

Relationship between sandals and diabetic foot ulcers in an outpatient clinic in Indonesia

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Background: Footwear can prevent the development of diabetic foot ulcers (DFUs) or become a source of risk when used inappropriately. This study aimed to understand the interaction between footwear and DFU characteristics. **Method:** This was a secondary analysis of data from a cross-sectional study conducted in Wahidin Sudirohusodo Hospital in Makassar, eastern Indonesia. Participants were aged ≥ 18 years with type 2 diabetes. DFUs were categorised using the Kobe classification and Wagner scale; footwear was categorised as a thong or belt sandal. **Results:** Of the 249 participants, 16 had DFUs (total DFUs = 23). Participants' median age was 65 years (IQR 61.5–69.5) and 13 were female (81.2%). Thirteen DFUs were Kobe type I. Calluses were mainly found in the plantar area ($n=13$, 72.2%; $p=0.002$) and were associated with necrosis ($n=11$, 78.6%; $p=0.018$). **Conclusion:** There was no relationship between DFU location and type of sandal. However, the incidence of DFUs was higher in areas of the foot in contact with footwear.

Development of diabetic foot ulcers (DFUs) may be related to internal factors, such as neuropathy and angiopathy (International Working Group on the Diabetic Foot, 2012), or caused by external factors, including footwear. Footwear has two contrasting effects on the development of DFUs: it can be preventative (Viswanathan et al, 2004) or it can be a source of risk when worn inappropriately (Waaijman et al, 2014). A recent cluster analysis confirmed that footwear is one of the greatest contributing factors in the development of DFUs (Lavery et al, 2008).

Many Asian patients wear sandals (Ungpakorn et al, 2004; Miyan et al, 2014). In Indonesia, sandals are mainly used as footwear worn when undertaking daily activities. Our epidemiological study confirmed that the majority of patients who have a DFU or who are at high risk of developing a DFU wear sandals (Yusuf et al, 2016). People with diabetes' choice of footwear in Indonesia appears to be based on practicality (bearing in mind the heat and humidity), rather than

its function in the prevention of DFUs. Determination of which type of sandal is most appropriate in diabetes patients with/at risk of a DFU could therefore form the basis of education in the selection of proper footwear.

Several studies have investigated the role of footwear in DFU development. Tang et al (2014) compared planar pressure with three types of insoles given to diabetic patients at risk of developing DFUs, Arts et al (2015) evaluated data from custom-made footwear used to offload the diabetic foot to prevent plantar foot ulcers, and McInnes et al (2012) assessed the impact of ill-fitting footwear in patients with diabetic peripheral neuropathy. All of these studies, however, focused on closed shoes rather than sandals. These two types of footwear have different shapes, functions and structure. This makes it difficult to apply the results of footwear studies to those who use sandals as their primary footwear.

Although extensive research has been carried out on footwear and DFUs, the links between wearing sandals and DFU characteristics are not

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Article points

1. Of 249 participants, 16 had at least one diabetic foot ulcer.
2. The majority of ulcers were Kobe type 1, calluses were mainly in the plantar area and were often associated with necrosis.
3. Foot ulcers occur most frequently in areas in contact with sandals.

Key words

- Diabetes mellitus
- Diabetic foot ulcers
- Footwear
- Sandals

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Figure 1: Footwear was defined as (a) thong sandals, which have two straps, extending toward either the medial or lateral heel, with an insertion point between the first and second metatarsals; or (b) belt sandals, which have a belt covering the dorsal forefoot.

well understood. The aim of this study was thus to investigate the relationship between different types of sandal and DFU characteristics.

Methods

This was a secondary analysis from a cross-sectional epidemiological study conducted in an outpatient

endocrine clinic at Wahidin Sudirohusodo Hospital, a regional hospital in Makassar, eastern Indonesia, between May 2013 and February 2014. Patients were invited to participate if they were aged ≥ 18 years, had type 2 diabetes and used sandals as their primary footwear.

Demographic data, general health, diabetes and DFU status were captured using a minimum data sheet. Body mass index was calculated, the waist-to-hip ratio measured with a tape measure, and HbA_{1c} status was evaluated in the hospital's laboratory.

The presence of neuropathy was evaluated using a 5.07/10g Semmes-Weinstein monofilament at four different sites (the dorsal hallux and metatarsals I, III and V) on each foot (Boulton et al, 2008). Meanwhile, the presence of ischaemia was evaluated by calculating the ankle or toe brachial index with a hand-held vascular Doppler (Bi-directional Doppler ES-100V3, Hadeco-Kawasaki, Japan) on both the dorsalis pedis and posterior tibialis. All DFUs were categorised by Wagner scale and Kobe classification (Terashi et al, 2011). The Kobe classification was used because it was developed based on Asian DFU characteristics. It categorises the foot based on risk status:

- Type I (mainly polyneuropathy)
- Type II (mainly peripheral arterial disease)
- Type III (mainly infection)
- Type IV (a combination of types I, II and III).

Meanwhile, DFU location was categorised based on the side of the foot it occurred on (dorsal, tip and plantar) and distal-to-proximal aspect (toe, forefoot and hind foot/heel).

The presence of DFUs was evaluated based on the International Working Group on the Diabetic Foot criteria by a wound care nurse (Schaper, 2004). DFU characteristics analysed in the study included shape, wound base, wound edges, periwound and exudate based on the 2004 Wound Ostomy and Continence Society guidelines, with depth and undermining as additional parameters.

Participants were asked what type of sandal they primarily wore, i.e. the type worn by participants on a daily basis, and this was confirmed by interview. Sandals were categorised based on type (belt or thong), material (leather, rubber and textile) and whether the sandal was in direct contact with the foot (Figure 1).

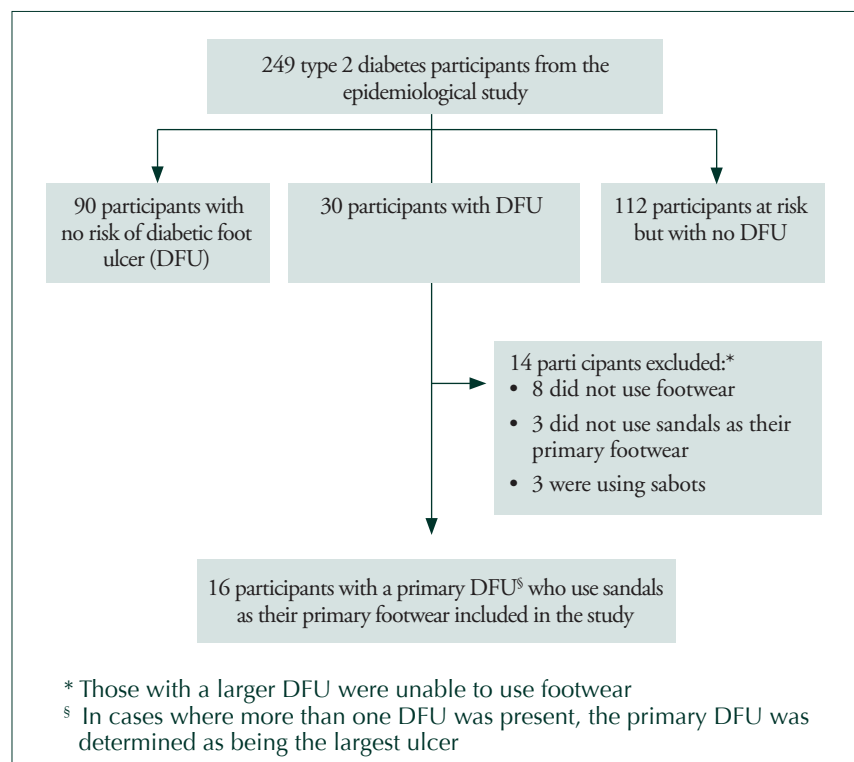


Figure 2: Flow chart of patient inclusion in the study.

Data analysis and ethical approval

Nominal data are presented as a number and percentage and continuous data are presented as a median and interquartile range (IQR: Q_1 – Q_3). Chi-squared or Fisher's exact test were used to report the findings of this study by using Statistical Package for Social Sciences version 16.0 (SPSS, Chicago, IL, USA).

Ethical approval for this study was obtained from Kanazawa University, Japan (no. 438) and Hasanuddin University, Indonesia (No: 0866/H4.8.4.5.31/PP36-KOMETIK/2013). Participants and family members also received an explanation of the study before giving their signed informed consent.

Results

Demographics and health status

Sixteen participants who wore sandals (Figure 2) as

their primary footwear were included in this study. Table 1 gives the demographics of the participants. Their median age was 65 years (IQR 61.5–69.5). Thirteen (81.2%) were female and 11 (68.8%) were Burinese. Half of the participants were housewives and 13 were unemployed. Five were senior high school graduates.

Eleven participants (68.8%) were insulin-dependent, and 10 of these were also using alternative therapy. The time since diabetes diagnosis was <10 years for eight participants. Six participants (37.5%) had received their diagnosis after investigations for general symptoms of type 2 diabetes. No participants had a history of amputation. Only two of participants had a history of smoking. Three-quarters of participants did not understand the aetiology of DFUs. General health parameters, see Table 2, included a median body

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Table 1. Demography of participants (n=16).

Characteristic	Number	Percentage
Age, years (median, Q ₁ -Q ₃)	65.0	61.5-69.5
Sex:		
• Male	3	18.8
• Female	13	81.2
Ethnicity:		
• Makassar	3	18.8
• Bugis	11	68.8
• Jawa	2	12.5
Occupation:		
• Housewife	8	50.0
• Employed	3	18.8
• Retired	5	31.2
Education (highest level):		
• Elementary school	4	25.0
• Junior high school	4	25.0
• Senior high school	5	31.2
• University	3	18.8
Marital status:		
• Married	15	93.8
• Unmarried	1	6.2

mass index of 26.9 (IQR: 24.4-30.1 kg/m²), waist-to-hip ratio of 1.02 (IQR: 0.94-1.08), and HbA_{1c} of 8.75% (IQR: 7.2-9.8%).

DFU status

In this study, we evaluated 23 primary DFUs from our 16 participants. The DFUs were classified using the Wagner ulcer classification scale, which goes from grade 0 (no open lesions) to grade 5 (extensive gangrenous involvement of the entire foot). Ten ulcers were Wagner grade 1 (superficial diabetic ulcer) and 13 were Wagner grade 2 (ulcer extension to ligament, tendon, joint capsule of deep fascia without abscess of osteomyelitis). Based on the Kobe wound classification system, 13 DFUs were type I (neuropathy), nine were type II (ischaemic) and one remained unclassified. There were no cases Kobe wound types III and IV.

Participants' DFUs were on the dorsal region (n=5), tip of the toe (n=5) and on the plantar aspect (n=13) of the foot. The majority of DFUs were on the toes (n=15). Four were on the forefoot and four on the hind foot/heal (see Table 3).

Table 2. General health and characteristics of participants' diabetes (n=16).

Variable	Number	Percentage
Diabetes therapy		
Oral	4	25.0
Insulin	11	68.8
Oral and insulin	1	6.2
Alternative therapy	10	62.5
Duration of diabetes		
<10 years	8	50.0
10-20 years	4	25.0
>20 years	4	25.0
When diabetes was diagnosed		
Presence of polyuria, polyphagia or polydipsia	4	25.0
General checkup	4	25.5
General symptoms	6	2
Presence of a diabetic foot ulcer	2	12.5
Smoking status		
Smoker	2	12.5
Non-smoker	14	87.5
Ulcer aetiology		
Unknown	12	75.5
Puncture	2	12.5
Heel crack	2	12.5
Other		
Body mass index (median, Q ₁ -Q ₃)	26.9	24.4-30.1
Waist-to-hip ratio (median, Q ₁ -Q ₃)	1.02	0.94-1.08
HbA _{1c} % (median, Q ₁ -Q ₃)	8.75	7.2-9.8

DFU locations, characteristics and contact with footwear

Belt and thong sandal users commonly had DFUs located on plantar (n=5; 62.5%) and dorsal (n=8; 53.3%) aspects of the foot (p=0.854). Interestingly, the prevalence of DFUs was higher in areas of the foot in contact with footwear (14 cases) compared to areas without contact (nine cases), see Table 4.

DFUs that have a wound base with necrotic tissue tend to occur in the plantar area (n=11; 78.6%; p=0.18). The majority of ulcers were associated with

Table 3. Diabetic foot ulcer characteristics

Variable	Number	Percentage
Wagner scale		
1	10	43.5
2	13	56.5
Kobe classification		
Type I	13	56.5
Type II	9	39.1
Unknown	1	4.4
Location		
Dorsal	5	21.7
Tip	5	21.7
Plantar	13	56.5
Location (distal to proximal)		
Toes	15	65.2
Forefoot	4	17.4
Hindfoot/heel	4	17.4

Table 4. Diabetic foot ulcer location and contact with footwear

	Total (n=23)	Belt sandal, n=8 (%)	Thong sandal, n=15 (%)	p value
Location:				0.854
• Dorsal	5	1 (12.5)	4 (26.0)	
• Tip	5	2 (25.0)	3 (20.0)	
• Plantar	13	5 (62.5)	8 (53.3)	
Contact:				1.000
• No	9	3 (37.5)	6 (40.0)	
• Yes	5	5 (2.5)	9 (60.0)	

the presence of a callus in the periwound area (n=13, 72.2%; $p=0.002$). No other characteristics (shape, edge, exudate, depth and undermining) were related to the location of the DFU ($p>0.05$) (Table 5).

Discussion

There is a lack of studies evaluating the relationship between DFUs and type of footwear among type 2 diabetes patients. Demographic data from this study confirmed that, with an average age of 65, patients are generally older, a factor that complicates DFU management. In addition to this, half of the participants had a <10-year history of diabetes, emphasising the importance of preventive strategies.

The prevalence of DFUs in Indonesia is high; the author's previous study reported that DFUs are major chronic wounds in the home care setting (Yusuf et al, 2013). The current study confirmed that the majority of DFUs are related to neuropathy (Kobe type I); as a result, many DFU complications were associated with dry, necrotic tissue and the presence calluses without an undermining condition (Wounds International, 2013). The presence of neuropathy, and the associated lack of sensation, in many participants with DFUs indicated that many participants were unaware that they were wearing inappropriate footwear.

A previous study reported that Asian patients mainly wear sandals (Ungpakorn et al, 2004). The majority of our study participants wore thong sandals, which tend to be made from rubber and do not provide protection from toe to heel, including the dorsal aspects of the foot. This puts the foot at high risk of external trauma. In Indonesia, people prefer to wear sandals because it is a tropical country associated with high temperatures and humidity. An important clinically-relevant finding of the current study was that calluses tended to be in the plantar area of the foot, indicating that sandals were unable to distribute pressure appropriately across the plantar area. There were no statistically significant differences in DFU characteristics between belt and thong sandals. The majority of participants were wearing sandals that do not have sufficient ability to protect the foot, which may contribute to external trauma. The current study indicates the importance of evaluating the properties of different types of sandals, since DFUs occur in areas of the foot directly in contact with footwear. Proper footwear that has the ability to protect the foot from external trauma and has an ergonomic shape that enables it to conform around the foot should, therefore, be introduced and evaluated among high-risk patients.

Study limitations

There were three main limitations in this study. The first relates to the small sample size, which could limit the ability to generalise our findings. Second, this was a cross-sectional study, precluding us from understanding the general protective role of sandals in DFUs. Third, since all of the DFUs were Wagner type I and II, caution should be taken in generalising the findings of this study.

Table 5. Characteristics of diabetic foot ulcers based on location on the foot.

Location (total)	Wound shape			Wound base			Wound edge			Periwound		
	Non round n (%)	Round n (%)	p value	Necrotic n (%)	Pale n (%)	p value	Well defined n (%)	Poorly defined n (%)	p value	Callus n (%)	Erythema n (%)	p value
Dorsal (5)	2 (40.0)	3 (16.7)	0.795	1 (7.1)	4 (44.4)	0.018	3 (33.3)	2 (14.3)	0.248	1 (5.6)	4 (80.0)	0.002
Tip (5)	1 (20.0)	4 (22.2)		2 (14.3)	3 (33.3)		3 (33.3)	2 (14.3)		4 (22.2)	1 (20.0)	
Plantar (13)	2 (40.0)	11 (61.1)		11 (78.6)	2 (22.2)		3 (33.3)	10 (71.4)		13 (72.2)	0 (0.0)	

Location (total)	Depth		p value	Undermining		p value	Exudate			p value
	Partial thickness n (%)	Full thickness n (%)		Yes n (%)	No n (%)		Dry n (%)	Small n (%)	Moderate n (%)	
Dorsal (5)	5 (21.7)	0 (0.0)	N/A	5 (21.7)	0 (0.0)	N/A	2 (20.0)	3 (27.3)	0 (0.0)	0.201
Tip (5)	5 (21.7)	0 (0.0)		5 (21.7)	0 (0.0)		1 (10.0)	2 (18.2)	2 (100.0)	
Plantar (13)	13 (56.5)	0 (0.0)		13 (56.5)	0 (0.0)		7 (70.0)	6 (54.6)	0 (0.0)	

An explanation related to role of sandals in DFU development and the healing process is beyond the scope of this study. A longitudinal, multisite study might yield more detailed information.

Implications for nursing practice

In Asian countries, a high number of type 2 diabetes patients walk barefoot (Khamseh et al, 2007) and wear inappropriate footwear (Ahmed et al, 2014). In Indonesia, type 2 diabetes patients mainly wear thong sandals. Nurses should advocate the importance of not going barefoot and of wearing appropriate, well-fitting footwear. They should advise patients on the benefits and risks associated with different forms of footwear. At this time, neither thong or belt sandals have been shown to be associated with lower DFU risk or occurrence.

Conclusion

The current study was unable to confirm a relationship between the occurrence of DFUs and choice of belt or thong sandals as the primary form of footwear. Despite this, DFUs occurred in areas of the foot that were in direct contact with sandals, and therefore sandals may be a factor in DFU development and should be studied further. ■

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