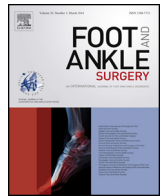




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## Population-based epidemiology of 9767 ankle fractures<sup>☆</sup>

Rasmus Elsoe, MD, PhD<sup>a,\*</sup>, Svend E. Ostgaard, MD, PhD<sup>a</sup>, Peter Larsen, PT, PhD<sup>b</sup>

<sup>a</sup> Department of Orthopaedic Surgery, Aalborg University Hospital, Aalborg, Denmark

<sup>b</sup> Department of Occupational Therapy and Physiotherapy, Aalborg University Hospital, Aalborg, Denmark

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### ABSTRACT

**Background:** The purpose was to provide up-to-date information concerning the incidence of ankle fractures in a large and complete population including all age groups, spanning a decade, and report the distribution of fractures, trauma mechanism and patient baseline demographics.

**Methods:** Population-based epidemiological study of all patients treated for an ankle fracture in a 10-year period from 2005 to 2014.

**Results:** A total of 9767 patients with ankle fractures were treated between 2005 and 2014. The mean age at time of fracture was 41.4 (24.3 SD) years. The mean incidence of ankle fractures between 2005 and 2014 was 168.7/100,000/year. Years with cold winters showed increased incidences compared with years with normal winters. For males, the incidence was 157.1/100,000/year, and for females, 179.5/100,000/year. The incidence shows a peak incidence among adolescents in both genders with a male predominance. After the age of 19 the male incidence declines with age, which is in contrast to females, who experience an increasing incidence. The most common fracture type in all age groups was a fracture of the lateral malleolus representing 55% of all fractures. The predominant mode of injury was falls (61%) followed by sports (22%).

**Conclusion:** This study shows an incidence of 168.7/100,000/year spanning a decade. The most common fracture type in all age groups was a fracture of the lateral malleolus representing 55% of all fractures. The predominant mode of injury was falls (61%) followed by sports (22%).

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### 1. Introduction

Fractures of the ankle are common injuries reported as 10.2% of all bone injuries [1]. The incidence is reported in a number of studies including both selected and non-selected patient groups [1–8]. Court-Brown [1] reported an overall incidence of 137.7/100,000/year in Edinburgh including all patients above 15 years in 2010–2011.

The mean age of patients with ankle fractures is reported as 49 years with a bimodal distribution with peaks in younger males and older females, but with an overall even gender distribution (male 46%/female 54%) [1,3].

The fracture distribution according to the OTA classification [9] is reported as 24.1% of Type A, 65.8% of Type B and 10.1% of Type C

[1]. Unimalleolar fractures represent 70% of all fractures, bimalleolar fractures 20% and trimalleolar fractures about 10% [1,3,6].

The most common mechanism of injury is reported as a fall from standing height representing about 80% of all fractures [1,3]. Court-Brown [1] reported that 20.8% of all Type C fractures were caused by sports injuries, with an average age of 32.5 years in patients and that all were males.

A number of studies in the past decades have reported an increasing incidence of ankle fractures. This is primarily thought to be caused by the growth in the number of people participating in sports and a shift in demographics towards an elderly population [1–3]. Change in incidence, fracture pattern and demographics with time are commonly reported for many different fracture types [1,10–12].

Despite fractures of the ankle being very common, recent literature concerning the epidemiology of ankle fractures is scarce. The incidence and epidemiology of ankle fractures are inconstant [3], and the literature lacks large-scale and recent population-based epidemiological studies of ankle fractures including all age groups, all fractures and studies based on accurate population sizes.

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\* Corresponding author at: Department of Orthopaedic Surgery, Aalborg University Hospital, Aalborg University, 18-22 Hobrovej, DK-9000 Aalborg, Denmark. Fax: +45 99 32 31 09.

E-mail address: [rae@rn.dk](mailto:rae@rn.dk) (R. Elsoe).

The purpose of this study was to provide up-to-date information concerning the incidence of ankle fractures in a large and complete population including all age groups spanning a decade. Furthermore, the purpose was to report the distribution of fractures, trauma mechanism and patient baseline demographics.

## 2. Materials and methods

At Aalborg University Hospital, Denmark, a population-based epidemiological study of all patients treated for an ankle fracture was carried out over a 10-year period from 2005 to 2014.

The study was conducted in the North Denmark Region, and was based on an average population of 579,119 citizens (Fig. 1). The region is served by Aalborg University Hospital (Level 1 Trauma Centre) and six minor hospitals. All patients in the Region treated for an ankle fracture from 2005 to 2014 were included. The patients were identified in the Region's medical records system.

Denmark has a unique opportunity to carry out population-based studies. All patient contacts with hospitals and clinics in Denmark are registered in the Danish National Patient Register (DNPR) [13] and is required by law. Hospital identification, date and time of activity, and patient's municipality (among other characteristics) are registered [14]. Moreover, hospitals are assigned payment based on these registrations [15]. The Central Person Register (CPR) number is given to all residents of Denmark and registered in the Civil Registration System. This system provides researchers with a complete registration of all health related issues on an individual and population-based level.

This study was conducted in accordance with the ethical standards of the responsible committee and with the ethical principles of the 1975 Declaration of Helsinki. The study was approved by the Danish Data Protection Agency (J. nr. 2008-58-0028).

Clinical information concerning age, gender and trauma mechanism was obtained. Trauma mechanism was divided into

falls, sports and RTA (Road Traffic Accident) and other trauma mechanisms. All fractures were classified according to the ICD-10 system [16] and divided into lateral, medial, bimalleolar, trimalleolar, fibula shaft and atypical fractures. Atypical fractures were defined as fractures not classifiable in the other five groups.

### 2.1. Statistics

Normal distribution was checked visually by Q-Q plots. Mean values and standard deviation (SD) are given for continuous variables. Frequencies and percentages (%) are used for categorical data. Statistical analysis was performed by an individual with dedicated training in statistics. The statistical analysis was performed by STATA 13, StataCorp, 4905 Lakeway Drive, College Station, Texas 77845 USA.

## 3. Results

A total of 9767 patients with ankle fractures were treated between 2005 and 2014. The mean age at time of fracture was 41.4 (24.3 SD) years. The mean age for males was 35.5 (21.9 SD) years, and females 46.4 (25.1 SD) years. The gender distribution was 5178 (53.0%) females and 4586 (47.0%) males.

The mean incidence of ankle fractures between 2005 and 2014 was 168.7/100,000/year. For males, the incidence was 157.1/100,000/year, and for females, 179.5/100,000/year. The incidence shows a peak in incidence among adolescents in both genders with a male predominance. After the age of 19 the male incidence declines with age, which is in contrast to women, who experience an increasing incidence after the age of 40 (Fig. 2).

Fig. 3 shows the incidence of fractures in the decade between 2005 and 2014. The incidence varies between approximately 156/100,000/year in 2013 and approximately 200/100,000/year in 2010, indicating a considerable year-to-year variation. The seasonal variation is presented in Table 1 and Fig. 4. Year

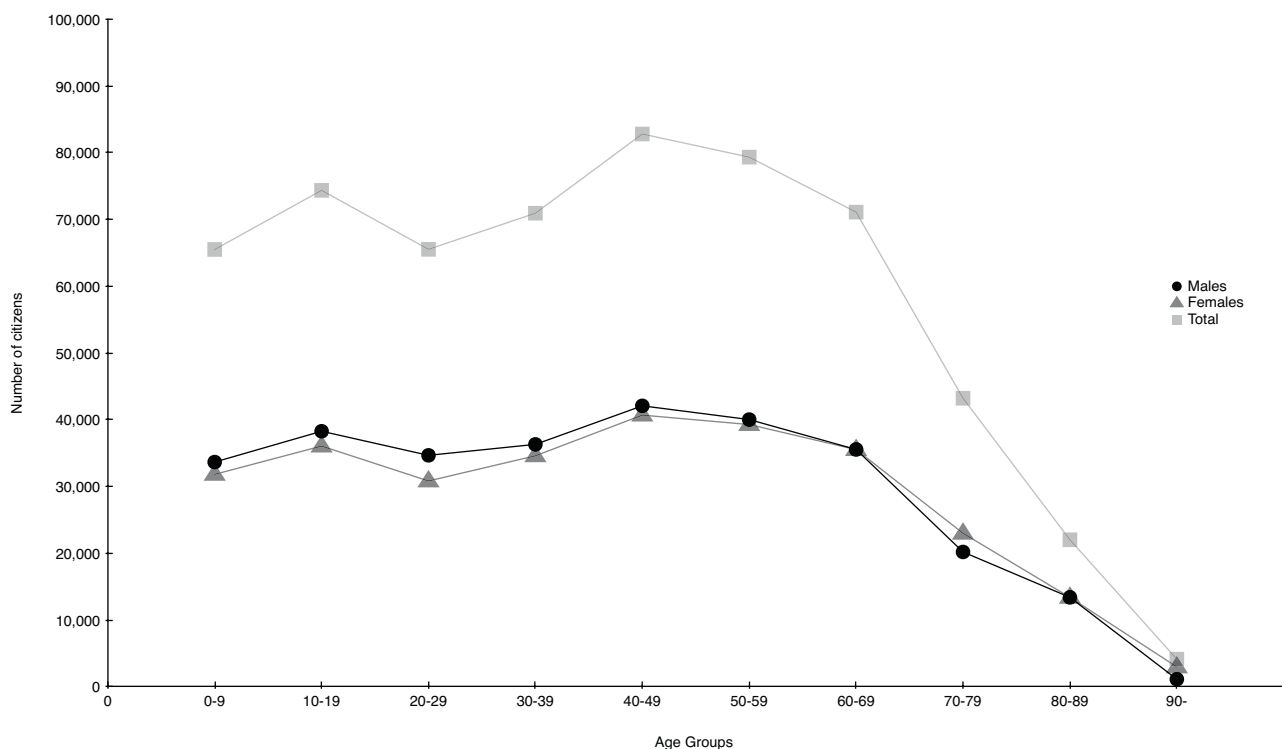


Fig. 1. Heading average population of North Denmark Region, 2005–2014.

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