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Prevalence and associated factors of foot and ankle pain among nurses at a university hospital in Japan: A cross-sectional study

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Abstract: Objectives: The purposes of this study were to clarify 1) the prevalence of foot and ankle pain and 2) the factors associated with foot and ankle pain among nurses. **Methods:** Nurses working at a university hospital in Japan were recruited to participate in this cross-sectional, questionnaire-based study. The occurrence of foot and ankle pain in the previous month was assessed by using the Standardized Nordic Questionnaire and the Manchester Foot Pain and Disability Index. Subjects also answered questions on footwear-related factors, including using the visual analog scale for shoe comfort. In addition, information on personal factors and psychosocial factors was collected using the Job Content Questionnaire. The relationships between the presence of foot and ankle pain and the associated factors were examined using multiple logistic regression analysis. **Results:** Responses of 636 nurses (response rate, 67%) were included for analysis. The prevalence of foot and ankle pain was 23% and 51% when using the Standardized Nordic Questionnaire and the Manchester Foot Pain and Disability Index, respectively. The prevalence of pain that prevented the nurses from performing activities of daily living and work was 4% and 17%, respectively. A low level of shoe comfort, personal factors (age and body mass index), and psychosocial factors (low job control and high job strain) was independently associated with the presence of foot and ankle pain. **Conclusions:** Foot and ankle pain occurred frequently in nurses. Shoe comfort, personal factors, and psychosocial factors were associated with foot and ankle pain.
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Introduction

Nurses are at high risk of musculoskeletal pain due to high physical demands, such as heavy lifting and prolonged standing. According to a systematic review, 55%, 42%, and 36% of nurses experienced low back pain, neck pain, and lower extremity pain in the past year, respectively[1]. Musculoskeletal pain can cause loss of motivation to work and is a major cause of sick leave and premature retirement among nursing personnel[2]. Musculoskeletal pain has placed a significant burden on nursing personnel and the healthcare system[1].

Foot and ankle pain among nurses has not been well studied, as compared with low back pain and neck pain, even though foot and ankle pain can cause significant problems in daily nursing work[3]. The prevalence of disabling foot and ankle pain among the general population is quite high, at up to 30%[4,5]. It is also common in younger people, and 50% of white-collar working women between 21 and 40 years of age had experienced the foot and ankle pain in the previous year[6]. Stress on the foot and ankle is expected to be higher in nurses than in the general population and white-collar workers, because nurses typically walk as many as 8 to 9.6 km in a 12-hour shift[7]. Consequently, the incidence of foot and ankle pain

has been reported to be high, and this pain impairs the quality of both work and daily life[8]. However, detailed information about this pain, such as the location of pain in the foot and ankle, has not been addressed.

Several studies have investigated various types of factors, including personal and life-style, work-related, and psychosocial factors, associated with pain in various anatomical sites among nurses. Nevertheless, few studies have examined the factors associated with foot and ankle pain[8,9]. Specifically, footwear-related factors, which are considered crucial in preventing foot and ankle pain among clinical nurses[10,11], have received less attention. Identification of this information is crucial in order to establish preventive measures to reduce the risk of foot and ankle pain[12].

The purposes of this study were to elucidate 1) the prevalence of foot and ankle pain and 2) the factors associated with foot and ankle pain, among nurses working at a university hospital in Japan.

Subjects and Methods

Subjects

This cross-sectional, questionnaire-based study was conducted at the Chiba University Hospital, Japan. All nurses in the hospital, except for those working in the administrative section, were included in the study. Nurses who declined to participate in the study, those who did not return the questionnaire, and those who provided insufficient answers to the questionnaire on foot and ankle pain were excluded. The questionnaires were sent to all eligible nurses in November 2016, and the nurses were requested to answer and return the questionnaires within 2 weeks. This was repeated thrice in the subsequent 2-month period to increase the response rate. The data were collected in an anonymous fashion. This study was approved by the Research Ethics Committee of our hospital.

Evaluation of foot and ankle pain

The presence of foot and ankle pain was assessed using the Standardized Nordic Questionnaire (SNQ)[13,14] and the Manchester Foot Pain and Disability Index (MFPDI)[15]. The SNQ includes questions on the presence of musculoskeletal pain and/or discomfort in body parts, including feet and ankles, neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs, and knees. The questionnaire was also aimed at identifying whether the pain prevented the nurses from performing their normal activities[13,14]. An amendment was made to maintain its consistency with the MFPDI. The original questionnaire enquired about the presence of pain in the previous 12 months, pain that prevented one from doing normal work in the previous 12 months, and pain in the previous 7 days. However, the revised questionnaire enquired about the pain in the previous month and pain that prevented one from doing normal work in the previous month. The answer for each question was either "yes" or "no." The MFPDI is a 19-item questionnaire to assess the presence of foot pain, as well as disability caused by foot pain in the previous month[15,16]. The possible answer for each question was "none of the time," "on some days," or "on most/every day (s)." Disabling foot pain was defined as answering at least one of the 19 questions as pain occurring "on most/every day (s)"[17]. We defined four outcome measures of foot and ankle pain: 1) the presence of pain and 2) the presence of pain that prevented one from performing normal work, both assessed using the SNQ, and 3) the presence of pain and 4) the presence of disabling pain, both assessed using the MFPDI.

The locations of foot and ankle pain were assessed using a foot drawing[18]. Subjects reporting foot and ankle pain upon answering the SNQ were requested to shade the location of their foot and ankle pain on a foot drawing that showed the dorsal, plantar, and posterior aspects of both feet and ankles. The location of the pain was scored using a transparent overlay, which divided the foot and ankle into 26 areas. This overlay was used as the template to define the exact location of pain. If any part of the shading was within a template area, the area was defined as the painful area. The areas were further classified into eight regions, including great toe, lesser toes, plantar forefoot, medial arch, midfoot (which includes the medial arch along with two other sections of the foot), ankle, plantar heel, and posterior heel[18].

Associated factors

Data on the following personal and life-style factors were collected: age (20-29 years/30-39 years/40-49 years/50-65 years), sex (woman/man), height, weight, BMI, smoking status (non-smoker/current or former smoker), alcohol consumption habits (none/occasionally or 1-2 days a week/3 days a week or more), marital status (married/unmarried, divorced/widowed), and having children of 6 years old or less (no/yes)[8,9,19,20]. Based on their BMI, the subjects were categorized as underweight (less than 18.5 kg/m^2), normal (18.5 kg/m^2 or more, but less than 25 kg/m^2), or overweight (25 kg/m^2 or more) for statistical analysis[21].

Work-related factors, including the position (head nurse or assistant head nurse/general duty nurse), section (ward/outpatient/operating room or intensive care units), work shift (day shift/8-hour shift or 12-hour shift), duration of employment, and total working hours in the previous week (less than 40 hours/40-48 hours/48 hours or more), were recorded[3,8,22].

The psychosocial work environment was assessed using the Japanese version of the Job Content Questionnaire[23,24]. The original questionnaire consists of 45 questions, and the response to each question is usually provided on a four-point scale from one to four, with a

higher number indicating higher demands, better control, and better support. Of the 45 questions, 27 items were used for this study to assess psychological demands (5 items), job control (9 items), supervisor support (4 items), coworker support (4 items), physical exertion (3 items), isometric load (2 items), and job strain index (psychological demands score divided by job control score)[25]. The subjects were dichotomized into those with higher and lower scores for each assessment using the median value.

All nurses were requested to wear any of the five types of commercial nursing shoes (690, 770, and 4966, Fuji Gomu Nurse, Omori-kita, Tokyo, Japan; CSS-300N, Midori Anzen, Hiroo, Tokyo, Japan; and MX-126, Kazen, Kanda, Tokyo, Japan) at work. All types of shoes had structures that are suitable for nursing footwear, including thick ethylene vinyl acetate midsoles, rigid heel cups, contoured insoles, and sufficient width (3E to 4E according to the Japanese industrial standards)[10]. Comfort of the nursing shoes was assessed using a visual analog scale, for which 0 indicated "not comfortable at all" and 10 indicated "most comfortable condition imaginable"[26]. The result of the visual analog scale scores were categorized into high comfort, medium comfort, and low comfort groups, using the tertile values. Subjects also revealed the frequency of wearing high-heeled shoes of 4 cm or more as never/occasionally, or 1 day per week/2 days per week, or more[6].

Statistics

The subjects' characteristics are presented as numbers and percentage values for the dichotomized and ordinal variables and as median and interquartile values for the continuous variables, as they had a non-normal distribution.

The relationship between foot and ankle pain and the associated factors was assessed using logistic regression analysis. For the first selection of potential associated factors, univariate logistic regression analysis was performed. Subsequently, multiple logistic regression analysis was performed to assess independent association, in which the presence of foot and ankle pain was the objective variable and the associated factors that showed significant associations in the univariate analysis were the explanation variables. Age, sex, and BMI were entered into the multiple logistic regression model regardless of their significance. For the other variables, those with a p value < 0.1 in the univariate analysis were entered into the multiple logistic regression model. Stepwise regression using the minimum Akaike's information criterion approach[27] was employed to identify the variables included in the final regression model. These analyses were performed separately for the four foot and ankle pain outcomes.

The frequencies of pain in eight foot and ankle regions, as evaluated using the foot drawing, were compared using Cochran's Q test. Statistical analyses were performed using JMP 11.2.1 (SAS Institute Inc., Cary, NY, USA). Statistical significance was set at $p < 0.05$.

Results

Of the 950 eligible nurses, 640 nurses returned the questionnaire. Of those, four nurses provided insufficient answers for the foot and ankle pain questionnaire. The remaining 636 questionnaires (response rate, 67%) were used for analysis.

As shown in Table 1, the subjects were relatively young; 58% of the subjects were younger than 30 years. The proportion of overweight subjects was only 9%, and 14% (n = 89) of subjects were categorized as underweight. The durations of employment were less than 48 months for 77% (n = 462) of subjects and 48 months or more for 25% (n = 160) (Table 1).

The prevalence of pain and/or discomfort of the foot and ankle in the previous month was 23% (n = 144) using the SNQ. This was ranked as the fifth most common location of pain after shoulder pain (64%), low back pain (61%), neck pain (52%), and back pain (27%). Among the 636 nurses, 4% (n = 25) reported that the pain prevented them from doing their normal work. The prevalence of pain was higher when assessed using the MFPDI, and 51% (n = 323) of subjects reported foot pain and disability in the previous month for at least one of the 17 items. Furthermore, 17% (n = 111) of subjects had disabling foot pain, defined as having trouble on most days for at least one of the 17 items.

In the multiple logistic regression analysis, the low shoe comfort score was independently associated with the presence of foot and ankle pain, assessed using the SNQ (p = 0.002, Table 2). The independent associations between shoe comfort and foot pain were also found when the pain (p = 0.006, Table 4) and disabling foot pain (p = 0.04, Table 5), assessed using the MFPDI, were used as the objective variables. Psychosocial factors, including high job strain (Table 2 and 3) and low job control (Table 4), were also associated with foot and ankle pain, although the association was not consistent across all pain outcomes. When disabling foot pain, assessed with the MFPDI, was used as the objective variable, the association between being overweight and the presence of pain was borderline significant (p = 0.06, Table 5). In contrast, being underweight was associated with a reduced risk of pain (p = 0.02, Table 5). Furthermore, subjects in their fifties or older had a higher risk of pain than those in their twenties (p = 0.01, Table 5).

The frequencies of foot and ankle pain were significantly different depending on the region ($p < 0.001$, Table 6). The common regions of pain were midfoot, great toe, and lesser toes, while pain in the plantar heel region and pain in the posterior heel region were less common (Table

Table 1. Subject characteristics (*n*=636)

Sex	Women	569 (89%)
	Men	67 (11%)
Age (years)	20-29	369 (58%)
	30-39	133 (21%)
	40-49	83 (13%)
	50-65	48 (8%)
Height (cm)		159 (155, 163) [1]
Weight (kg)		52 (48, 58) *
Body mass index (kg/m^2)		20.4 (19.1, 22.3) [1]
	Underweight (<18.5)	89 (14%)
	Normal (≥18.5, <25)	468 (74%)
	Overweight (≥25)	55 (9%)
Smoking	Non-smoker	589 (93%)
	Current smoker/Former smoker	46 (7%)
Alcohol	None	108 (17%)
	Occasionally/1-2 days a week	443 (70%)
	≥3 days a week	82 (13%)
Marital status	Unmarried/Divorced or bereaved	443 (70%)
	Married	192 (30%)
Children≤6 years old	No	544 (86%)
	Yes	89 (14%)
Duration of employment (month)		54 (19, 143) [1]
	<40	134 (21%)
	≥40, <48	328 (52%)
	≥48	160 (25%)
Position	General duty nurse	554 (88%)
	Head nurse/Assistant head nurse	78 (12%)
Section	Ward	398 (63%)
	Outpatient	105 (17%)
	Operating room or intensive care unit	131 (21%)
Night shift	No	156 (25%)
	Yes	473 (75%)
Weekly working hours (hour)		42 (40, 48) [1]
	<40	134 (21%)
	40-47	328 (52%)
	≥48	160 (25%)
Psychological demands		36 (33, 40) [1]
Job control		68 (64, 74) [1]
Supervisor support		12 (11, 13) [1]
Coworker support		12 (11, 13) [1]
Physical exertion		9 (9, 11) [1]
Isometric load		5 (4, 6) [1]
Job strain index		0.53 (0.47, 0.60) [1]
Shoe comfort visual analogue scale		60 (40, 78) [1]
Use of high heel shoes	Never	291 (46%)
	Occasionally/1 day a week	265 (42%)
	≥2 days a week	76 (12%)

Values show the number (percentage) of subjects unless otherwise indicated. [1]Median (25, 75 percentile) values. Note that the total number of subjects for each variable may not be 636 due to the missing data

Table 2. Multiple logistic regression analysis of the associated factors for the presence of foot and ankle pain assessed with the Standardized Nordic Questionnaire

Associated factor		Odds ratio (95% CI)	*p* value
Job strain index	Low stress	Reference	
	High stress	1.57 (1.05-2.36)	0.03
Shoe comfort VAS	High comfort	Reference	
	Medium comfort	1.38 (0.83-2.31)	0.21
	Low comfort	2.12 (1.31-3.50)	0.002

Model p=0.009. CI, confident interval; VAS, visual analogue scale

Table 3. Multiple logistic regression analysis of the associated factors for the presence of foot and ankle pain that prevented from normal work assessed with the Standardized Nordic Questionnaire

Associated factor		Odds ratio (95% CI)	*p* value
Job strain index	Low stress	Reference	
	High stress	2.83 (1.16-7.95)	0.02
Isometric load	Low load	Reference	
	High load	2.59 (1.12-6.51)	0.03

Model p=0.01. CI, confident interval

Table 4. Multiple logistic regression analysis of the associated factors for the presence of foot pain, assessed with the Manchester Foot Pain and Disability Index

Associated factor		Odds ratio (95% CI)	*p* value
Children≤6 years old	No	Reference	
	Yes	0.54 (0.31-0.93)	0.03
Job control	High control	Reference	
	Low Control	1.42 (1.02-2.00)	0.04
Physical exertion	Low exertion	Reference	
	High exertion	1.54 (1.09-2.18)	0.02
Shoe comfort VAS	High comfort	Reference	
	Medium comfort	1.11 (0.74-1.66)	0.62
	Low comfort	1.78 (1.18-2.69)	0.006

Model p<0.001. CI, confident interval; VAS, visual analogue scale

6). In total, 9% (n = 58) of subjects reported pain in one or two regions, 12% (n = 76) in three to five regions, and 2% (n = 14) in six regions or more.

Discussion

We showed that foot and ankle pain was quite common among nurses working at a university hospital in Japan. We also showed that the pain was independently associated with footwear comfort, as well as several personal and psychosocial factors. The pain was more common in the midfoot and toes, although it was distributed in all regions of the foot and ankle. As suggested previously, shoe modifications may relieve foot and ankle pain in nurses[10,11]. Further research with a larger subject number is warranted to clarify whether shoe modification can reduce the risk of foot and ankle pain.

In this study, 23% and 51% of subjects had foot and ankle pain when assessed using the SNQ and the MFPDI, respectively. However, the prevalence of pain that prevented the nurses from performing their activities of daily life and work was 4% and 17%, respectively. Quantitative comparison of our results with those of previous studies is difficult because of the differences in cultural and regional backgrounds, as well as the differences in the definition of foot and ankle pain. The reported prevalence of

Table 5. Multiple logistic regression analysis of the associated factors for the presence of disabling foot pain assessed with the Manchester Foot Pain and Disability Index

Associated factor		Odds ratio (95% CI)	*p* value
Age (years)	20	Reference	
	30	0.90 (0.48-1.62)	0.73
	40	1.41 (0.72-2.67)	0.31
	>50	2.74 (1.27-5.78)	0.01
Body mass index (kg/m^2)	Normal	Reference	
	Underweight	0.40 (0.16-0.87)	0.02
	Overweight	2.69 (0.94-8.12)	0.06
Alcohol	Never	Reference	
	Occasionally/1-2 days a week	0.58 (0.34-1.00)	0.05
	≥3 days a week	0.31 (0.13-0.71)	0.005
Shoe comfort VAS	High comfort	Reference	
	Medium comfort	1.46 (0.83-2.61)	0.19
	Low comfort	1.76 (1.01-3.11)	0.04

Model $p<0.001$. CI, confident interval; VAS, visual analogue scale

Table 6. Location of pain in the foot and ankle (*n*=636)

Location	
Great toe	88 (14%)
Lesser toe	87 (14%)
Plantar forefoot	58 (9%)
Medial arch	56 (9%)
Midfoot	99 (16%)
Ankle	62 (10%)
Plantar heel	41 (6%)
Posterior heel	47 (7%)
Overall	144 (23%)

Values indicate the number (percentage) of subjects

foot and ankle pain in nurses varies among studies, ranging from 4% to 74%[8,9]. However, the incidence in this study seems to be relatively lower than that reported in previous studies. One possible explanation could be that the subjects in this study had low-risk personal and lifestyle characteristics, such as young age, low BMI, and low rate of smoking.

The prevalence of foot and ankle pain was reported to be higher when assessed using the MFPDI than that when using the SNQ, even though the former questionnaire enquired about the pain only in the foot, while the latter enquired about the pain in the broader area of the foot and ankle. The discrepancy might be due to the format of the questionnaires. The MFPDI consists of 19 questions and enquires about pain and disability in various situations of daily life[15]. In contrast, the simple question "Have you at any time had trouble (ache, pain, or discomfort) ?" is used in the SNQ[13]. Researchers need to recognize that the prevalence of foot and ankle pain is dependent on the definition of the pain, and the SNQ may underestimate the prevalence of foot and ankle pain.

Notably, shoe comfort was independently associated with three of the four foot and ankle pain outcomes. Our study results agree with those reported by Chiu et al., who suggested that providing comfortable footwear for clinical nurses is essential for reducing fatigue and discomfort in the lower extremities, even though Chiu et al. did not quantify the shoe comfort or its association with foot and ankle pain[10]. Shoe comfort has also been highlighted in studies on running shoes. Shoe comfort, rather than cushioning and stability, has been proposed as an important factor for injury prevention and running economy[28]. This was a cross-sectional study, and, therefore, it did not address the cause-effect relationship between shoe comfort and foot and ankle pain. Parker et al. showed that replacing the usual shoes nurses were wearing with a walker-type shoe reduced foot pain among nurses in the neonatal intensive care unit[11]. The sample size of their study[11] was only 15, and further studies with a larger number of subjects are necessary to clarify whether footwear intervention can reduce the risk of foot and ankle pain.

Other than shoe comfort, several psychosocial factors, such as high job strain and low job control, were associated with the presence of foot and ankle pain. Our study results are consistent with those of the systematic review by Bernal et al., which reported that high psychosocial demands and low job control were significantly associated with pain in various anatomical sites among hospital nurses[12]. Our study results also agree with those reported by Arvidsson et al., who showed significant associations of high job demands and low job control with the foot

and ankle pain[9].

Greater age and being overweight were associated with disabling foot pain, assessed using the MFPDI, even though an association was not found with the other foot and ankle pain outcomes. Studies have shown that these two factors increase the risk of foot pain among the general population, as well as among nurses[5,9]. Interestingly, the subjects who were underweight had a lower risk of foot and ankle pain than those with a normal BMI. The prevalence of being underweight has been increasing among young women in Japan[29], and 14% of nurses were classified as underweight in this study. Being underweight can be a risk for several health problems, such as osteoporosis and adverse pregnancy outcomes[29]. However, in this study, it reduced the risk of foot and ankle pain, presumably through the reduced stress on the foot and ankle during weight-bearing activities.

Pain was more frequent in the midfoot and toe regions than in the plantar heel and posterior heel regions. Among the general population, a systematic review showed that the most common locations of pain in the foot were the toe and forefoot, followed by the arch, and the heel and hindfoot across all age groups[5]. This trend is consistent with results of our study. Pain in a specific location can be caused by specific foot and ankle diseases. For example, pain in the hallux could be associated with hallux valgus, and plantar heel pain could be caused by plantar fasciitis[30,31]. This study was a questionnaire-based study and did not address the source of pain for each pain region. Future studies should include a detailed examination of the foot and ankle to clarify the cause of pain.

This study has several limitations. First, this study was performed at a single university hospital in Japan. Therefore, the results may not be extrapolated to other hospital nurses who have other personal, cultural, and occupational backgrounds. Second, the response rate of the questionnaire in this study was 67%, which may be lower than that in previous studies. Nevertheless, we collected the data from as many as 636 nurses, which were comparable to previous studies. Third, as was the case for most of the previous studies, this was a cross-sectional study. Therefore, as mentioned above, the causality between the foot and ankle pain and the associated factors was not clarified in this study. Clearly, future longitudinal studies are necessary to address this issue. Fourth, although we assessed a wide range of variables, several factors that might have been associated with foot and ankle pain were not assessed. For example, we did not evaluate foot posture, which is known to be correlated with foot pain[32].

In conclusion, foot and ankle pain was common in nurses working at the university hospital in Japan. Shoe comfort, personal factors, and psychosocial factors were associated with foot and ankle pain. Footwear modification to improve shoe comfort could reduce the risk of pain; however, further research is necessary in this direction.

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Conflicts of interest: None declared.

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