.039; $P = 0.003$). **Conclusion:** In the Saudi Arabian population, HV is a prevalent foot deformity that is associated with big toe pain, positive family history, and female gender.

Keywords: Bunion, foot, hallux valgus, orthopedics, prevalence

Introduction

Hallux valgus (HV) is one of the most common foot deformities seen in medical practice.[1] It is characterized by medial deviation and varus malrotation of the first metatarsal with or without bunion formation of the first metatarsal head.[2,3] The estimated prevalence of HV ranges from 21% to 70% in different epidemiological studies.[4-9]

HV is associated with a marked reduction in foot-specific and general health-related quality of life as the severity of the condition increases.[5,10] This indicates that HV is a disabling and significant musculoskeletal condition, which might require intervention to correct the deformity or slow its progression.[5,10,11]

Multiple risk factors have been associated with HV including, but not limited to, age, female gender, pes planus, genetic factors, footwear, big toe pain, nodal osteoarthritis, and self-reported osteoarthritis.[4,11,12] The etiological mechanisms, however, responsible for the development of HV may differ between males and females. In males, HV is associated with higher body mass index (BMI) and pes planus. Whereas, in females, it is associated with lower BMI and wearing high heels during adulthood and middle-age years.[12]

Women tend to wear shoes with a broader toe box and lower heels as they get older.[13] Wearing shoes with narrow toe boxes for younger women might predispose them to exert direct pressure on their first metatarsophalangeal joint.[14] Wearing constrictive footwear, high heels, and extremely narrow toe box

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between the ages of 20 and 29 years is common among females and might be responsible for developing HV later in life.[15,16]

It is evident that there is a scarcity of studies and epidemiological data on HV in Saudi Arabia, making it difficult to measure the impact of the deformity. Considering the varying and high prevalence rates of HV across the populations, national data concerning the estimated prevalence of HV in each population are necessary.[17] The main aim of this study is to provide an estimate of HV prevalence, report its characteristics, and identify its possible associations among the general Saudi population residing in Riyadh.

Materials and Methods

Study setting and participants

To obtain a representative sample of the general population living in Riyadh, Saudi Arabia, a cross-sectional study was conducted at four commercial centers and three universities located in different geographical areas. Riyadh, the capital city of Saudi Arabia, has a population of around 6.5 million people, with Saudis representing around 64.19% of the total population.

Adult Saudis living in Riyadh were included in the study. The exclusion criteria were non-Saudis, young participants (defined as <15 years), and participants with a documented previous foot trauma and/or surgery.

Sampling and data collection

Convenience sampling technique was used for this study. Data were collected from December 2017 to February 2018. To estimate the prevalence of HV among Saudis, participants were given the Manchester scale and were asked to choose one out of four pictures most closely resembled their feet [Figure 1].[18]

The Manchester scale

The Manchester scale is a valid and reliable assessment tool that is used in most prevalence studies as a screening tool for HV. The Manchester scale utilizes photographs of real cases of HV that are selected by a panel of podiatrists. These cases represent the full spectrum of the deformity (none, mild, moderate, and severe). The Manchester scale assessment tool highly correlates with the measurements of radiography with a high retest reliability. As such, the Manchester scale was used to estimate the prevalence of HV in Riyadh, Saudi Arabia.

A data collection tool of Menz *et al*. was used to investigate the usage of high heels.[13] This tool is composed of line drawings depicting four heel heights (flat, low, medium, and high) and four toe box shapes (very wide, wide, narrow, and very narrow).

Interview

An interview-based and self-reported data collection method was used to investigate possible associated risk factors among participants of the study. Some of the possible associated risk factors were as follows: (1) BMI: calculated by measuring the weight and height of the participant; (2) family history: by asking the participant whether there was a maternal or paternal history of HV; (3) pain: participants were asked about the presence of chronic pain on the metatarsal joint of the big toe; (4) childhood footwear: participants were asked about the type of footwear (barefoot vs. sandals vs. sports shoes) they had been mostly wearing during childhood; (5) usage of high heels: participants were asked to choose the most frequent shoe type (flat vs. low vs. medium vs. high) they had been wearing in the past and recently; and (6) toe box shape: participants were asked to choose the most frequent shoe type closely resembling their toe box shape (very wide vs. wide vs. narrow vs. very narrow).

Figure 1: Grading of hallux valgus using the Manchester scale. (a) No deformity; (b) mild deformity; (c) moderate deformity; (d) severe deformity

Data management and analysis plan

The data were coded and entered into IBM SPSS (version 23, IBM corporation, Armonk, New York, United States). Descriptive statistics were used to present the prevalence-related data, including footwear during childhood and family history. These are presented as frequencies and percentages. The mean and standard deviation were calculated for numerical variables such as age, weight, height, and BMI.

Cross-tabulation, using odds ratio (OR), was used to investigate the possible risk factors contributing to the development of HV such as footwear, BMI class, and family history. Pearson's Chi-Square test was used to investigate whether the association between HV and possible risk factors was significant. Logistic regression was used to test the relationship between HV and possible risk factors. All tests with $P \leq 0.05$ were considered statistically significant.

Results

A total of 420 participants were included in the study. The mean age of the participants was 28 ± 10 (range: 15–62 years). The mean height of the participants was 163 ± 8.6 cm, the mean weight was 67.9 ± 17.4 kg, and the mean BMI was 25.3 ± 5.8 kg/m^2. Most of the participants were overweight (n = 125; 29.7%), and around 18% (n = 79) of the participants were classified as obese, according to the BMI classification. Details of the participants' baseline characteristics are listed in Table 1.

The overall prevalence of HV for all participants was 43% (n = 181). The prevalence of HV among males and females was 30.7% (n = 43) and 49.2% (n = 138), respectively. Bilateral HV was noted in around one-third (n = 142) of the participants. Around one-third (n = 133) of the participants had a mild degree of HV. Moderate and severe degrees of HV were observed in 5.47% (n = 23) of the participants [Table 1].

Around 13% (n = 55) of the participants reported big toe pain, especially in the medial side of the big toe. Importantly, most participants (n = 32; 58.1%) reported that they experience big toe pain when walking. Around one-third of the patients with big toe pain (n = 15, 27.2%) were experiencing symptoms at rest. Around 32.3% of the entire sample (n = 136) reported having a family member with HV. Siblings were mostly affected by HV, followed by the mother, father, grandmother, and grandfather. Most participants reported more than one family member with HV. Details of big toe pain and family history are listed in Table 2.

Among female participants, only 7.5% (n = 21) reported that they do not wear high heels throughout the year. Most female participants (n = 122; 43.5%) used to wear high heels with narrow toe box shapes. Details of the footwear during childhood and high heels are listed in Table 3.

Among male participants, 25.7% (n = 36) had a mild degree of HV. Among female participants, a mild degree of HV was noted in 41% (n = 115) of the sample. A total of 34 (24.2%) male participants reported a positive family history of HV, as opposed to 36.4% (n = 102) among female participants. Table 4 compares the characteristics of male versus female participants.

Possible risk factors contributing to the development of HV were investigated using cross-tabulation. The incidence of HV was more common in participants who reported a positive family history. Participants with a positive family history had an OR of 2.47 (95% confidence interval [CI] = 1.62–3.75), with $P < 0.001$.

HV was equally prevalent in females who used to wear high-heeled shoes versus flat shoes. The OR for developing HV in females who used to wear flat shoes was 0.965 (95% CI = 0.541–1.719) with $P = 0.903$. Females who tend to wear shoes with a narrow toe box had an OR of 1.21 (95% CI = 0.747–1.925) with $P = 0.451$.

A multivariate analysis was performed using logistic regression to identify the OR of age, gender, BMI, big toe pain, family

Table 1: Participants' baselines characteristics

Variable	*n* (%)*
Mean age±SD, range	28±10 (15-62)
Gender, *n* (%)	
Male	140 (33.3)
Female	280 (66.6)
Body habitus	
Height (cm)	163±8.6
Weight (kg)	67.9±17.4
BMI (kg/m^2)	25.3±5.8
BMI class, *n* (%)	
Underweight	40 (9.5)
Normal	176 (41.9)
Overweight	125 (29.76)
Obese I	52 (12.3)
Obese II	18 (4.2)
Obese III	9 (2.14)
Hallux valgus, *n* (%)	
Bilateral	142 (78.4)
Right**	14 (7.73)
Left†	25 (13.8)
Manchester scale - right foot, *n* (%)	
None	264 (62.8)
Mild	133 (31.6)
Moderate	21 (5)
Severe	2 (0.4)
Manchester scale - left foot, *n* (%)	
None	253 (60.2)
Mild	141 (33.5)
Moderate	23 (5.4)
Severe	3 (0.7)

*The values are expressed in percentages, unless indicated otherwise, **Isolated hallux valgus of the right foot, †Isolated hallux valgus of the left foot. BMI: Body mass index, SD: Standard deviation

Table 2: Big toe pain characteristics and family history among participants

Variable	*n* (%)
Big toe pain - location	
Bilateral	17 (30.9)
Right	24 (43.6)
Left	14 (25.4)
Big toe pain - frequency	
Rarely	9 (16.3)
Sometimes	29 (52.72)
Always	17 (30.9)
Big toe pain - timing	
At rest	15 (27.27)
While walking	32 (58.1)
At rest and while walking	8 (14.5)
Family history - hallux valgus*	
Father	23 (16.9)
Mother	38 (27.9)
Grandfather	8 (5.8)
Grandmother	17 (12.5)
Siblings	50 (36.76)

*Most participants reported more than one family member with hallux valgus

Table 3: High heels characteristics among female participants

Variable	*n* (%)
Usage of high heels	
No	21 (7.5)
Rarely	117 (41.7)
Sometimes	136 (48.5)
Daily	6 (2.1)
Heels height	
Flat	58 (20.7)
Low	17 (6)
Medium	86 (30.7)
High	119 (42.5)
Heels toe box shape	
Very wide	71 (25.3)
Wide	87 (31)
Narrow	104 (37.1)
Very narrow	18 (6.4)

Table 4: Detailed comparison in characteristics between male and female participants

Variable	Males (*n*=140), *n* (%)*	Females (*n*=280), *n* (%)*
Age		
15-24	45 (32.1)	178 (63.5)
25-34	37 (26.4)	34 (12.1)
35-44	38 (27.1)	41 (14.6)
>45	20 (14.2)	19 (6.7)
Weight (kg)	140 (79.2)	280 (62.2)
Height (m)	140 (1.71)	280 (1.59)
BMI (kg/m^2)	140 (26.8)	280 (24.5)
BMI ≥30 (kg/m^2)	32 (22.8)	47 (16.78)
Manchester scale		
None	97 (69.2)	142 (50.7)
Mild	36 (25.7)	115 (41)
Moderate	5 (3.5)	21 (7.5)
Severe	2 (1.4)	2 (0.7)
Family history		
Yes	34 (24.2)	102 (36.4)
No	106 (75.7)	178 (63.5)

*The values are expressed in percentages, unless indicated otherwise. BMI: Body mass index

history, usage of high heels, big toe box shape, and footwear during childhood. Table 5 lists the OR of possible factors contributing to the development of HV.

Discussion

In the present study, it is noteworthy to mention that the prevalence of HV in female participants (49.2%) was 1.6 times greater than male participants (30.7%). Around one-third of the participants reported having a family member with HV. Of note, participants who reported a family history of HV were 2.14 times more likely to have HV ($P = 0.001$). As such, this indicates that having a positive family history of HV is a statistically significant risk factor for the development of HV.

Table 5: Logistic regression model analysis for risk factors of hallux valgus

Variable	OR	95% CI	*P*
Age*	0.997	0.974-1.021	0.808
Gender			
Males	Reference	-	-
Females	2.039	1.281-3.244	0.003
BMI*	0.996	0.958-1.035	0.837
Big toe pain			
No	Reference	-	-
Yes	2.97	1.584-5.570	0.001
Family history			
No	Reference	-	-
Yes	2.144	1.392-3.304	0.001
High heels			
No	Reference	-	-
Yes	1.085	0.578-2.036	0.8
Toe box shape (females)			
Wide	Reference	-	-
Narrow	0.844	0.503-1.417	0.522
Footwear (males)			
Shoes/sandals	Reference	-	-
Barefoot	1.568	0.708-3.474	0.268

*An incremental increase of 1 year. OR: Odds ratio; CI: Confidence interval; BMI: Body mass index

Wearing high heels with narrow toe box did not seem to have a statistically significant impact on the development of HV among the participants. Furthermore, two-thirds of the participants (n = 37/55) who reported big toe pain had HV, which translates to an OR of 2.97 (P = 0.001). Using the Manchester scale, the estimated prevalence of HV for all participants is 43% (n = 181/420). The prevalence of HV is close to what has been reported by Al-Abdulwahab and Al-Dosry in Saudi Arabia 19 years ago, indicating that HV is a common deformity in the general population.[16]

HV is considered a disabling foot deformity that impairs and reduces the general quality of life. The surgical decision should not only be based on the degree of deformity alone. Rather, it should be based on the health-related quality of life.[19] Abhishek *et al*. reported that impaired quality of life is associated with having HV and big toe pain, but not HV alone.[20]

Big toe pain is significantly associated with HV,[21] possibly because the participants were young females and pain was caused by walking and intense exercises, which put greater strain on their feet.[3] Therefore, HV should be investigated among females who report big toe pain to identify and address the condition at an early stage.[3] Although big toe pain was associated with HV, pain in other body regions was more likely to be reported as well, such as the knee, lower back, hip, and foot pain.[11]

Pain intensity in HV does not significantly correlate with the degree of HV angle. Therefore, foot pain should always be

assessed in the context of general health and physical activity engagement for the patient.[22]

Genetic factors might play a significant role in the development of HV.[23] HV was indicated to be a hereditary autosomal dominant disorder with variable penetrance.[24] One study reported that HV was more prevalent in females with a positive family history in the mother or maternal grandmother than in those without a positive family history.[3] A positive family history of HV was present in 47.7% of the participants with HV.[3] Another study, published in 2010, reported that positive family history was present in 88% of the participants with HV.[25]

Wu and Louie concluded that wearing high heels does not predispose females to develop HV in the Chinese population. Family history, however, was the major risk factor for developing HV.[25] The conclusion of Wu and Louie is consistent with the findings of the present study. In contrast, Hong *et al*. stated that wearing high heels negatively affects muscle coordination and increases muscle loads on the lower back and lower extremities, especially the quadriceps and erector spinae muscles. This, in turn, causes muscle fatigue and predisposes people to increased risk of injury. Wearing flat shoes or lowering the height of the high heels is one of the best methods to decrease the chances of injuries.[26]

Gait parameters tend to be affected by HV deformity, which in turn, predispose people with HV to develop increased mediolateral postural sway.[27,28] For instance, there is a reduced rearfoot supination, ankle dorsiflexion, and early onset of intrinsic muscle activity, especially at heel strike. Consequently, elderly individuals might have a less stable gait, especially when walking on irregular surfaces.[27,28] Hurn *et al*. reported that there are no significant differences in postural sway, muscular strength, and gait parameters in adults with a mild degree of HV as compared to the control group. Earlier intervention, therefore, may prevent further progression of the deformity to "severe HV" that might impair gait parameters.[29]

In Saudi Arabia, a study was published in 2000 by Al-Abdulwahab and Al-Dosry, which investigated HV and the preferred shoe types among 100 young healthy female college students.[16] To our knowledge, their study was the first of its kind that investigated the prevalence of HV in Saudi Arabia. The study reported that bilateral HV was present in 39% of the participants, 20 participants of which reported tenderness or pain in the foot.[16]

Finally, there are a few limitations that need to be acknowledged regarding the current study. Pes planus was not investigated as a possible association of HV due to the difficulty of clinically examining pes planus and assessing its severity in the general population. Big toe pain could not be differentiated from other conditions causing pain such as first metatarsophalangeal joint (MTP) joint degeneration, gout, rheumatoid arthritis, sesamoid conditions, osteochondral problems, or associated hallux rigidus. The study was cross-sectional and was performed in a convenience sampling technique. All participants were interviewed in an urban setting, that is, commercial centers and universities. This likely represented a higher socioeconomic class and lacked participants from rural areas. The method of data collection was participant based and was prone to recall bias. However, numerous efforts have been undertaken to overcome the obstacles in the study. In spite of these limitations, the current study highlighted the importance of investigating HV prevalence, characteristics, and its associated risk factors from an epidemiological perspective. To the best of our knowledge, this is the largest study, conducted in Saudi Arabia, estimating the prevalence of HV and identifying its associations.

Conclusion

HV is a prevalent foot deformity in the general Saudi Arabian population residing in Riyadh. Positive family history, female gender, and big toe pain are greatly associated with HV. No statistically significant association could be established between HV and BMI, high heels, and toe-box shape. Further studies are required to identify, assess, and screen for possible associations in the general population.

Ethical considerations

This study was approved by the Institutional Review Board (IRB) at King Abdullah International Medical Research Center (KAIMRC), Ministry of National Guard Health Affairs (NGHA), Riyadh, Saudi Arabia (Study Number: RC17/172/R).

Participants were interviewed voluntarily. Participants' demographics were kept anonymous and, therefore, no one was able to identify the participant through the interview. Participants' names were not required for participation in the study.

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Conflicts of interest

There are no conflicts of interest.

Authors' contributions

NSA conceived the idea and designed the study. AA, FA, and AN reviewed the literature, collected data, and wrote the manuscript. KA collected data and finalized the manuscript. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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