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## Skin lesions and other foot problems associated with safety footwear

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**ABSTRACT.** *The principal purpose of this epidemiological cross-sectional study was to evaluate the frequency of foot problems associated with the wearing of safety footwear (SFW). We examined 509 workers from 12 separate metal-working factories, representing all workers employed in these factories. All subjects wore SFW on a daily basis. The study was based on an interviewer-administered questionnaire and a clinical examination of the feet, with particular attention to skin lesions. 81% of the workers had at least one foot problem. The most frequently reported shoe concern was the hot/wet conditions inside the SFW (42%), followed by weight (27.5%), fit (22.9%) with narrowness (19%) and poor sole flexibility (16.3%). Preventive measures should be implemented to reduce the risk associated with SFW. To achieve this goal, it is necessary on one hand to improve the comfort of SFW from a physiological and ergonomic point of view and, on the other hand, to make an appropriate choice of this personal protective device from the various brands and models available on the market.*

**Key words:** safety footwear, foot problems, comfort, metal-working factories, cross-sectional study.

**RIASSUNTO.** Scopo principale di questo studio epidemiologico trasversale è stato determinare la frequenza delle affezioni del piede associate all'impiego delle scarpe antinfortunistiche. Un totale di 509 lavoratori impiegati in 12 distinte fabbriche metalmeccaniche prese parte allo studio. Tutti i soggetti esaminati indossavano giornalmente le scarpe di sicurezza. Lo studio era basato su una intervista con compilazione di un questionario standard e su un esame clinico del piede con particolare attenzione alle lesioni cutanee. L'81% dei lavoratori presentava almeno una affezione del piede. Le più frequenti preoccupazioni riferite all'impiego delle scarpe antinfortunistiche erano le condizioni di caldo-umido all'interno della scarpa (42%), il peso della scarpa (27.5%), la calzatura (22.9%), la calzatura stretta (19%) e la scarsa flessibilità della suola (16.3%). Misure preventive devono essere attuate al fine di ridurre i rischi associati alle scarpe antinfortunistiche. Per il raggiungimento di questo obiettivo è necessario da un lato migliorare il comfort della scarpa antinfortunistica dal punto di vista fisiologico ed ergonomico e dall'altro operare una scelta appropriata di tale dispositivo di protezione fra le diverse marche e modelli presenti sul mercato.

**Parole chiave:** scarpa antinfortunistica, lesioni ai piedi, comfort, fabbriche metalmeccaniche, studio epidemiologico trasversale.

The use of safety footwear (SFW) (footwear incorporating a toe cap) has been made obligatory in Italy to protect feet against the various risks of occupational accidents such as crushing, impact, perforation, chemicals, extreme temperatures and electrical sources (1).

In addition to risk factors for the foot specific to the working environment, it is necessary to consider other risk factors connected with the use of unsuitable SFW that may be affecting the health and safety of workers.

The literature data regarding foot problems associated with SFW are extremely scarce, not up-to-date and are the result of epidemiological studies mostly performed outside Europe (2-4).

The aim of the present epidemiological cross-sectional study was to evaluate the frequency of skin lesions and of other foot problems associated with the wearing of SFW in metalworkers. The influence of potential risk factors such as age, gender, Body Mass Index (BMI) and duration of use of SFW was also studied.

### Materials and methods

Between 2011 and 2012, twelve separate metal-working factories in the Emilia Romagna Region, Italy, took part in this study. The study was cross-sectional, surveying a sample of workers required to wear SFW at one point in time. The sample represents all workers employed in these factories in the various stages of production, with the exception of office personnel. The study was carried out on site in these factories, at the same time as the periodic medical examinations foreseen by the current regulations regarding health and safety in the workplace. Written informed consent was given to participate in this additional investigation. The study was based on an interviewer-administered questionnaire and a clinical examination of the feet, with particular attention to skin lesions. The questionnaire consisted of 27 main-questions about gender, age, health profiles, any treatment the worker was undergoing, previous and present work, job classification, exertion level, current perceived foot problems and treatment, experiences with SFW, type of SFW worn, how long SFW had been worn and aspects of SFW concerns, type of socks/stockings worn under SFW, problems connected with the use of non-work footwear. The dermatological

examination was supplemented by a podological examination for all participants in the study.

Univariate statistics were used to describe the sample and examine the distributions of variables of interest. The association between categorical variables was assessed by a Pearson's chi-square test. Foot problems associated with the wearing of SFW were studied with reference to age, gender, BMI and duration of use of SFW. To evaluate the influence of each of these factors, a multivariate logistic regression analysis was performed using the presence of foot problems (1 or more vs 0) as a dependent variable (Table I). The significance level was defined at 5% and all statistical tests were two-sided. All analyses were performed by using STATA 11.0 SE software (Stata Corporation, Texas, USA).

## Results

A total of 509 subjects (417 men and 92 women) were included in the study. The sample was almost exclusively Caucasian (97.8% of the total), the remaining 2.1% being represented by people of North African race. The mean age of the sample was 38 years (range 18-68 years) with 22.2% of the subjects between 18 and 29 years, 31.4% between 30-39 years, 27.5% between 40-49 years and 18.8% > 50 years.

The majority of the workers were unskilled and were employed full-time in manual occupations. The daily shifts generally lasted 8 hours with a lunch break of about 30 minutes. In all the factories the exertion level of the work was usually high and the entire work shift was performed in the erect position, mostly moving about, with limited opportunity to sit down.

The duration of the current employment ranged from 1 month to 32 years (mean 4,1 years).

The composition of socks and stockings worn under SFW was mostly (94.6% of cases) a mixture of cotton and nylon. Only a small percentage (5.3%) wore natural fibres (cotton or wool).

The mean duration of daily use of SFW was  $7.5 \pm 0.8$  hours.

The most frequent shoe concern consistent with the foot problems was the hot/wet conditions inside the non-aerated SFW (42%), followed by weight (27.5%), fit (22.9%) with narrowness of the shoes (19%) and poor sole flexibility (16.3%). Other shoe concerns were the pressure of the toe cap and the prevention of easy foot bending due to the toe cap, reported by 14.1% and 3.9% of all workers, respectively. The actual appearance of the SFW was not a major concern for males and females.

Table II summarizes the concerns expressed by workers on features of their SFW.

None of the participants reported concerns about the use of non-work footwear.

413 metalworkers (81.1% of the total) had at least one foot problem, some dermatological, some orthopedic. Of these, 72/92 (78,2%) were females and 341/417 (81.7%) were males.

The duration of use of SFW > 5 years and personal characteristics, such as BMI > 25 (including obese and

overweight subjects) and age > 50 years, were identified in a logistic regression model as being risk factors (odds ratio > 1) for the presence of one or more foot problem. The risk for duration of use > 5 years is 2.97 greater than duration < 1 year. The subjects aged 50 years and over had a risk 3.97 times that of reference class (aged 18-29 years). The risk for subjects with BMI > 25 is 78% greater than subjects with BMI < 25 (underweight/normal) (Table I). For BMI we considered only two classes: < 25 and > 25 because the obese (BMI of 30 or greater) and underweight (BMI < 18.5) classes each had only a very small number of cases.

**Table I. Associations of foot problems with length of use of SFW, age, BMI and gender: results from multivariate logistic regression analysis**

	OR	CI (95%)	p-value
Length of use of SFW			
< 1 yr	1.00		Reference class
>1 yr but < 2 yr	2.12	0.67-6.71	0.201
>2 yr but < 5 yr	2.19	0.73-6.55	0.160
>5 yr	2.97	1.10-8.02	0.031
Class of age			
18yr-29yr	1.00		Reference class
30yr-49yr	1.84	1.10-3.10	0.019
>50 yr	3.97	1.84-8.56	0.000
Class of BMI			
BMI< 25	1.00		Reference class
BMI> 25	1.78	1.15-2.74	0.009
Gender			
Male	1.00		Reference class
Female	0.64	0.38-1.07	0.091

The odds ratio (OR) for each variable estimates the relative risk of foot problems. CI: 95% confidence interval.

**Table II. Percentages of concerns expressed by workers on features of their SFW according to gender**

Concerns	Males	Females	Total
Hot/sweaty	43.1%	36.9%	42%
Weight	27%	29.3%	27.5%
Fit	23.5%	20.6%	22.9%
Too wide	0.9%	2.1%	1.1%
Poor sole flexibility	16%	17.3%	16.3%
Too narrow	19.1%	18.4%	19%
Toe cap too shallow	4%	5.4%	4.3%
Pressure of toe cap on toes	13.9%	15.2%	14.1%
Prevention by toe cap of easy foot bending	3.8%	4.3%	3.9%
Appearance	-	5.4%	0.9%

The gender variable was not statistically significant in the present logistic regression model.

The number of specific foot problems for each worker varied from one to five with a prevalence almost identical in both genders (an average of two lesions for each worker).

214 metalworkers (42% of the total) had corns/calluses. The most frequent shoe concerns were the narrowness and the poor sole flexibility, expressed by 27.1% and 30.8% of the subjects with corns/calluses, respectively. Flat foot was the most common malformation associated with calluses of the plantar region present in 19.1% of the subjects.

In 37 metalworkers (7.2% of all participants) fungal infections were clinically diagnosed; in 15 of these cases the toenails were involved and in 22 the skin of the foot. In 2 cases, the fungal infection was associated with diabetes mellitus (type 2). The most frequent concern was the hot/wet conditions due to insufficiently aerated SFW, reported in 89.1% of subjects with fungal infection.

147 participants (28.8% of the total) complained of foot pain on most days over the previous month. In all these cases, the pain was present without clinical evidence of foot lesions. The foot pain was in some cases associated with pain in other sites, including knee, leg, hip and back. Females were more likely to report foot pain than males (30.4% and 28.5% respectively). This symptom was more frequent in the workers aged > 50 years (37.5%) compared to the workers aged between 18-29 years (12.3%). In 3 workers, foot pain was associated with diabetes mellitus type 1 (one case) and type 2 (two cases). The most frequent shoe concerns were the weight of SFW, the pressure of the toe cap on the toes and the narrowness, expressed by 51.7%, 25.8% and 19.7% of the subjects with foot pain, respectively.

Table III summarizes the foot problems associated with the wearing of SFW.

## Discussion

Very few other studies have been carried out looking at foot problems associated with SFW.

Between 1972 and 1984, 13 cases of contact allergy due to components of SFW were found by Foussereau and coworkers (2). The causal agents do not seem different from those found in other types of shoes. No cases of allergy to components of SFW or to socks and stockings worn under SFW were recorded in our study.

In a study conducted in Australia in 1990-1991 by Marr and Quine (3), 95% of the wearers of SFW employed in a broad range of work activities presented one or more foot problems, compared to 81% in our study. The shoe concerns consistent with the foot problems, were: weight (48%), hot/sweaty conditions inside the SFW (65%), sole inflexibility (52%), fit (39%), narrowness (37%), pressure from toe caps (47%), prevention by the toe cap of easy foot bending (44%).

Another study carried out in Australia in 1999 by Wood and coworkers (4) investigated foot problems associated

**Table III. Percentages of dermatological and orthopedic foot problems observed in wearers of SFW according to gender**

Foot problems	Males	Females	Total
Corn/calluses	41.7%	43.4%	42%
Flat feet	10.3%	13%	10.8%
High arch	17%	14.1%	16.5%
Bunions	7.1%	16.3%	8.8%
Hammer toes	9.5%	9.7%	9.6%
Foot pain	28.5%	30.4%	28.8%
Thick toe nails	16.3%	14.1%	15.9%
Maceration	12.9%	9.7%	12.3%
Onycholysis	8.1%	6.5%	7.8%
Subungual hemorrhages	5.9%	3.2%	5.5%
Fungal infections	7.6%	5.4%	7.2%
Ingrown toenails	0.9%	1%	0.9%
Dyshidrosis	1.9%	2.1%	1.9%
Traumatic abrasions/blisters	1.9%	3.2%	2.1%
Plantar fasciitis	2.8%	2.1%	2.7%
Others	3.1%	2.1%	2.9%

with steel toe capped gumboots in workers in the underground coal mining industry. The main foot problems reported were calluses (48.5%), blisters (3%), and maceration (14.7%). 7.8% of the workers presented fungal infections of the feet, a rate slightly higher than that in our study (7.2%). The most frequent concern about the wearing of SFW was the hot/sweaty condition inside the boots (78%).

Our study shows a high frequency of foot problems associated with SFW, but at levels lower than those reported in the two previous Australian studies (3, 4). Some factors may have contributed to these differences, such as, for example, the improved construction quality of the SFW used by the participants in our study, more appropriate with respect to the past as regards the workers' health and ergonomic requirements, as well as occupational risks (5, 6). We believe, however, that an important role can be attributed also to the different sample demographic characteristics and geographical conditions, and the different work activities.

Despite recent technological innovations introduced in the production of SFW in order to improve comfort and safety, 81% of the subjects in our study had at least one foot problem, which is a rate in excess of that found in the various general population-based studies, affecting 17% (7) to 61% (8) of people (the first rate is probably underestimated and the second rate overestimated, according to the opinion of the same authors) (7, 8).

Even if the prevalence rate in our study also includes mild foot problems, it is still unacceptably high. Therefore, preventive measures should be implemented to reduce the risk associated with SFW. To achieve this goal we have two possibilities:

- the first is to improve the comfort of SFW from a physiological and ergonomic point of view, through the

adoption of new and more appropriate technologies by the footwear manufacturing industry;

- the second is to make an appropriate choice of SFW from the various brands and models available on the market; for this purpose, educational programmes should be set up to assist occupational health and safety personnel, purchasing officers and workers in the choice of SFW based on comfort and health in addition to safety requirements. These requirements are not taken into sufficient consideration in some companies, where cost savings often prevail at the time of purchase. This means that obligatory footwear, perhaps in extreme cases only one model and of poor quality, can lead to foot problems with consequent damage to the workers and to the company due to periods of absence from work. As already is the case in some companies, workers should be allowed some margin of choice in selecting the model of footwear most comfortable and suitable for their feet.

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