ORIGINAL ARTICLE

Prevalence and Factors Associated with the Stratified Risk to Develop Diabetic Foot Ulcer in Type 2 Diabetes Mellitus Patients in Primary Care Unit of Songklanagarind Hospital

Pawita Limsomwong, MD[1], Panitan Wajanacomkul, MD[1]

[1] Department of Family and Preventive Medicine, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand

Objective: To determine the prevalence of and to assess factors associated with diabetic foot in type 2 diabetes mellitus (DM) patients in the primary care unit (PCU) of Songklanagarind Hospital.

Materials and Methods: The present study was a cross-sectional study that collected the data of 160 type 2 DM patients attending the PCU of Songklanagarind Hospital between March and July 2020 using a questionnaire and face-to-face interviews. The classification of diabetic foot severity was based on foot examination using the 2017 Guideline of the Diabetes Association of Thailand.

Results: There were 160 participants in the present study, 44.4% were male and 55.6% were female. There were 58.1% aged less than 60 years and 41.9% aged more than or equal to 60 years. The diabetic patients who had foot ulcer were not found in the present study. There were 31.2%, 63.1%, and 5.6% of the patients had low, medium, and high risk of diabetic foot, respectively. In multivariate analysis, the adjusted odds ratios (ORs) with 95% confidence intervals (CI) found the factors associated with positively increased diabetic foot risk were some occupations including self-employed 5.19 (1.53 to 18.91) and agriculturist 4.82 (1.38 to 18.44), chronic kidney disease (CKD) 18.17 (2.46 to 131.32), longer duration of DM 3.14 (1.40 to 7.40), diabetic retinopathy (DR) 11.90 (3.44 to 50.00). Some factors negatively increased the risk were low-density lipoprotein (LDL) less than 100 mh/dL 0.37 (0.16 to 0.81), self-care behavior including asking others to check blind areas of the foot 0.21 (0.07 to 0.63), and foot exercise 0.29 (0.12 to 0.68) ($p<0.05$).

Conclusion: Diabetic foot in type 2 DM patients at the PCU of Songklanagarind Hospital was not found. However, it is important to establish PCU to identify feet at risk included occupations, CKD, longer duration of DM, LDL more than 100 mh/dL, DR, and lack of self-care practices for primary and secondary prevention in DM patients.

Keywords: Diabetes mellitus; Diabetic foot; Primary care

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Diabetes mellitus (DM) is a chronic metabolic disease characterized by elevated levels of blood glucose. It has become a major global public health problem[1]. The incidence of DM is increasing worldwide. Nowadays, about 425 million people are inflicted with DM[2]. The seriousness of DM is a result of associated vascular complications that affect the patient's health, and one of the main complications involves the foot in a condition known as diabetic foot.

Diabetic foot is used to describe any wound at one or both feet that is associated with neuropathy, ischemia, and infection[2]. The International Diabetes Federation (IDF)[3] separates the risk of a patient developing diabetic foot into four categories as (a) category 0 is normal plantar sensation, (b) category 1 is loss of protective sensation (LOPS), (c) category 2 is LOPS with either high pressure or poor circulation or structural foot deformities or onychomycosis, and (d) category 3 is history of ulceration, amputation or neuropathic fracture. However, the Thai Clinical Practice Guideline for Diabetes (2017)[4] separates the risk of diabetic patients developing diabetic foot into three categories as (a) low risk is normal skin at

Correspondence to:

Wajanacomkul P.

Department of Family and Preventive Medicine, Faculty of Medicine, Prince of Songkla University, Songkhla 90110, Thailand.

Phone: +66-89-6562450, **Fax**: +66-74-451331

Email: panitan_w@outlook.com

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the feet, (b) moderate risk is used to describe patients with abnormal sensations at the foot or with an Ankle Brachial Index of less than 0.9 but no history of ulcer or amputation, and (c) high risk refers to a patient with a history of ulcers or amputation of a foot or a patient with moderate risk plus foot deformity.

Diabetic foot is one of the most common reasons for hospitalization of diabetic patients[5] and results in a significant economic burden on the patients, and their families and society as a whole[6,7]. The patients also suffer from reduced quality of life (QoL)[8].

Factors that affect the rate of diabetic foot complications among type 2 DM patients can be divided into sociodemographic factors, behavioral factors, clinical factors, and self-care practices. Studies[9-12] have identified factors associated with diabetic foot included older age, rural residence, poor self-care practices, having the disease for a long time, high body mass index (BMI), type 2 DM, smoking, and the presence of neuropathy.

Identifying factors associated with diabetic foot would provide information for health care providers and policy makers to create effective policies concerning prevention and risk minimization of diabetic foot. On literature review, there are limited published data on the classification of diabetic foot risk in Thailand in the primary care settings. Most studies were done within tertiary care setting, which were not similar in primary care settings because of the severity of the diseases, and comorbidities.

In the primary care unit (PCU) in Thailand, the health care providers normally used the Guideline of the Diabetes Association of Thailand issued in 2017 to determine the prevalence of diabetic foot ulcer in patients within three risk groups but there is no study about evaluating the factors associated with the diabetic foot in PCU that can help health care providers and DM patients. Hence, the present study aimed to determine the prevalence of, and the factors associated with diabetic foot among type 2 DM patients in the PCU at Songklanagarind Hospital, Thailand.

Materials and Methods

Study designs and setting

The present study was a cross-sectional descriptive study conducted in a PCU between March 1 and July 31, 2020. Ethical approval was received from the Ethics Committee of Faculty of Medicine, Prince of Songkhla University, certificate of approval (COA) no. REC. 62-447-9-4.

Participants

The study population was identified by the hospital information system (HIS) and included 844 patients who had been diagnosed type 2 diabetes at the PCU of Songklanagarind Hospital. After simple random sampling where the researchers prepared a list of all the population, then each member was marked with a specific number. Then, the researchers chose random samples using random number tables. One hundred sixty-seven participants were included in the present study. Seven participants were excluded because of incomplete data. Finally, 160 participants were analyzed in the present study.

Inclusion and exclusion criteria

Inclusion criteria were patients diagnosed with type 2 DM according to ICD-10: CODE E11.0-E11.9 at PCU of Songklanagarind Hospital. The exclusion criteria were patients who had an ulcer from accident during the study period, and those who did not have complete laboratory results including HbA1C, lipid profile, and creatinine before the study in the last one year.

Variables of the study

The dependent variable was the presence of diabetic foot ulcer.

The independent variables were:

- Sociodemographic factors: age, gender, and place of residence
- Behavioral factors: cigarette smoking and foot self-care behavior
- Clinical factors: fasting blood sugar (FBS) level, HbA1C, lipid profile, creatinine, comorbidities, body mass index, history of ulceration, history of amputation, and duration of DM

Data sources/measurements

Study size: The single population proportion formula was used to calculate the required sample size considering the following assumptions, prevalence of diabetic foot ulcer 39.1%[13], 95% confidence level, and 7% margin of error for an absolute level of precision. The sample of relevant factors were calculated from the primary objective of the research by comparing two proportion[14]. The sample size was 152 participants. Therefore, the final sample size was adjusted by using the probability of a 5% non-response rate, and the total sample size was adjusted to be equal to 160 participants.

Quantitative variables

Outcome: The primary outcome was the prevalence of DM foot ulcer in type 2 DM patients in PCU of Songklanagarind Hospital. The secondary outcomes were the factors associated with DM foot ulcer risk in type 2 DM in PCU of Songklanagarind Hospital.

Data collection

Data were collected using a structured and pretested questionnaire via face-to-face interviews, a recording of the interview for later review if necessary, and direct observation and examination of the patients. Diabetic foot problem was assessed by foot examinations that included dermatological, musculoskeletal, vascular, and neurological examinations by 10-g Semmes Weinstein monofilament[14]. The questionnaire was prepared in the local language, which was Thai[15]. This questionnaire was assessed for content validity by five experts, and the content validity index (CVI) was 0.95, Cronbach alpha coefficient was 0.70. The present study included only questions that had corrected item-total correlations of more than 0.30. In addition, the various lab results of FBS, HbA1C, lipid profiles, and creatinine were obtained from the computerized medical records, the PSU hospital information system.

Statistical analysis

All data were entered in a case record form. Double data entry was done by researchers using Epidata. The researchers performed statistical analysis using R software, version 3.6.2. Descriptive statistics, percentages, means, medians, and interquartile range (IQR) were used for the study analyses. The prevalence of each classification category of the stratified risk of developing diabetic foot ulcer was calculated into three groups, mild, moderate, and high risk. Factors associated with the three group of stratified risk of developing diabetic foot were assessed using the chi-squared test, Fisher's exact test, Kruskal-Wallis test, or ANOVA F-test, as appropriate; and further refined through multiple ordinal logistic regression analysis, a p-value less than 0.05 was considered statistically significant.

Results

From the 160 participants, 71 cases were male (44.4%) and 89 were female (55.6%). Ninety-three cases (58.1%) were aged less than 60 years, and 67 cases (41.9%) were aged more than or equal to 60 years. The highest number of the patients were unemployed with 36 participants (22.5%), followed by self-employed with 35 participants (21.9%), government officer with 34 participants (21.2%), agriculturist with 27 participants (16.9%), and others with 28 participants (17.5%). More than one-third of the patients had duration of DM more than 10 years, 88.8% had hyperlipidemia, while 75%, 5%, and 4.4% had hypertension, cardiovascular disease, and chronic kidney disease (CKD), respectively. The main sociodemographic characteristics and clinical baseline are summarized in Table1.

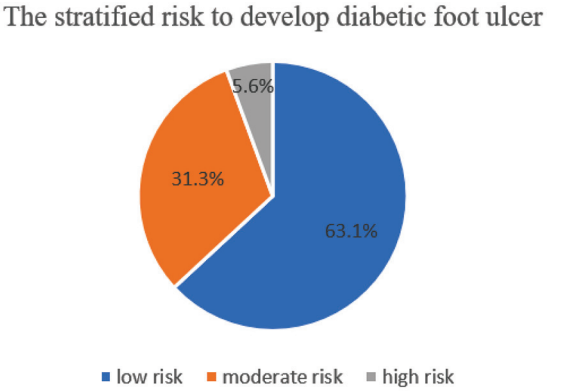

Figure 1. Prevalence of the stratified risk to develop diabetic foot ulcer of 160 adult diabetes mellitus patients in Songklanagarind, PCU, 2020.

Prevalence of diabetic foot. Among the 160 study participants, none had diabetic foot ulcer during the present study period, 101 (63.1%) of the patients were at moderate risk of diabetic foot, and nine (5.6%) of the patients were at high risk (Figure 1).

Table 2 found an increased risk of diabetic foot with increasing age, careers in agriculture, longer duration of DM, and history of foot ulcers. Certain comorbidities were: diabetic retinopathy (DR), diabetic nephropathy, and lack of foot exercise.

A multiple ordinal logistic regression analyses of the prevalence of diabetes foot ulcer risk was performed, using occupation, peripheral arterial disease (PAD), CKD, duration of diabetes, HbA1C, low-density lipoprotein (LDL), diabetes retinopathy, and selected self-care practices including foot protection and exercise as its predictors reported. The factors associated with increased positively the risk of developing diabetic foot ulcer were self-employed (adjusted OR 5.19, 95% CI 1.53 to 18.91, p=0.001), agriculturist (adjust OR 4.82 95% CI 1.38 to 18.44, p=0.018), CKD (adjusted OR 18.17, 95% CI 2.46 to 131.32, p=0.004), duration of DM (adjust OR

Table 1. Sociodemographic and selected clinical characteristics of the study patients (n=160)

Characteristic	Total patients; n (%)	Low risk of DF; n (%)	Moderate risk of DF; n (%)	High risk of DF; n (%)
Total	160	50	101	9
Age (years)				
<60	93 (58.1)	34 (68.0)	57 (56.4)	2 (22.2)
≥60	67 (41.9)	16 (32.0)	44 (43.6)	7 (77.8)
Sex				
Male	71 (44.4)	24 (48.0)	43 (42.6)	4 (44.4)
Female	89 (55.6)	26 (52.0)	58 (57.4)	5 (55.6)
Occupation				
Government officer	34 (21.2)	14 (28.0)	18 (17.8)	2 (22.2)
Self-employed	35 (21.9)	7 (14.0)	26 (25.7)	2 (22.2)
Unemployed	36 (22.5)	10 (20.0)	24 (23.8)	2 (22.2)
Agriculturist	27 (16.9)	4 (8.0)	20 (19.8)	3 (33.3)
Other	28 (17.5)	15 (30.0)	13 (12.9)	0 (0.0)
Current smoker				
No	113 (70.6)	40 (80.0)	66 (65.3)	7 (77.8)
Yes	47 (29.4)	10 (20.0)	35 (34.7)	2 (22.2)
Residence				
Rural	89 (55.6)	29 (58.0)	54 (53.5)	6 (66.7)
Urban	71 (44.4)	21 (42.0)	47 (46.5)	3 (33.3)
Body mass index (BMI)				
18.5 to 22.9	34 (21.2)	10 (20.0)	22 (21.8)	2 (22.2)
23.0 to 24.9	37 (23.1)	17 (34.0)	19 (18.8)	1 (11.1)
25.0 to 29.9	51 (31.9)	15 (30.0)	32 (31.7)	4 (44.4)
≥30	38 (23.8)	8 (16.0)	28 (27.7)	2 (22.2)
Duration of diabetes mellitus (years)				
<10	96 (60.0)	37 (74.0)	58 (57.4)	1 (11.1)
≥10	64 (40.0)	13 (26.0)	43 (42.6)	8 (88.9)

DF=diabetes foot; OR=odds ratio; CI=confidence interval

3.14, 95% CI 1.40 to 7.40, p=0.008), and diabetes retinopathy (adjust OR 11.90, 95% CI 3.44 to 50.00, p<0.001). The factors that negatively associated higher risk of diabetic foot ulcer were LDL less than 100 mh/dL (adjust OR 0.37, 95% CI 0.16 to 0.81, p=0.016), and some of self-care practices that included asking others to check blind areas of the foot (adjust OR 0.21, 95% CI 0.07 to 0.63, p=0.007, and foot exercise (adjusted OR 0.29, 95% CI 0.12 to 0.68, p=0.006) as shown in Table 3.

Discussion

There is a wide variation in the reported rates of diabetic foot. This can be explained on the basis of the different diagnostic criteria employed and study populations[9,12,13,16]. The population surveyed in the present study consisted of diabetic patients routinely attending the PCU in Songklanagarind Hospital, the largest tertiary care institute in Southern Thailand. The diabetic foot was not found in the present study period. Moderate and high risk of diabetic foot ulcer were 63.1% and 5.6%, respectively. The results of the present study might underestimate the prevalence of diabetic foot in Thai diabetic patients. The data collection was performed in the primary care setting where most patients did not have serious complication. Diabetic patients with complex medical complications, for example, type 1 DM, end stage renal disease, were referred to specialists including endocrinologists at the internal medicine department.

Importantly, the duration of DM was the statistically significant risk factor. There was high risk after 10 years of duration of diabetes (increased risk by 3.14 times, 95% CI 1.40 to 7.40 times increase, p=0.008). The result was in keeping with the other diabetic population studies in Suphanburi, Thailand, Bangkok, Thailand, and Ethiopia[13,17,18]. However, in the present research, HbA1C greater than 8 mg% or poor glycemic control was not associated with the stratified risk of developing diabetic foot ulcer.

Table 2. Factor associations with the stratified risk of developing diabetes foot ulcer

DM patients	Total patients	Low risk of DF	Moderate risk of DF	High risk of DF	p-value
Total	160	50	101	9	
Age (years); n (%)					0.032[0]
<60	93 (58.1)	34 (68.0)	57 (56.4)	2 (22.2)	
≥60	67 (41.9)	16 (32.0)	44 (43.6)	7 (77.8)	
Sex; n (%)					0.819[0]
Male	71 (44.4)	24 (48.0)	43 (42.6)	4 (44.4)	
Female	89 (55.6)	26 (52.0)	58 (57.4)	5 (55.6)	
Occupation; n (%)					0.029§
Government officer	34 (21.2)	14 (28.0)	18 (17.8)	2 (22.2)	
Self-employed	35 (21.9)	7 (14.0)	26 (25.7)	2 (22.2)	
Unemployed	36 (22.5)	10 (20.0)	24 (23.8)	2 (22.2)	
Agriculturists	27 (16.9)	4 (8.0)	20 (19.8)	3 (33.3)	
Others	28 (17.5)	15 (30.0)	13 (12.9)	0 (0.0)	
Current smoking; n (%)					0.158[0]
No	113 (70.6)	40 (80.0)	66 (65.3)	7 (77.8)	
Yes	47 (29.4)	10 (20.0)	35 (34.7)	2 (22.2)	
Hypertension (HT); n (%)					0.111[0]
No	40 (25.0)	16 (32.0)	24 (23.8)	0 (0.0)	
Yes	120 (75.0)	34 (68.0)	77 (76.2)	9 (100)	
Dyslipidemia (DLP); n (%)					0.431[0]
No	18 (11.2)	8 (16.0)	9 (8.9)	1 (11.1)	
Yes	142 (88.8)	42 (84.0)	92 (91.1)	8 (88.9)	
Cardiovascular disease (CVD); n (%)					0.273§
No	152 (95.0)	49 (98.0)	95 (94.1)	8 (88.9)	
Yes	8 (5.0)	1 (2.0)	6 (5.9)	1 (11.1)	
Peripheral arterial disease (PAD); n (%)					0.099§
No	158 (98.8)	50 (100)	100 (99.0)	8 (88.9)	
Yes	2 (1.2)	0 (0.0)	1 (1.0)	1 (11.1)	
Chronic kidney disease (CKD); n (%)					0.059§
No	153 (95.6)	49 (98.0)	97 (96)	7 (77.8)	
Yes	7 (4.4)	1 (2.0)	4 (4.0)	2 (22.2)	
Others; n (%)					0.216[0]
No	144 (90.0)	42 (84.0)	94 (93.1)	8 (88.9)	
Yes	16 (10.0)	8 (16.0)	7 (6.9)	1 (11.1)	
Address; n (%)					0.687[0]
Rural	89 (55.6)	29 (58.0)	54 (53.5)	6 (66.7)	
Urban	71 (44.4)	21 (42.0)	47 (46.5)	3 (33.3)	
Body mass index (BMI); n (%)					0.38§
18.5 to 22.9	34 (21.2)	10 (20.0)	22 (21.8)	2 (22.2)	
23.0 to 24.9	37 (23.1)	17 (34.0)	19 (18.8)	1 (11.1)	
25.0 to 29.9	51 (31.9)	15 (30.0)	32 (31.7)	4 (44.4)	
≥30	38 (23.8)	8 (16.0)	28 (27.7)	2 (22.2)	
Duration of diabetes mellitus; n (%)					0.001[0]
<10	96 (60.0)	37 (74.0)	58 (57.4)	1 (11.1)	
≥10	64 (40.0)	13 (26.0)	43 (42.6)	8 (88.9)	
Systolic blood pressure (SBP); median (IQR)	134.1 (15)	136 (128, 142.8)	132 (125, 140)	142 (139, 155)	0.114*
Diastolic blood pressure (DBP); mean [SD]	73.2 [10.2]	75 [9.9]	72.7 [10]	69.2 [13.3]	0.214+
Fasting blood sugar (FBS); n (%)					0.727§
>130	84 (52.5)	24 (48)	55 (54.5)	5 (55.6)	
≤130	76 (47.5)	26 (52)	46 (45.5)	4 (44.4)	
HbA1C; n (%)					0.459[0]
>8	40 (25.0)	15 (30.0)	22 (21.8)	3 (33.3)	
≤8	120 (75.0)	35 (70.0)	79 (78.2)	6 (66.7)	

DF=diabetes foot; IQR=interquartile range; SD=standard deviation

§ Fisher's exact test, [0] Chi-squared test, * Kruskal-Wallis test, + ANOVA F-test

Table 2. (continued)

DM patients	Total patients	Low risk of DF	Moderate risk of DF	High risk of DF	p-value
Total cholesterol; n (%)					0.068§
>240	4 (2.5)	2 (4.0)	1 (1.0)	1 (11.1)	
≤240	156 (97.5)	48 (96.0)	100 (99.0)	8 (88.9)	
Triglyceride (TG); n (%)					0.229[0]
>150	43 (26.9)	9 (18.0)	31 (30.7)	3 (33.3)	
≤150	117 (73.1)	41 (82.0)	70 (69.3)	6 (66.7)	
High-density lipoprotein (HDL); n (%)					0.355[0]
<40	21 (13.1)	4 (8.0)	15 (14.9)	2 (22.2)	
≥40	139 (86.9)	46 (92.0)	86 (85.1)	7 (77.8)	
Low-density lipoprotein (LDL); n (%)					0.191[0]
>100	68 (42.5)	16 (32.0)	48 (47.5)	4 (44.4)	
≤100	92 (57.5)	34 (68.0)	53 (52.5)	5 (55.6)	
Creatinine (Cr); median (IQR)	0.9 (0.3)	0.8 (0.7, 1.1)	0.9 (0.7, 1)	0.9 (0.8, 1.3)	0.349*
Drug; n (%)					0.601[0]
Without insulin use	138 (86.2)	45 (90)	85 (84.2)	8 (88.9)	
With insulin use	22 (13.8)	5 (10)	16 (15.8)	1 (11.1)	
History of ulcer; n (%)					<0.001[0]
No	142 (88.8)	50 (100)	87 (86.1)	5 (55.6)	
Yes	18 (11.2)	0 (0.0)	14 (13.9)	4 (44.4)	
History of amputation; n (%)					<0.001[0]
No	160 (100)	50 (100)	101 (100)	9 (100)	
Diabetic retinopathy (DR); n (%)					<0.001[0]
No	136 (85.0)	49 (98.0)	84 (83.2)	3 (33.3)	
Yes	24 (15.0)	1 (2.0)	17 (16.8)	6 (66.7)	
Diabetic nephropathy (DN); n (%)					<0.001[0]
No	140 (87.5)	47 (94.0)	89 (88.1)	4 (44.4)	
Yes	20 (12.5)	3 (6.0)	12 (11.9)	5 (55.6)	
Self-care practice; n (%)					
Daily evaluation by yourself (looked)					0.382[0]
• No	55 (34.4)	17 (34.0)	33 (32.7)	5 (55.6)	
• Yes	105 (65.6)	33 (66.0)	68 (67.3)	4 (44.4)	
Daily evaluation by yourself (palpated)					0.835[0]
• No	92 (57.5)	29 (58.0)	57 (56.4)	6 (66.7)	
• Yes	68 (42.5)	21 (42.0)	44 (43.6)	3 (33.3)	
Asking other to check feet at blind area					0.287[0]
• No	120 (75.0)	34 (68.0)	78 (77.2)	8 (88.9)	
• Yes	40 (25.0)	16 (32.0)	23 (22.8)	1 (11.1)	
Wipe the feet immediately after washing					0.206[0]
• No	60 (37.5)	22 (44.0)	33 (32.7)	5 (55.6)	
• Yes	100 (62.5)	28 (56.0)	68 (67.3)	4 (44.4)	
Using lotion for protect dry feet					0.613[0]
• No	110 (68.8)	32(64.0)	71 (70.3)	7 (77.8)	
• Yes	50 (31.2)	18(36.0)	30 (29.7)	2 (22.2)	
Washing feet after becoming dirty					1§
• No	8 (5.0)	3 (6.0)	5 (5.0)	0 (0.0)	
• Yes	152 (95.0)	47 (94.0)	96 (95.0)	9 (100)	
Rubbing feet by brush					0.554§
• No	74 (46.2)	20 (40.0)	49 (48.5)	5 (55.6)	
• Yes	86 (53.8)	30 (60.0)	52 (51.5)	4 (44.4)	
Foot exercise					0.033§
• No	79 (49.4)	18 (36.0)	54 (53.5)	7 (77.8)	
• Yes	81 (50.6)	32 (64.0)	47 (46.5)	2 (22.2)	

DF=diabetes foot; IQR=interquartile range; SD=standard deviation

§ Fisher's exact test, [0] Chi-squared test, * Kruskal-Wallis test, + ANOVA F-test

Table 3. Multiple ordinal logistic regression analysis for the prevalence of the stratified risk of developing diabetic foot (DF) ulcer and related factors

Variable	Low risk of DF; n (%)	Moderate risk of DF; n (%)	High risk of DF; n (%)	Ordinal OR (95% CI)	p-value
Occupation					
Government officer	14 (28.0)	18 (17.8)	2 (22.2)	-	
Self-employed	7 (14.0)	26 (25.7)	2 (22.2)	5.19(1.53 to 18.91)	0.001
Unemployed	10 (20.0)	24 (23.8)	2 (22.2)	2.66(0.85 to 8.74)	0.101
Agriculturist	4 (8.0)	20 (19.8)	3 (33.3)	4.82(1.38 to 18.44)	0.018
Other	15 (30.0)	13 (12.9)	0 (0)	0.35(0.10 to 1.19)	0.099
Peripheral arterial disease					
No	50 (100)	100 (99.0)	8 (88.9)	-	
Yes	0 (0.0)	1 (1.0)	1 (11.1)	27.27(0.81 to 972.06)	0.047
Chronic kidney disease					
No	49 (98.0)	97 (96.0)	7 (77.8)	-	
Yes	1 (2.0)	4 (4.0)	2 (22.2)	18.17 (2.46 to 131.32)	0.004
HbA1C					
>8	15 (30.0)	22 (21.8)	3 (33.3)	-	
≤8	35 (70.0)	79 (78.2)	6 (66.7)	1.90 (0.79 to 4.66)	0.156
Duration of diabetes mellitus					
<10	37 (74.0)	58 (57.4)	1 (11.1)	-	
≥10	13 (26.0)	43 (42.6)	8 (88.9)	3.14 (1.40 to 7.40)	0.008
Low-density lipoprotein					
>100	16 (32.0)	48 (47.5)	4 (44.4)	-	
≤100	34 (68.0)	53 (52.5)	5 (55.6)	0.37 (0.16 to 0.81)	0.016
Diabetic retinopathy					
No	49 (98.0)	84 (83.2)	3 (33.3)	-	
Yes	1 (2.0)	17 (16.8)	6 (66.7)	11.90 (3.44 to 50.00)	<0.001
Daily evaluation (palpated)					
No	29 (58.0)	57 (56.4)	6 (66.7)	-	
Yes	21 (42.0)	44 (43.6)	3 (33.3)	2.18 (0.82 to 6.05)	0.125
Asking another to check feet at blind areas					
No	34 (68.0)	78 (77.2)	8 (88.9)	-	
Yes	16 (32.0)	23 (22.8)	1 (11.1)	0.21 (0.07 to 0.63)	0.007
Wipe the feet immediately after washing					
No	22 (44.0)	33 (32.7)	5 (55.6)	-	
Yes	28 (56.0)	68 (67.3)	4 (44.4)	2.14 (0.91 to 5.17)	0.088
Using lotion to protect dry feet					
No	32 (64.0)	71 (70.3)	7 (77.8)		
Yes	18 (36.0)	30 (29.7)	2 (22.2)	0.48(0.19 to 1.16)	0.107
Foot exercise					
No	18 (36.0)	54 (53.5)	7 (77.8)	-	
Yes	32 (64.0)	47 (46.5)	2 (22.2)	0.29 (0.12 to 0.68)	0.006

DF=diabetes foot; OR=odds ratio; CI=confidence interval

While this outcome is the same as some study[19,20], it is not consistent with other studies[13,17]. Therefore, the HbA1C is not an ideal test to readily predict diabetic foot ulcers in patients with type 2 DM[20].

Those diabetic patients who were self-employed and agriculturists were 5.19 times (95% CI 1.53 to 18.91 times increase, p=0.001), and 4.82 times (95% CI 1.38 to 18.44 times increase, p=0.018), respectively, more likely to develop diabetic foot ulcer than diabetic patients who were government officers. This finding was in line with the studies conducted in Suphanburi and Bangkok, Thailand, and Ethiopia[13,17,18]. Most agriculturists spent their time in farm areas or outdoors, either using boots that had a

hard tread, or not wear shoes while they are working. This may make the person more likely to get blisters on their feet. Another possible explanation might be that agriculturists had poorer awareness about personal hygiene and foot self-care practice, which could increase the risk of foot ulcer.

Having PAD or CKD were the other main variables that had strong associations with diabetic foot. Diabetic foot patients who had PAD or CKD were 27.27 and 18.17 times, respectively, more likely to develop diabetic foot compared to the diabetic patients with normal levels. The present study result is consistent with the studies conducted in Tanzania, and Pakistan[9,21].

In the present study, the overall prevalence of diabetic peripheral neuropathy in diabetes retinopathy patients was significantly higher than in patients without diabetes retinopathy, as has also been reported in a systematic review and a meta-analysis[11,22]. Retinopathy is the result of microvascular complications. The impairment of microcirculation in type 2 DM may lead to secondary complications in the lower extremities due to dysfunctional vasodilation. Furthermore, diabetic foot ulcer patients with retinopathy have higher levels of diabetic biomarkers such as ceruloplasmin, which could explain the link between diabetic foot ulcer and retinopathy.

Evidence from various studies done in Singapore, Ethiopia, India, and multi-center studies from four continents that include Asia, Africa, Europe, and South America[12,16,23,24] has suggested that an elevated LDL cholesterol (LDL-C) level greater than 130 mg/dL can increase the risk of DM foot ulcer. These studies concluded that patients with higher levels of LDL-C have higher risk of developing diabetic foot ulcer. LDL-C transports fats or lipids, to the arteries which in turn lead to arthrosclerosis in the arteries, which increases the risk of vascular complications.

The present study also found that patients with poor foot self-care practices, especially inadequate use of protective footwear, were more likely to develop foot ulcers. Diabetic patients who had not practiced adequate foot self-care were four times more likely to develop diabetic foot ulcers than those who had practiced good foot self-care. This finding is similar to the studies conducted in Pattalung and Suphanburi, Thailand, Ethiopia, and India[18,24-26]. Practicing good foot self-care could reduce the development of diabetic foot ulcers, including practices such as asking another person to check the feet for blind areas, drying one's feet immediately after washing, and getting adequate foot exercise. These recommendations underline the importance of education on caring for insensate feet to prevent minor trauma, which is a significant factor in the development of foot ulcers.

The clinical importance of the present study is that it provides information for health care providers and DM patients of the factors associated with the risk of diabetic foot ulcer, and to help improve efforts to prevent this serious complication.

Strength

The strength of the present study is that this was the first study performed to determine the prevalence of diabetic foot ulcer in patients as defined by the guidelines of the Diabetes Association of Thailand issued in 2017 with three risk groups to evaluate the factors associated with diabetic foot, which can help health care providers and DM patients made conscious about these factors.

Limitation

As a cross-sectional study set in the PCU at Songklanagarind Hospital, there were potential confounders that the researchers could not collect the data such as comorbidities, diabetes nephropathy, and the severe cases that had been referred to the Internal Medicine Department. The study collected data from the PCU only, which might limit the generalizability of the study.

Conclusion

In the present study, diabetes foot ulcer among type 2 DM patients at the PCU of Songklanagarind Hospital was not found. Of the patient studied, 31.3%, 63.1%, and 5.6% had low, medium, and high risk of diabetic foot, respectively. The statistically significant factors associated with diabetes foot were occupation as self-employed or agriculturists, CKD, longer duration of type 2 DM, high LDL greater than 100 mg/dL, DR, and lack of self-care behavior, mainly daily evaluation and foot exercise.

In light of these findings, health care providers in the PCU should provide targeted interventions for type 2 DM patients with diabetes retinopathy, PAD, dyslipidemia, and lack of self-care practice.

What is already known on this topic?

Rates of diabetic foot has been reported with a wide range of prevalence due to the basis of the different diagnostic criteria employed, timing, and study populations.

What this study adds?

This study determined the prevalence and the factor associated with increasing diabetic foot risk that occurred in PCU.

The results of this study aid in the knowledge of the factor related to increasing risk of diabetic foot in Thai population, which were occupation, some health condition including CKD, longer duration of type 2 DM, and some complication of DM, and lack of self-care behavior.

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Conflicts of interest

The authors declare no conflict of interest.

References

1. World Health Organization. Diabetes [Internet]. 2020 [cited 2020 Oct 20]. Available from: https://www.who.int/westernpacific/health-topics/diabetes.
2. World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications: report of a WHO consultation. Part 1, Diagnosis and classification of diabetes mellitus [Internet]. 1999 [cited 2020 Oct 19]. Available from: https://apps.who.int/iris/handle/10665/66040.
3. International Diabetes Federation. IDF diabetes atlas [Internet]. 9th edition. 2019 [cited 2020 Oct 19]. Available from: https://www.diabetesatlas.org/en/.
4. Diabetes Association of Thailand. Clinical practice guideline for diabetes 2017 [Internet]. 2017 [cited 2020 Oct 20]. Available from: https://www.dmthai.org/new/index.php/sara-khwam-ru/bukhlakr-thangkar-phaethy/cpg/clinical-practice-2017.
5. Johannesson A, Larsson GU, Ramstrand N, Turkiewicz A, Wiréhn AB, Atroshi I. Incidence of lower-limb amputation in the diabetic and nondiabetic general population: a 10-year population-based cohort study of initial unilateral and contralateral amputations and reamputations. Diabetes Care 2009;32:275-80.
6. Moulik PK, Mtonga R, Gill GV. Amputation and mortality in new-onset diabetic foot ulcers stratified by etiology. Diabetes Care 2003;26:491-4.
7. Thirapatarapong W, Srisawasdi G. Epidemiology and direct cost of diabetes-related lower extremity amputations at Siriraj hospital. J Thai Rehabil Med 2008;18:65-9.
8. Ragnarson Tennvall G, Apelqvist J. Health-related quality of life in patients with diabetes mellitus and foot ulcers. J Diabetes Complications 2000;14:235-41.
9. Khan A, Junaid N. Prevalence of diabetic foot syndrome amongst population with type 2 diabetes in Pakistan in primary care settings. J Pak Med Assoc 2017;67:1818-24.
10. Boyko EJ, Ahroni JH, Stensel V, Forsberg RC, Davignon DR, Smith DG. A prospective study of risk factors for diabetic foot ulcer. The Seattle Diabetic Foot Study. Diabetes Care 1999;22:1036-42.
11. Valk GD, Kriegsman DM, Assendelft WJ. Patient education for preventing diabetic foot ulceration. A systematic review. Endocrinol Metab Clin North Am 2002;31:633-58.
12. Litwak L, Goh SY, Hussein Z, Malek R, Prusty V, Khamseh ME. Prevalence of diabetes complications in people with type 2 diabetes mellitus and its association with baseline characteristics in the multinational A1chieve study. Diabetol Metab Syndr 2013;5:57.
13. Laotaveerungrueng N, Wanthong S, Wannachalee T, Lertwattanarak R. Prevalence of chronic microvascular complications and diabetic foot problems in patients with diabetes mellitus at Siriraj Hospital. J Med Assoc Thai 2018;101:1349-55.
14. Boulton AJ, Kirsner RS, Vileikyte L. Clinical practice. Neuropathic diabetic foot ulcers. N Engl J Med 2004;351:48-55.
15. Sankote R, Mato L, Amatachaya S. Development of a foot care behavior scale for type 2 diabetes patients with peripheral neuropathy. J Nurs Health Care 2015;33:74-83.
16. Agrawal RP, Ola V, Bishnoi P, Gothwal S, Sirohi P, Agrawal R. Prevalence of micro and macrovascular complications and their risk factors in type-2 diabetes mellitus. J Assoc Physicians India 2014;62:504-8.
17. Mariam TG, Alemayehu A, Tesfaye E, Mequannt W, Temesgen K, Yetwale F, et al. Prevalence of diabetic foot ulcer and associated factors among adult diabetic patients who attend the diabetic follow-up clinic at the University of Gondar Referral Hospital, North West Ethiopia, 2016: Institutional-based cross-sectional study. J Diabetes Res 2017;2017:2879249.
18. Seelacharoen N. Relative factors for diabetic foot ulcers patients in diabetic mellitus type2 in Doembangnangbuat district, Suphanburi province. Bull Dept Med Serv 2017;42:85-95.
19. Bich TT, Thosingha O, Puwarawuttipanit W. Factors related to diabetic foot ulcers in persons with type 2 diabetes. Nurs Sci J Thai 2017;35:13-21.
20. Moodley RM, D'Almeida SS, Lameko V, Ghimire S. Novel relationship between hemoglobin A1c levels and foot ulcer development among patients with type 2 diabetes mellitus admitted at Tupua Tamasese Meaole Hospital. Cureus 2021;13:e20054.
21. Chiwanga FS, Njelekela MA. Diabetic foot: prevalence, knowledge, and foot self-care practices among diabetic patients in Dar es Salaam, Tanzania - a

cross-sectional study. J Foot Ankle Res 2015;8:20.
22. Lauterbach S, Kostev K, Kohlmann T. Prevalence of diabetic foot syndrome and its risk factors in the UK. J Wound Care 2010;19:333-7.
23. Lekshmi Narayanan RM, Koh WP, Phang J, Subramaniam T. Peripheral arterial disease in community-based patients with diabetes in Singapore: Results from a Primary Healthcare Study. Ann Acad Med Singap 2010;39:525-7.
24. Fekadu H, editor Incidence and determinants for vascular complications among type II diabetes mellitus patients in University of Gondar Referral Hospital: A retrospective follow-up study [Internet]. 2017 [cited 2020 Oct 19]. Available from: https://core.ac.uk/download/199938820.pdf.
25. Chandalia HB, Singh D, Kapoor V, Chandalia SH, Lamba PS. Footwear and foot care knowledge as risk factors for foot problems in Indian diabetics. Int J Diabetes Dev Ctries 2008;28:109-13.
26. Tongkham N, Tayakkanon K. Prevalence of diabetic foot and prevalence of risk factors of diabetic foot in diabetic mellitus patients in Makree, Tamod district, Pattalung province [Dissertation]. Songkhla: Prince of Songkla University; 2015.