

Prevalence of Morton's toe and assessment of the associated risk factors: a cross-sectional study

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SUMMARY

Morton's toe results in an uneven distribution of pressure across the feet. Awareness about Morton's toe and its associated risk factors is clinically important. Although studies have reported the prevalence of Morton's toe, not many studies appear in literature discussing its impact on the associated risk factors such as hammertoe, bunion deformity, overpronation and plantar fasciitis, respectively. Hence, we have undertaken this study to analyze the prevalence of Morton's toe in the Gulf region to assess its impact on the foot. A cross-sectional descriptive epidemiological study was carried out between November 2021 and December 2022 on the feet of 100 individuals (male=50; female=50) with ages ranging from 17 to 75 years. The study included the Bahraini & non-Bahraini residents. Individuals with severe foot injuries and deformities resulting from surgery were excluded. A total of 56 Morton's toe cases (male=18; female=38) were noted in the study sample. The overall prevalence of Morton's toe was 28% and majority of the participants with Morton's toe were females (67.9%). Of 56 Morton's

toe cases, the majority were seen in the age group from 30 to 40 years, particularly in females. Our findings clearly showed a significant association between Morton's toe and hammertoe ($p=0.044$), bunion and usage of high heels ($p<0.001$), respectively. However, the association between Morton's toe and other risk factors such as plantar fasciitis and overpronation of the foot were found to be statistically nonsignificant ($p>0.05$). Our study provides baseline data for the first time on the prevalence of Morton's toe and associated risk factors.

Key words: Prevalence – Morton's toe – Gulf region – Associated risk factors

INTRODUCTION

The human foot normally has five toes. Each toe has three phalanges, which are the proximal, middle, and distal, except the first toe. The first toe has only two phalanges, which are the proximal and distal (Agur and Dailey, 2006). The first toe is very important for maintaining the biome-

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chanics of the foot. Normally, in most cases, the first toe is longer than the second toe because the first metatarsal bone is longer than the second metatarsal bone. However, studies have reported that the first toe could be shorter than the second toe. When the second toe is longer and lower than the first toe, it is called Morton's toe. This structural anomaly was first described by American orthopedic surgeon Dudley Morton (Morton, 1927).

Morton's toe results in an uneven distribution of pressure across the feet. This uneven distribution of pressure causes inward curling of the first toe leading to the formation of hammertoe. Over time, this can lead to an overpronation (turning inward) of the foot along with other risk factors, such as bunion deformity and plantar fasciitis, respectively (Gutteck et al., 2019; Dang and Coughlin, 2020). Knowledge about Morton's toe and its associated risk factors is clinically important. Studies about the prevalence of Morton's toe in various populations are few, and no studies appear in the literature in a way in which we conducted our study, i.e., discussing its impact on the associated risk factors. Hence, we have undertaken this study to analyze the prevalence of Morton's toe in the Gulf region to assess its impact on the foot.

MATERIALS AND METHODS

Type of study

A cross-sectional descriptive epidemiological study was carried out between November 2021 and December 2022.

Sample size

This study was conducted on the feet of 100 individuals (male=50; female=50) with ages ranging from 17 to 75 years with mean age of 39.3 ± 14.3 . The study included the Bahraini & non-Bahraini residents. Any individuals with severe foot injuries and deformities resulting from surgeries were excluded. This study was approved by the Research and Ethics Committees of the College of Medicine and Medical Science (CMMS) at Arabian Gulf University (AGU) (approval number: (E24-PI-11-21). Informed consent was obtained from all the individuals who participated in this study.

Assessment of Morton's toe and associated risk factors

Each individual was asked to place his/her foot on a horizontal surface to examine the length of the 2nd toe. If the 2nd toe is longer than the first toe, it was considered a Morton's toe. The subjects who presented Morton's toe were also examined for their hammertoe, bunion deformity, overpronation of the foot and plantar fasciitis, respectively. The females that presented with Morton's toe in this study were also asked whether they use high-heeled footwear. This was done to assess the association of high-heel usage with Morton's toe.

Statistical analysis

The collected data were analyzed by using the Statistical Package for Social Sciences (SPSS), version 28 (Chicago, IL, USA). Categorical variables were represented as frequencies and percentages, whereas continuous variables were represented as the mean and standard deviation. A pie chart and clustered bar chart were used to present a categorical variable. The number and ratio of the presence of Morton's toe were calculated according to different risk factors. The chi-square test was used to measure the associations between outcome variable (Morton's toe) and some categorical variables. A *p-value* of less than 0.05 was considered statistically significant.

Power estimation

To determine the appropriate sample size for Chi-square of independence (Pearson Chi-square test), power analysis was conducted using G*power software based on several factors: target power (0.80); a significance level (alpha level) $\alpha=0.05$; large effect size (0.6) for Cramer's phi. The power estimation suggested a minimum sample size of 76 participants.

RESULTS

Prevalence of Morton's toe

In our study of 100 individuals, 50% were males ($n=50$) and 50% were females ($n=50$). A total of 200 feet were assessed for Morton's toe. A total of 56 Morton's toe cases (male=18; female=38)

were noted in the individuals aged between 17-75 years (Table 1). The overall prevalence of Morton's toe was 28%, and the majority of participants with Morton's toe were females (67.9%). Of 56 Morton's toe cases, the majority were seen in the age group from 30 to 40 years, particularly in females. The results revealed that there was a significant relationship between the outcome variable (Morton's toe) and each gender and age groups ($\chi^2=9.921$, $df=1$, $p=0.002$; $\chi^2=9.543$, $df=3$, $p=0.023$), respectively (Table 1, Fig. 1).

Morton's toe and associated risk factors

Morton's toe with associated risk factors is presented in Fig. 2. Our findings clearly showed that there was a statistically significant association between Morton's toe and hammertoe ($p=0.044$),

whereas the association between Morton's toe, bunion deformity ($\chi^2=19.056$, $df=1$, $p<0.001$); and usage of high heels was highly significant statistically ($\chi^2=11.360$, $df=1$, $p<0.001$). However, the association between Morton's toe and overpronation of foot ($\chi^2=2.584$, $df=1$, $p=0.108$) and plantar fasciitis ($\chi^2=1.644$, $df=1$, $p=0.200$) were not statistically significant (Table 2). All the associated risk factors except overpronation of the foot were noted significantly higher in females (Fig. 3).

DISCUSSION

Morton's toe, which is also referred to as Greek foot, Royal toe, Turkey toe, LaMay toe or Shepard's toe, occurs due to congenital shortening of the first metatarsal bone. Studies have reported that the premature closure of the epiphysis in the

Table 1. The association between Morton's toe and socio-demographic variables.

Demographic Variables	Morton's toe		Chi-Square Value	P-value
	Present n (%)	Absent n (%)		
Gender				
Male ($n=100$)	18 (32.1)	82 (56.9)	9.921	0.002
Female ($n=100$)	38 (67.9)	62 (43.1)		
Age Group				
< 30 Years ($n=60$)	16 (28.6)	44 (30.6)	9.543	0.023
30-40 Years ($n=66$)	27 (48.2)	39 (27.1)		
41-50 Years ($n=32$)	6 (10.7)	26 (18.1)		
>50 Years ($n=42$)	7 (12.5)	35 (24.3)		

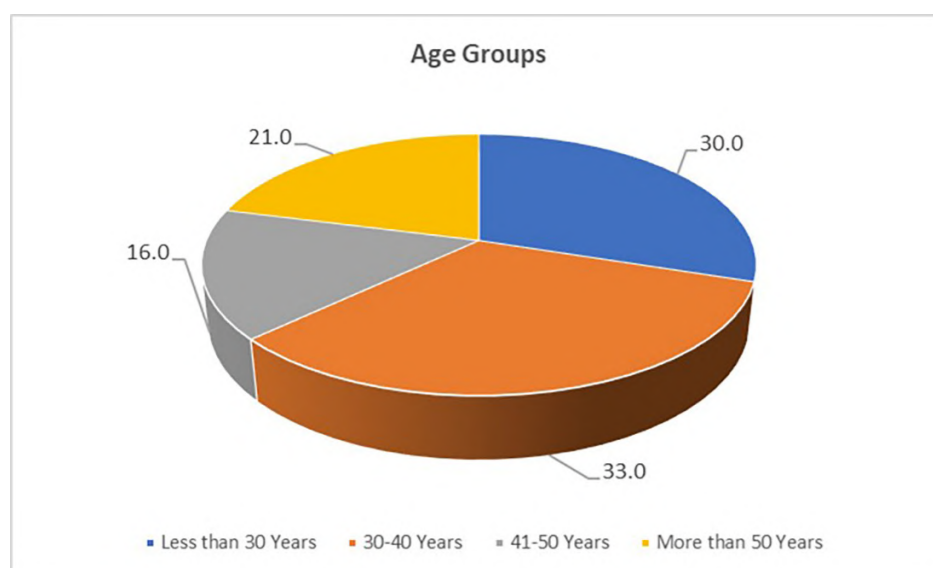


Fig. 1.- Age wise occurrence of Morton's toe.

Table 2. The association between Morton's toe and the risk factors.

Risk Factors	Morton's toe		Chi-Square Value	P-value
	No n (%)	Yes n (%)		
Hammer's toe				
No (<i>n</i> =189)	139 (96.5)	50 (89.3)	4.069	0.044
Yes (<i>n</i> =11)	5 (3.5)	6 (10.7)		
Bunion deformity				
No (<i>n</i> =184)	140 (97.2)	44 (78.6)	19.056	< 0.001
Yes (<i>n</i> =16)	4 (2.8)	12 (21.4)		
Overpronation of foot				
No (<i>n</i> =199)	144 (100)	55 (98.2)	2.584	0.108
Yes (<i>n</i> =1)	0 (0)	1 (1.8)		
Plantar fasciitis				
No (<i>n</i> =155)	115 (79.9)	40 (71.4)	1.644	0.200
Yes (<i>n</i> =45)	29 (20.1)	16 (28.6)		
Usage of high heels				
No (<i>n</i> =150)	117 (81.8)	33 (58.9)	11.360	< 0.001
Yes (<i>n</i> =49)	26 (18.2)	23 (41.1)		



Fig. 2.- Morton's toe observed in one of the cases (2A) and the Morton's toe with Hammertoe (2B) and bunion. * in 2A showing Morton's toe and * in 2B showing the hammertoe and the bunion.

first metatarsal bone could be a contributing factor for the occurrence of Morton's toe (Marinova et al., 2022). Data available in literature suggest that the prevalence of Morton's toe varies in populations between 0.5% - 50% (Ogawa and Hyaku-

soku, 2006; Vounotrypidis and Noutsou, 2015; Aigbogun et al., 2019; Marinova et al., 2022; Paul et al., 2023). Our data show a prevalence of 28%, with more cases of Morton's toe in the female gender and in the age group from 30 to 40 years. This

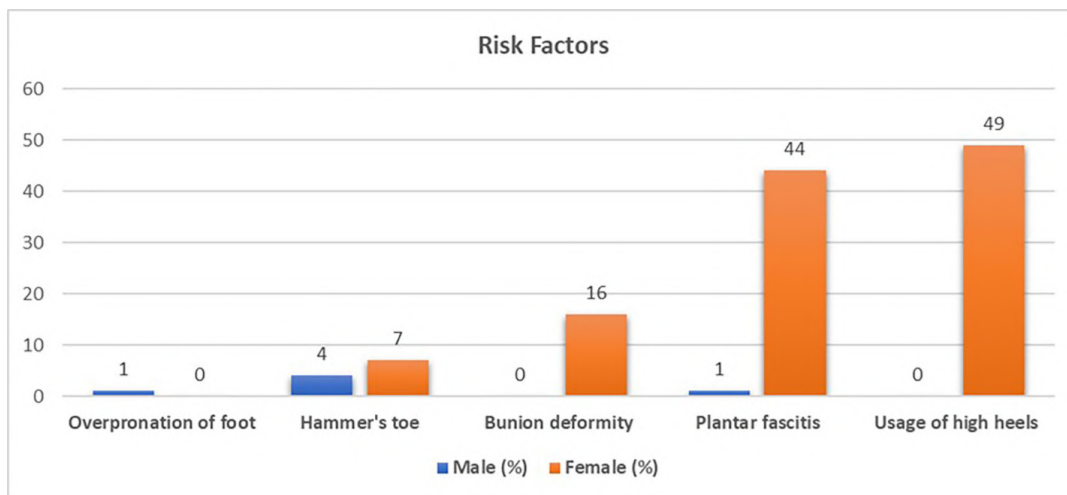


Fig. 3.- Percentage of associated risk factors of Morton's toe among male and female.

pattern was also observed in a recent study, but in males (Paul et al., 2023). Contrary to Morton's toe, few studies have reported that the first toe is the longest in 69% of the population studied, and this is termed as Egyptian foot (Ogawa and Hyakusoku, 2006). Similarly, a cross-sectional, descriptive study conducted on 331 participants from a Spanish population revealed that the most prevalent foot was Egyptian foot, followed by square foot and Greek foot, respectively (Perez Pico et al., 2018). Another study of a Nigerian population reported that these anomalies could be genetically inherited (Aigbogun et al., 2019). However, our study did not show any pattern of inheritance.

It has been postulated that the shortened first metatarsal bone puts more stress load on the longest second toe during the propulsive phase of the gait, and this could disturb the distribution of body weight during gait. Therefore, individuals with Morton's toe are at an increased risk of developing associated clinical risk such as metatarsalgia, hammertoe, plantar fasciitis, bunions, and Morton's neuroma, respectively. Our findings revealed a significant association between Morton's toe and hammertoe. The hammertoe deformity resulting from foot anomalies leads to painful callosities, difficulties in wearing shoes, and painful ambulation (Dang and Coughlin, 2020). Although we did not find a significant association between Morton's toe and plantar fasciitis in our study, it is very important to understand a hypothesis that the individuals with Morton's toe are more likely to overpronate their feet inwards when they run

or walk, and this could increase the distance between the calcaneus and the toes. Furthermore, this is associated with greater tension on the plantar fascia leading to plantar fasciitis and myofascial pain syndrome (Gutteck et al., 2019). In cases of hammertoe, when inward curling of the first toe occurs, the pressure and frictional force are exerted on the skin and soft tissue of the first metatarsophalangeal joint. Over time, this might lead to callous formation. Although, it is thought to be secondary to hereditary and environmental factors, the higher incidence of bunion is seen in women compared to men is believed to be due to tightly fitting women's footwear (Ayub et al., 2005).

Studies reported that the Morton's neuroma resulting from anatomical variations such as Morton's toe could be seen more in females, particularly those wearing narrow and high-heeled footwear (Del Mar Ruiz-Herrera et al., 2022). This is evident from our study, besides the fact that all the associated risk factors were statistically significant in females including usage of high-heeled footwear and Morton's toe. Studies reported that the pain in Morton's neuroma cases is often exacerbated by walking, use of tight or heeled shoes, while the rest of cases or wearing the right footwear with appropriate insoles and orthotics ameliorated the pain (Mahadevan et al., 2015; Ganguly et al., 2018; Hartz and Biancalana, 2022). Furthermore, a recent study conducted on 214 patients revealed that the uneven distribution of the pressure on the foot with Morton's toe contrib-

uted to back pain, knee pain, hip pain and neck pain (Hartz and Biancalana, 2022).

In conclusion, our data confirmed a significant association between Morton's toe and the majority of the associated risk factors and provided a standard dataset on the prevalence of Morton's toe. With these findings, it is essential to raise awareness of Morton's toe in the region, and of taking preventive measures for mitigating associated risk factors.

AUTHORS' CONTRIBUTIONS

Conceptualization and study design: PBK. Data acquisition: BMMS, NA, PBK. Data analysis and interpretation: PBK, AA, BMMS. Drafting of the manuscript: PBK. Critical revision of the manuscript: PBK, AA.

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