

Foot and Ankle Fracture Incidence in South-Eastern Australia: An Epidemiological Study

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Abstract

Objective: The aim of this study was to report the incidence of all foot and ankle fractures during 2006 and 2007 among residents from the Barwon Statistical Division, located in south-eastern Australia.

Methods: Incident fractures were ascertained using X-ray reports from the imaging centres serving the region during the years 2006 and 2007. All fractures with ICD-9 code 824 (ankle) or 825 (foot) were included in this study. Age, proportions of left/right side fractures, cause of fracture and incidence rates (per 10,000 person-years) were all determined for foot and ankle fractures separately as well as for the two sites combined.

Results: There were 312 males and 274 females identified with foot fractures and 344 males and 410 females with ankle fractures. The median age for both foot and ankle fracture was lower in males compared to females. The proportions of left and right side fractures were approximately equal; no sex or site (foot or ankle) showed higher proportions of either left or right side fractures. Among those for whom cause of fracture was known, most foot or ankle fractures (>75%) in both sexes were caused by an accidental fall. For both sexes, there was a bimodal pattern of incidence across the age groups, with peaks around adolescence/early adulthood and in the elderly. Incidence rates (per 10,000 person-years) for foot and ankle fractures combined were similar in both sexes; 25.85 and 25.88 for males and females, respectively. However, the incidence rate for foot/ankle fractures combined in those aged 50 years or over was lower in males than in females.

Conclusion: Males sustained foot and ankle fractures at a lower median age than females and most fractures were the result of an accidental fall. Males sustain fractures mainly during adolescence and young adulthood, whereas fractures in females were sustained largely by individuals over 50 years of age. Despite this, the overall incidence rates were similar for both sexes.

Keywords: Epidemiology; Incident fractures; Foot; Ankle; Australia; Fracture; Incidence

Introduction

Fractures of the foot and ankle are common in both sexes and all ages. They are often the result of missteps or falls and, sometimes, from direct trauma [1]. Fractures of these sites can have a significant public health burden related to hospitalisations, treatments and future disability of individuals who have sustained a fracture [2]. Males with ankle or foot/toe fractures reportedly take a substantial amount of time off work, are unable to drive, require the use of a walking aid and cannot participate in sporting activities [3]. Females can also lose independence after foot or ankle fractures and, may need assistance with daily tasks such as housework or personal care up to 12 months post fracture [4]. Complications of treatments for foot and ankle fractures can include painful movement restrictions, loss of function of the joint, infection of soft tissue or bone and mal-union or non-union

[1]. These complications can lead to severe disability and in extreme cases, to amputation of the limb [5].

There are a number of risk factors associated with an increased risk of sustaining foot and ankle fractures including smoking, diabetes, obesity, previous falls and/or fractures, very high or low levels of physical activity, and low bone mineral density (BMD) [1,6]. Specifically for older individuals, additional risk factors include female sex, comorbidities and multiple medications [6].

Despite the impact that foot and ankle fractures have on contributing to the public health burden of the entire community, studies of foot and ankle fractures usually focus on specific groups such as sports players [7], dancers [8], the elderly [7-10] or those with comorbidities (e.g. diabetes) [11]. The aim of this study was to report on the incidence of foot and ankle fractures in an Australian region for all ages and both sexes.

Methods

Participants

This study included residents living in the Barwon Statistical Division (BSD), located in south-eastern Australia. This region is useful for epidemiological fracture studies because of the large (~250,000) population and the existence of only four medical imaging centres serving the entire region. Additionally, the BSD is representative of the whole Australian population [12]. This study was approved by The Barwon Health Human Research Ethics Committee.

Fracture ascertainment

Fractures were ascertained using X-ray reports from the imaging centres serving the BSD during the years 2006 and 2007. All fractures with ICD-9 code 824 (ankle) or 825 (foot) were included in this study. Individuals living outside of the BSD were excluded. This study included 312 males and 274 females with foot fractures and 344 males and 410 females with ankle fractures.

“Cases” of fracture were ascertained through examination of the X-ray reports and only definite fractures were included. “Likely” or “possible” fractures were not included unless a subsequent X-ray report was available confirming the presence of fracture. Four males and seven females had sustained both a foot and an ankle fracture. Since these multiple fractures were at different sites, they were included in calculations of incidence for each of the fracture sites separately. No pathological or spontaneous fractures were observed.

Descriptive statistics

The median age and inter-quartile range (IQR) of individuals with foot and ankle fractures were determined. The proportions of fractures occurring on the left and right sides as well as bilateral fractures were also determined.

Some individuals (351 males, 53.5% and 143 females 20.9%) had data on cause of fracture. These were classified into the following groups; motor vehicle accidents (including motor vehicle traffic accidents, motor vehicle non-traffic accidents, other road vehicle accidents and water vehicle accidents), accidental falls and other accidents. The proportions of each cause were calculated to determine the most common cause of foot and ankle fractures as well as the two fracture sites combined.

Incidence rate calculations

Incidence rates (per 10,000 person-years) were calculated for each age decade using population data from the Australian Bureau of Statistics 2006 Census Community Profile Series for the BSD (catalogue number 2001.0). The numbers of fractures (foot, ankle and foot/ankle combined) as well as the population data were used to calculate the incidence of fractures for the entire BSD region. Incidence rates overall for both sexes, as well as for adulthood-only and over 50 years were also calculated.

Results

Descriptive statistics

Table 1 shows the descriptive statistics for the fracture cases. In males, there were 312 cases of foot fractures and 344 cases of ankle

fractures over the two year period. Females had sustained 274 foot fractures and 410 ankle fractures. Foot and ankle fractures combined totalled 652 males and 677 females due to four males and seven females sustaining a fracture at both sites.

The median ages (and IQR) for foot and ankle fractures in males were 28.22 (IQR 18.03-46.92) years and 32.33 (IQR 16.88-51.13) years, respectively. For females, the median ages of foot and ankle fractures were 49.76 (IQR 28.33-64.10) and 52.76 (33.22-67.62) years. The median ages for males was lower than females at all fracture sites ($p \leq 0.0001$).

The proportion of left side and right side fractures are shown in Table 1. For males, foot fractures occurred approximately equally on both sides; 129 for left and 176 for right. Ankle fractures had similar proportions; 162 for left and 178 for right. Females also showed similar proportions of left and right fractures for both foot; 128 left and 144 right, and ankle, 191 left and 213, right. Bilateral fractures were rare and contributed less than 2% of the total fractures.

	N	Age (years, median [IQR])	Side of fracture N (%)		
			Left	Right	Both
Male					
Foot	312	28.22 [28.89] ^a	129 (41.6)	176 (57.8)	5 (1.6)
Ankle	344	32.33 [34.25] ^b	162 (47.1)	178 (51.7)	4 (1.2)
Foot and ankle	652	30.77 [32.00] ^c	289 (44.5)	353 (54.3)	8 (1.2)
Female					
Foot	274	49.76 [35.77] ^a	128 (46.7)	144 (52.6)	2 (0.7)
Ankle	410	52.76 [34.41] ^b	191 (46.5)	213 (52.0)	6 (1.5)
Foot and ankle	677	51.75 [35.67] ^c	318 (47.0)	351 (51.8)	8 (1.2)

Table 1: Descriptive statistics of the fracture cases. ^aMedian age of foot fractures for males was lower than females ($p=0.000$). ^bMedian age of ankle fractures for males was lower than females ($p=0.000$). ^cMedian age of foot and ankle fractures for males was lower than females ($p=0.000$).

Description	Motor vehicle accidents	Accidental falls	Other accidents
Foot			
Male (N=181)	14 (7.7)	153 (84.5)	14 (7.7)
Female (N=64)	1 (1.6)	57 (89.1)	6 (9.4)
Ankle			
Male (N=172)	16 (9.3)	132 (76.7)	24 (14.0)
Female (N=82)	2 (2.4)	73 (89.0)	7 (8.5)
Foot and ankle			
Male (N=351)	28 (8.0)	285 (81.2)	38 (10.8)
Female (N=143)	2 (1.4)	128 (89.5)	13 (9.1)

Table 2: Causes of fracture in the foot and ankle for males and females of all ages ^a. ^a Missing data for 304 males and 541 females.

Cause of fracture was documented for 494 individuals (351 males and 143 females). For both sexes, the predominant cause of fracture at all sites was accidental falls (all proportions over 75%) (Table 2). Falls contributed more than 75% to the fractures. The next most common cause was “other accidents” which included “striking against or struck accidentally by objects or persons” and “overexertion or strenuous movements.” Approximately 8-10% of foot and ankle fractures in both sexes resulted from this cause. The next most common cause was “motor vehicle accidents” which included “motor vehicle traffic accident involving collision with pedestrian” and “other non-collision motor vehicle accidents”. Males had a higher proportion of fractures resulting from this cause; approximately 8-9%, while females had proportions around 1.5-2.5%.

Incidence rates

Figures 1 and 2 show the incidence rates of foot and ankle fractures in males and females, respectively. The pattern of foot fractures was similar to the pattern for ankle fractures in both sexes and across all age groups. For males, most of the foot/ankle fractures combined occurred in adolescence (10-19 years) with an incidence of 44.14 per 10,000 person-years or young adulthood (20-29 years) with an incidence of 43.11 per 10,000 person-years. There was a substantial decrease in fracture incidence in the older age groups, with a small peak at 60-69 years (incidence 24.66 per 10,000 person-years). Females showed a similar pattern to males, but the incidence was greater. In females, there was a small peak in adolescence (10-19 years) with an incidence rate 14.01 per 10,000 person-years for foot/ankle fractures combined. From the age of 50 years, the incidence of foot and ankle fractures increases substantially. For all age groups over 50 years, the incidence was 25 per 10,000 person-years or higher.

The total incidence of male foot/ankle fractures combined was 25.85 per 10,000 person-years and the incidence for females was a similar, 25.88 per 10,000 person-years. For adulthood-only incidence, the values were 25.36 for males and 28.71 per 10,000 person-years for females. Despite these similar incidence rates overall, the distribution of foot and ankle fractures differed between the sexes. This can be described by considering the incidence rate of those aged 50 years and over. For males, this rate was 19.74 and for females, 40.51 per 10,000 person-years. Overall incidences for all ages and both sexes were 11.31, 14.56 and 25.87 per 10,000 person-years for foot, ankle and foot/ankle combined, respectively.

Discussion

This study reports on foot and ankle fractures occurring in the BSD over a two year period. The results show that the median age when males sustained a foot or ankle fracture was lower than the age for females. This was also evident in the incidence rates, where males had a high peak of fracture incidence in adolescence and young adulthood, while females were more likely to sustain a foot or ankle fracture in older age (50 years and over). The incidence rates we report here were similar for males and females overall, but differed substantially when comparing the incidence rates for individuals over 50 years.

There have been some studies that report on the incidence of foot and ankle fractures in various age groups and populations. One such study involved 9704 elderly women (aged 65 years or over) from the USA who were followed over 10 years from their first clinical visits between 1986 and 1988 [10]. Over the follow up period, 301 women had sustained a foot fracture and 291 an ankle fracture. The authors

reported an incidence of 3.1 for foot and 3.0 per 1000 woman years for ankle fractures. In another study by Kannus et al. [10], patients 60 years of age or over were selected from Hospital Discharge Registers in Finland for a study of low trauma ankle fractures. The study covered the years 1970 and 2000 and showed that the incidence of low trauma ankle fractures in the elderly had increased over this time period. In 1970, the age-adjusted incident rate for ankle fractures was 38 per 100,000 persons per year in men and 66 per 100,000 person-years in women. In the year 2000, the incidence had increased substantially to 114 per 100,000 person-years in men and 174 per 100,000 person-years in women. The values for the year 2000 are similar in magnitude to our results for ankle fracture for men and women over 50 years of age; 113.2 and 258.1 (converted to per 100,000 people). Our values for incidence in men are similar, but for women, our incidence was higher. This may be due to differences in the population of Finland compared to Australia, or due to the fact that we did not exclude fractures on the basis of trauma.

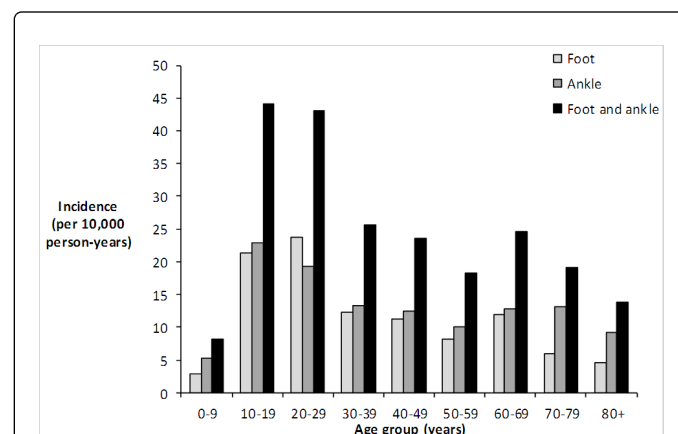


Figure 1: Male incidence (per 10,000 person-years) by age group of foot and ankle fractures in the Barwon Statistical Division, south-eastern Australia.

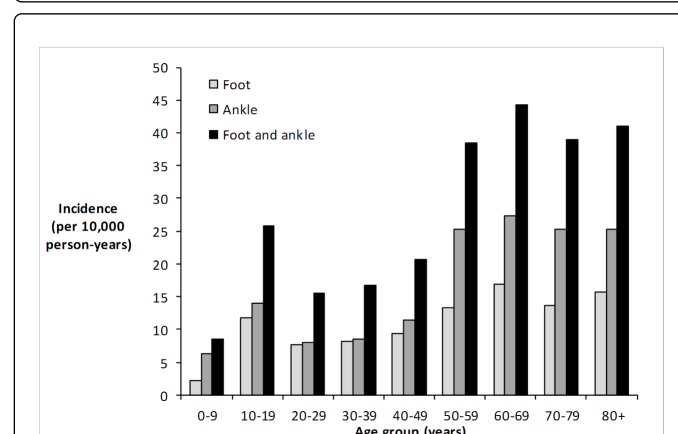


Figure 2: Female incidence (per 10,000 person-years) by age group of foot and ankle fractures in the Barwon Statistical Division, south-eastern Australia.

There are also studies involving participants of younger age. For example, a study of USA males and females aged 35 years or over was

completed for a three year period between 1989 and 1991 and aimed to describe the incidence rates of all types of fractures [13]. During the study period, 2901 individuals had sustained 3665 fractures. The overall incidence rate for ankle fractures in this study was 141 per 100,000 per persons per year for men and 194 for women. Another study of 103,052 men and 119,317 women aged 20 years or over living in England and Wales examined the incidence of all fractures between 1988 and 1998 [14]. The authors of this study reported ankle fractures grouped with tibia and fibula, making comparisons to our data difficult, but foot fracture was reported separately. Their incidence rates for foot fractures were 12.2 per 10,000 persons per year for men and 11.9 for women. Our values for foot fractures in adults were 12.19 and 11.44 per 10,000 persons per year for men and women respectively, which is in good agreement with our results.

Finally, a Danish study involving individuals of all ages and both sexes who were treated for ankle fracture over a one year period from 1994 to 1995 [15]. Of 211 participants, 212 ankle fractures were sustained. The overall incidence rate was 107 per 100,000 person-years, which is similar to our overall result for males and females of 145.6 per 100,000 person-years. Additionally, this study reported that 87% of the fractures were caused by a fall, similar to the values presented in our study (Table 1).

The risk factors for ankle fracture may help explain the patterns of incidence we observed. Ankle fractures occur more commonly in those with a higher body mass index and those with a higher risk of falling [5], while foot fractures have been associated with a lower bone mineral density (BMD). Perhaps the higher level of activity in younger males, particularly in risk taking and sports activities, might explain the high rates of ankle and foot fractures in this age group. Younger females might be less active than males, however later in life have a higher propensity to fall [16], that coincides with postmenopausal bone loss [17,18], resulting in an increase in fracture risk.

There are some strengths and limitations of this study. We used radiological reports instead of hospital discharge (separation) data, which avoided multiple ascertainment of the same fracture. However, in doing so, we might have missed some residents of the BSD who had sustained a fracture outside the region and were treated elsewhere. However, validation of this method showed that using radiological records for the region was a reliable way to comprehensively ascertain hip fractures and the method has been extrapolated to identify all fractures [19]. Although we only had a moderate number of cases with cause of fracture recorded, our values were similar to published literature, suggesting that the results are not substantially biased with missing information. Additionally, because we were able to capture all fractures occurring in the BSD our data is comprehensive for the region and we did not need to rely on a sample of the population for inferring fracture rates for the entire region.

Conclusions

We reported on foot and ankle fractures in both sexes and all ages in the BSD region of south-eastern Australia for the years 2006 and 2007. The results showed that males had a lower median age at fracture for both the foot and ankle sites than females and most fractures were the result of an accidental fall. The incidence rates for foot and ankle fractures combined was similar in both sexes; 25.85 per 10,000 person-years for males and 25.88 for females. Even though the overall incidence rates were similar, male fractures mainly occurred

during adolescence and young adulthood, whereas females sustained fractures mainly over 50 years of age.

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References

1. Pichl J, Hoffmann R (2011) [Ankle fractures in the elderly]. *Unfallchirurg* 114: 681-687.
2. Parenteau CS, Viano DC, Lövsund P, Tingvall C (1996) Foot-ankle injuries: influence of crash location, seating position and age. *Accid Anal Prev* 28: 607-617.
3. Otmar R, Kotowicz MA, Brennan SL, Bucki-Smith G, Korn S, et al. (2013) Personal and Psychosocial Impacts of Clinical Fracture in Men. *Journal of Men's Health*: 22-27.
4. Pasco JA, Sanders KM, Hoekstra FM, Henry MJ, Nicholson GC, et al. (2005) The human cost of fracture. *Osteoporos Int* 16: 2046-2052.
5. Urruela A, Egol K (2011) Foot and ankle fractures in the elderly patient. *Aging Health*: 591-605.
6. Olsen JR, Hunter J, Baumhauer JF (2013) Osteoporotic ankle fractures. *Orthop Clin North Am* 44: 225-241.
7. Sobhani S, Dekker R, Postema K, Dijkstra PU (2013) Epidemiology of ankle and foot overuse injuries in sports: A systematic review. *Scand J Med Sci Sports* 23: 669-686.
8. Kadel NJ (2006) Foot and ankle injuries in dance. *Phys Med Rehabil Clin N Am* 17: 813-826, vii.
9. Kannus P, Palvanen M, Niemi S, Parkkari J, Järvinen M (2002) Increasing number and incidence of low-trauma ankle fractures in elderly people: Finnish statistics during 1970-2000 and projections for the future. *Bone* 31: 430-433.
10. Hasselman CT, Vogt MT, Stone KL, Cauley JA, Conti SF (2003) Foot and ankle fractures in elderly white women. Incidence and risk factors. *J Bone Joint Surg Am* 85-85A: 820-4.
11. Shibuya N, Humphers JM, Fluhman BL, Jupiter DC (2013) Factors associated with nonunion, delayed union, and malunion in foot and ankle surgery in diabetic patients. *J Foot Ankle Surg* 52: 207-211.
12. Pasco JA, Nicholson GC, Kotowicz MA (2012) Cohort profile: Geelong Osteoporosis Study. *Int J Epidemiol* 41: 1565-1575.
13. Melton III LG, Crowson CS, O'Fallon WM (1999) Fracture Incidence in Olmsted County, Minnesota: Comparison of Urban with Rural Rates and Changes in Urban Rates Over time. *Osteoporos Int.*: 29-37.
14. van Staa TP, Dennison EM, Leufkens HG, Cooper C (2001) Epidemiology of fractures in England and Wales. *Bone* 29: 517-522.
15. Jensen SL, Andresen BK, Mencke S, Nielsen PT (1998) Epidemiology of ankle fractures. A prospective population-based study of 212 cases in Aalborg, Denmark. *Acta Orthop Scand* 69: 48-50.
16. Masud T, Binkley N, Boonen S, Hannan MT (2011) Official Positions for FRAX® clinical regarding falls and frailty: can falls and frailty be used in FRAX®? From Joint Official Positions Development Conference of the International Society for Clinical Densitometry and International Osteoporosis Foundation on FRAX®. *Journal of Clinical Densitometry*: 194-204.
17. Henry MJ, Pasco JA, Pocock NA, Nicholson GC, Kotowicz MA (2004) Reference ranges for bone densitometers adopted Australia-wide: Geelong osteoporosis study. *Australas Radiol* 48: 473-475.

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18. Henry MJ, Pasco JA, Korn S, Gibson JE, Kotowicz MA, et al. (2010) Bone mineral density reference ranges for Australian men: Geelong Osteoporosis Study. *Osteoporos Int* 21: 909-917.
19. Pasco JA, Henry MJ, Gaudry TM, Nicholson GC, Kotowicz MA (1999) Identification of incident fractures: the Geelong Osteoporosis Study. *Aust N Z J Med* 29: 203-206.