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# Does the use of high-heeled shoes lead to fore-foot pathology? A controlled cohort study comprising 197 women

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ABSTRACT

*Background:* High-heeled shoes have been suggested as a main explanation for the female dominance in foot pain and deformities. Aim of study was to test this hypothesis scientifically.
*Methods:* Women 40–66 years were included in two groups. 95 women who had worn high-heeled shoes at work for at least 5 years were compared to 102 women who had never worn high-heeled shoes at work. The investigations were weight bearing radiographs of foot and ankle, the SEFAS questionnaire and the AOFAS Clinical Rating System. Evaluators were blinded to the group-affiliation.
*Results:* Radiographs showed no statistically significant differences between the two groups concerning deformities or joint disease. Foot function measured by SEFAS and AOFAS total score, were similar in the two groups. The high-heeled group had more pain and more callosities.
*Conclusion:* For women aged 40–66 years wearing of high-heeled shoes had not caused foot deformation, but more foot pain and callosities.


## 1. Introduction

Women contact health professionals for foot disabilities twice as often as men [1]. Among patients undergoing surgery for hammertoes and hallux valgus, studies have shown that nearly 90% are women [2,3]. It is commonly assumed that the long term use of high-heeled shoes may lead to chronic foot pain and deformities and some studies have suggested that this type of shoe explains the predominance of foot problems among women [4,5]. Biomechanical studies have shown that the vertical ground reaction force, ankle plantar flexion, maximum anteroposterior braking force, and forefoot loading is increased by wearing high-heeled shoes [6–8]. Based on theoretical consideration, it is reasonable to believe that wearing high-heeled shoes may lead to foot disabilities. However, the results of previous clinical studies on women wearing high-heeled shoes are conflicting [9–12]. The aim of this study was to assess whether women reporting to wear high-heeled shoes at work are more likely to report foot pain, have more foot deformities and poorer foot function than women who never use high heeled shoes at work. Our hypothesis was that high-heeled shoes cause pain and foot-deformities.

## 2. Materials and methods

We included two groups of women; a high-heeled group and a control group, and based on statistical power calculation we aimed to include 100 women in each group (see Section 2.4).

### 2.1. Inclusion/exclusion criteria

The inclusion criterion for the high-heeled group was women who had used high-heeled shoes regularly at work for 5 years or more. A high heel was defined as 5 cm or higher. The women who served as the control group stated they had never used high-heeled shoes at work. Only women between the ages of 40 and 66 years were included, as arthritis, deformities and soft tissue disabilities and foot pain are uncommon before the age of 40 [1,13]. The upper age limit was chosen because the official retirement age in Norway is 67 years. All women who had been previously operated in the foot or ankle were excluded.

### 2.2. Recruitment process

We used a brief recruitment form distributed to shoe-shops and work-places such as banks, hotels and hair-dressers during the period October 1st to December 31st 2012. An electronic version of

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the recruitment form was also published on our hospital's website. Women were asked how many years they had used high-heeled shoes at work and also the number of days they had been wearing high-heeled shoes during leisure time the week prior to completing the form. We excluded 70 of the 927 responders because they had not given their phone-numbers, 492 did not fulfil our age criterion and 17 had used high-heeled shoes at work for less than 5 years. Fig. 1 shows the flow chart of the recruitment process for the remaining women. The women were called by telephone in a random order based on a list put together by an administrative aid. All of the 144 women that satisfied the inclusion criteria in the high-heeled group were contacted. A sample (146 of the 204 potential controls) randomly selected by the administrative aid was likewise contacted.

### 2.3. Examinations

The clinical and the radiological evaluations were performed blinded to the group-affiliation. The clinical examinations were performed by the principal investigator (GEB) and the radiological investigations were evaluated by a single radiologist (ATV). A total of 205 women were investigated; 100 from the high-heeled group and 105 controls.

Weight bearing radiographs were obtained in sagittal and anterior-posterior projections of the foot and ankle bilaterally. The hallux valgus angle and the inter-metatarsal angle between first and second ray were measured from the AP projections. For hallux rigidus the Menz scoring system was used [14]. Grade two or more was recorded as hallux rigidus.

As measurements of general foot function the total score of SEFAS (Self-reported Foot and Ankle Score) and AOFAS (American Orthopaedic Foot Ankle Society) instruments were used.

When attending the clinical assessment, the women were asked to fill in the SEFAS questionnaire [15] that contains 12 items which are scored concerning pain, function, and limitation of function.

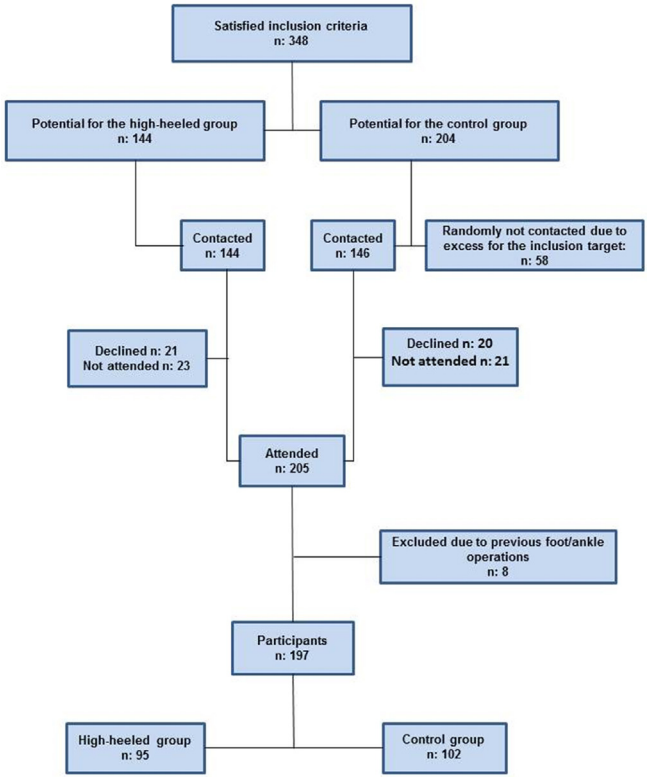


**Fig. 1.** Recruitment flow chart.

The scores range from 0 to 4, with 4 as the best score yielding a maximal score of 48.

The AOFAS Clinical Rating System for ankle, mid-foot, hallux and lesser toes were completed [16]. It combines information from the patients as well as results from the clinical examination. For each anatomic site, pain, function and limitation of function are noted. The clinical examination includes gait abnormalities, motion, stability and alignment. Each item has a maximum score between 5 and 40 and is summarized to give a total score between 0 (worst) and 100 (best) for each of the four anatomical areas. Alignment in the hind-foot and the lesser toes was examined in accordance with AOFAS in a tree scale system. To distinguish the different foot types we used a mirrored photo-box. The sagittal range of motion in the ankle (flexion plus extension) was measured with a goniometer in degrees. Callosities were recorded as existing or not, regardless of symptoms, under the metatarsal heads on the sole of the foot.

### 2.4. Statistics

As foot pain has been found to be around 20% in the general population [1,13] we chose pain as our main outcome. Statistical power calculation was based on a supposed 20% increased amount of pain in the high-heeled group. It was calculated that 82 women had to be included in each group to obtain $\alpha = 0.05$ and $\beta = 0.80$, IBM (Sample-power version 3). We aimed to include 100 women in each group. The statistical calculations were performed using IBM SPSS Statistics version 21. First, pain measurements from AOFAS were dichotomized into no pain or any pain in one or both feet and statistically analysed using the Pearson's chi square test. Second, we analysed pain in each foot in accordance with AOFAS in a four level ordinal scale system (severe/almost always present, moderate/daily, mild/occasional and none) from each of the four regions; lesser toes, hallux, mid-foot and the ankle, from each foot. Linear Mixed Models (continuous outcomes) and Generalized Linear Mixed Models (categorical outcomes) were used to account for the data dependency caused by the two-level structure; feet, (level one) nested within persons, (level two). Alignment in the hind-foot and the lesser toes were analysed in a three levels ordinal scale. Callosities and hallux rigidus were analysed as binominal data. The hallux valgus angle, the inter-metatarsal angle and the range of motion in the ankle were analysed as continual variables. Akaike's information criterion was used to identify the most parsimony models [17]. Visual inspection of Q–Q plots were used to investigate if data were normally distributed. The age and total scores from AOFAS and SEFAS were not normally distributed and analysed using the Mann Whitney test (the total scores from AOFAS and SEFAS were compared between the groups as the mean score from the right and left foot from each individual). For the other measured continuous outcome parameters the residuals were found normally distributed. The statistical level of significance was set to $P$ less than 0.05 (in the tables marked with *).

### 2.5. Ethics

The study was approved by the Regional Committee for Medical and Health Research Ethics (REC 2012/1185b). Informed consent was obtained from all individual participants included in the study.

## 3. Results

Eight women were excluded due to previous foot-and ankle operations, leaving 95 women in the high-heeled group and 102 in the control group.

There was no statistically significant difference in age between the two groups ($P = 0.60$). In the high-heeled group median age was

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