Prevalence and related factors of peripheral arterial disease in diabetes mellitus inpatients: a cross-sectional study in China

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Abstract. Peripheral arterial disease (PAD) can result in diabetic foot ulcers, gangrene, and even amputation. Since most cases of PAD in diabetic patients are associated with peripheral neuropathy, the symptoms of vascular disease are easily concealed by the symptoms of neuropathy and are ignored by people, so it is critical for health care providers to screen PAD for the diabetes patients. This study was carried out to identify the prevalence and related factors of PAD in diabetes mellitus inpatients. This was a cross-sectional observational study. A total of 855 patients were enrolled in the study from December 2018 to December 2019. The patients were divided into a non-PAD group (ABI = 0.9–1.3) and a PAD group (ABI <0.9). Logistic multivariate regression analysis showed that age, LDL-C, dorsalis pedis artery pulsation (left foot), and sensory-current threshold (right foot) were related factors for peripheral arterial disease. Patients who are older and have a higher LDL-C level, abnormal dorsal foot pulse, and abnormal sensory-current threshold must be vigilant, and receive early screening for PAD diagnosis and treatment to avoid a malignant outcome. In clinical work, medical staff should actively apply PAD screening to diabetic patients, identify risk factors as early as possible, conduct early interventions, reduce the risk of PAD in patients, and avoid the occurrence of adverse outcomes.

Key words: Diabetes, Peripheral vascular disease, Related factors

THE ONGOING acceleration of the aging process and changes in eating habits and lifestyle in the population are resulting in increases in the incidence, disability, and mortality rates of diabetes, which has seriously affected public health. Diabetes incidence has nearly tripled worldwide over the last 3 decades [1]. In 2019, there were approximately 463 million diabetics worldwide, accounting for 9.3% of adults (20–79 years), with China having the largest diabetics population (116 million) [2]. Peripheral arterial disease (PAD) is one of the most serious chronic complications of diabetes, and it can be a major risk for diabetic foot ulcers, gangrene, and even amputation [3]. PAD is two to threefold more likely to develop in diabetic than nondiabetic patients [4]. However, PAD is a complication that is often ignored by medical workers during its early stages. Most diabetic patients with PAD have diabetic peripheral neuropathy (DPN), and therefore lack the clinical symptoms of PAD, which are typically not found until symptoms such as intermittent claudication, rest pain, and ischemic gangrene appear. The difficulties of current treatments result in great pain among patients but also increase the economic burden [3, 5]. PAD often coexists with arterial thrombotic diseases such as coronary artery and cerebrovascular diseases. In addition to inducing lower limb ischemic ulcers, gangrene, and amputation, PAD also increases the risk of cardiovascular events and mortality [6, 7]. It is therefore very important for health care workers to conduct routine PAD screening for diabetes patients.

The ankle-brachial index (ABI) is one of the most common indicators used in PAD diagnosis. Examining limbs with a Doppler ultrasound machine reveals the value of this indicator, and is the most simple and objective noninvasive method for PAD clinical diagnosis [8,
An ABI examination is also cheap, rapid, repeatable, and easily accepted by patients, making it the most popular and acceptable method in clinical practice. When the ABI threshold is 0.9, the positive predictive value of diagnosing PAD is 90%, the negative predictive value is 99%, and the total accuracy is 98%, according to a consensus provided by Chinese experts in the diagnosis and treatment of arterial disease of lower extremities [10]. A literature research revealed that for ABI ≤0.9, the sensitivity and specificity of diagnosing PAD are 100% and 95%, respectively [11].

Elucidating the risk factors of PAD is helpful for screening high-risk populations and early detection of patient’s lower extremity arterial vascular disease. Early diagnosis can be promptly given corresponding treatment, which can reduce the rate of amputation and improve the quality of life and prognosis of patients. The independent factors associated with PAD in type 2 diabetic patients have been investigated. Cardoso et al. have reported that increased carotid intima-media thickness and aortic stiffness were independent factors associated with PAD in type 2 diabetic patients [12]. Bertrand et al. demonstrate that HDL-cholesterol, ApoA-I, total cholesterol/HDL-cholesterol ratio or non-HDL-cholesterol were independent factors associated with PAD in patients with type 2 diabetes [13]. Fasting plasma glucose, hemoglobin A(1c), homocysteine levels, age, duration of diabetes, hypertension, cigarette smoking, serum creatinine, estimated glomerular filtration rate, and urinary albumin-creatinine ratio history of myocardial infarction and stroke have been also reported to be associated with PAD [14-17].

On the other hand, calluses and abnormal sensations are related to foot ulcers and diabetic feet in diabetic patients [18]. However, the relationship between foot screening data and diabetic PAD is still largely known. This study aimed to investigate the prevalence of PAD and its associated factors in Chinese hospitalized diabetic patients.

Materials and Methods

Study population

This study was a prospective cross-sectional observational study. Patients selected for this study were enrolled in the First Affiliated Hospital of Jinan University in Guangzhou, China from December 2018 to December 2019. The inclusion criteria were as follows: 1) diabetes diagnosed according to criteria from the World Health Organization in 1999; 2) free movement of limbs, with muscle strength reaching grade 4 or above (ability to partially or completely resist resistance); 3) good cognitive ability and cooperative with examinations; and 4) voluntary participation in the study. The exclusion criteria were as follows: 1) gestational diabetes mellitus or other special types of diabetes; 2) diabetes mellitus with acute complications (e.g., diabetic ketoacidosis and hyperosmotic states); 3) complicated with major organ dysfunction; 4) inability to take care of oneself due to vision impairment; 5) unable to cooperate due to mental illness; or 6) with type I diabetes. This study was approved by the institutional review board of the First Affiliated Hospital of Jinan University (approval no. KYk-2021-002). The study strictly followed the principles of the Declaration of Helsinki, with each participant giving written informed consent.

Demographic and clinical data

Demographic and clinical data of all patients were collected by trained researchers, including sex, age, disease duration, education level, marital status, use of hypoglycemic drugs, family history, smoking history, drinking history, body mass index, diabetic retinopathy, nephropathy, DPN, and diabetic foot. Diabetic retinopathy, nephropathy, and DPN, and diabetic foot were diagnosed in accordance with the 2017 edition of the Chinese guidelines for the prevention and treatment of type 2 diabetes.

Laboratory data

All patients were required to fast for more than 8 hours, and fasting venous blood was collected at 7 am the next morning. Detection of fasting blood glucose, triglyceride, cholesterol, high-density lipoprotein cholesterol, low density lipoprotein-cholesterol were done using a fully automated biochemical analyzer (Model 7600 Series, Hitachi, Tokyo, Japan). The glycated hemoglobin was detected by high-performance liquid chromatography (D-10 kit, Bio-Rad, USA).

Foot screening data

Foot screening was carried out by professionally trained medical staff, and was conducted in a quiet environment. All patients were instructed to close their eyes during the examination. Screening items included foot calluses, abnormal sensation (numbness or pain), temperature discrimination, sensation of vibration, sensation of touch, dorsalis pedis artery pulsation, posterior tibial artery pulsation, sensory nerve conduction threshold, and vibration sensory threshold. Specific screening methods were derived from literature [19].

ABI determination

ABI is the ratio of the systolic blood pressure of the ankle artery (posterior-tibial or dorsal-foot artery) to the ipsilateral brachial artery [20]. All patients in this study
had ABI tested by professionally trained medical staff, and the pressures in the bilateral upper limb brachial artery, lower limb dorsalis pedis artery, and posterior tibial artery were measured using an ultrasonic Doppler blood flow detector (VistaAVS, Summit Doppler Systems, USA). According to the standards of the American Diabetes Association, ABI > 1.3 indicates that significant arterial calcification is present, 0.9 ≤ ABI ≤ 1.3 indicates that it is within the normal range, and PAD can be diagnosed when ABI < 0.9 [21].

Statistical analysis
A database was established using SPSS software (version 22.0) and was analyzed statistically. Measurement data that conformed to a normal distribution were described using mean ± SD values, and pairs of independent samples were analyzed using t-tests. Count data were described by frequency and percentage values, and analyzed using chi-square test. ABI > 1.3 indicates that it is within the normal range, and PAD can be diagnosed when ABI < 0.9 [21].

Results
Comparison of clinical characteristics between the PAD and non-PAD groups
This study excluded 46 patients with ABI > 1.3 and 32 patients with type 1 diabetes, and the remaining 855 patients comprised 457 males (53.5%) and 398 females (46.5%). They were aged 59.32 ± 13.76 years and had a disease duration of 8.28 ± 7.25 years. The PAD group comprised 71 (8.3%) cases, and the non-PAD group had 784 (91.7%) cases. Compared with the non-PAD group, the PAD group tended to be older, and have a longer diabetes duration (Table 1). There were no significant inter-group differences in sex, marital status, type of diabetes, use of hypoglycemic drugs, family history, smoking history, drinking history, body mass index, fasting blood glucose, glycosylated hemoglobin, triglyceride, cholesterol, high-density lipoprotein cholesterol, or low density lipoprotein cholesterol (Table 1).

Comparison of foot screening results between the PAD and non-PAD groups
The foot screening results are compared between the PAD and non-PAD groups in Table 2. Significant differences between the two groups were found for abnormal sensation (numbness or pain of both feet), abnormal temperature sensation (right foot), abnormal vibration sensation from a tuning fork (both feet), abnormal pressure sensation from a nylon filament (both feet), abnormal pulsation of the dorsalis pedis artery (both feet), abnormal pulsation of the posterior tibial artery (both feet), abnormal sensory-current threshold (both feet), abnormal threshold of vibration sensation (both feet), and ABI (both feet). However, there were no significant differences between the two groups for foot calluses (both feet) or abnormal temperature perception (left foot).

Comparison of complication incidence between the PAD and non-PAD groups
The incidence of complications is compared between the two groups in Table 3. The incidence rates of DPN and diabetic foot were higher in the PAD group than in the non-PAD group, whereas the incidence rates of retinopathy and diabetic nephropathy did not differ significantly between the two groups. Of the 39 PAD patients who without symptoms (numbness or pain), 17 (43.6%) had DPN.

Logistic regression analysis of factors related to PAD pathogenesis
Logistic multivariate regression analysis was performed using PAD incidence as the dependent variable and the statistically significant parameters in Tables 1, 2, and 3 as independent variables. The results indicated that age, LDL-C level, dorsalis pedis artery pulsation (left foot), and sensory-current threshold (right foot) were related factors for peripheral arterial disease. (Table 4).

Discussion
In this study, we investigated the prevalence of PAD and its associated factors in Chinese hospitalized diabetic patients. The results showed that the prevalence of PAD was 8.3% (71/855). Logistic multivariate regression analysis showed that older age, LDL-C levels, dorsalis pedis artery pulsation (left foot), and sensory-current threshold (right foot) were the independent factors associated with PAD in hospitalized diabetic patients.

The incidence of diabetic PAD has varied between studies. The reported prevalence of PAD ranged from 7.6% to 36% in different regions of India [4, 22, 23], 8.8% in France [13], 23.1% in Saudi Arabia [14], 35.6% in Nigeria [24], 10.4% in Singapore [16]. The PAD prevalence rate in Chinese type 2 diabetes patients older than 50 years was reported to be 21.2%, of which 10.6% were previously diagnosed and 11.8% were newly diagnosed.
with a missed diagnosis rate of 55.7% [25]. In this study, the PAD prevalence was 8.3%. The discrepancy may be due to the differences in the populations and PAD detection methods among studies.

In the present study, 82.9% of diabetic patients were hospitalized in nonendocrine departments, with some diabetic patients choosing to see a doctor in the outpatient clinic. This hospital tends to only screen PAD for diabetes patients in the endocrine department, while most patients in nonendocrine departments and outpatient clinics are not screened for PAD, suggesting that the reported PAD prevalence rate is lower than the actual prevalence rate. Research results have also indicated that 56.3% of the PAD-group patients had no clinical symptoms, with combined DPN accounting for 56.3% of cases, which may be significant. Most diabetic PAD cases are associated with DPN, resulting in peripheral vascular disease symptoms being either ignored or hidden [3, 5]. Early diagnosis and intervention of PAD therefore needs to be prioritized, and more attention

### Table 1: Comparison of clinical characteristics between PAD and non-PAD groups

| Variables                          | Total (N = 855) (%) | PAD (N = 71) (%) | Non-PAD (N = 784) (%) | t/χ² | p value |
|-----------------------------------|---------------------|-----------------|-----------------------|------|---------|
| Sex                               |                     |                 |                       |      |         |
| Male                              | 457 (53.45)         | 33 (46.48)      | 424 (54.08)           | 1.512| 0.219   |
| Female                            | 398 (46.55)         | 38 (53.52)      | 360 (45.92)           |      |         |
| Age (years)                       | 59.32 ± 13.76       | 69.24 ± 13.71   | 58.42 ± 13.41         | 6.496| <0.001  |
| Course of disease (years)         | 8.28 ± 7.25         | 12.72 ± 8.62    | 7.88 ± 6.98           | 5.471| <0.001  |
| Educational level                 |                     |                 |                       | 5.690| 0.058   |
| Primary school and below          | 308 (36.02)         | 33 (46.48)      | 275 (35.08)           |      |         |
| Secondary school                  | 339 (39.65)         | 28 (39.44)      | 311 (39.67)           |      |         |
| Junior College and above          | 208 (24.33)         | 10 (14.08)      | 198 (25.26)           |      |         |
| Marriage                          |                     |                 |                       |      |         |
| Single                            | 14 (1.64)           | 2 (2.82)        | 12 (1.53)             | 0.669| 0.326   |
| Married                           | 841 (98.36)         | 69 (97.18)      | 772 (98.47)           |      |         |
| The glucose solution              |                     |                 |                       |      |         |
| No                                | 113 (13.22)         | 6 (8.45)        | 107 (13.65)           | 5.205| 0.157   |
| Oral medicine                     | 465 (54.39)         | 34 (47.89)      | 431 (54.97)           |      |         |
| Insulin injection                 | 62 (7.25)           | 6 (8.45)        | 56 (7.14)             |      |         |
| Oral medicine and Insulin injection | 215 (25.15)       | 25 (35.21)      | 190 (24.23)           |      |         |
| Family history                    |                     |                 |                       |      |         |
| No                                | 621 (72.63)         | 46 (64.79)      | 575 (73.34)           | 2.396| 0.122   |
| Yes                               | 234 (27.37)         | 25 (35.21)      | 209 (26.66)           |      |         |
| Smoking history                   |                     |                 |                       |      |         |
| No                                | 674 (78.83)         | 60 (84.51)      | 614 (78.32)           | 1.495| 0.221   |
| Yes                               | 181 (21.17)         | 15 (15.49)      | 166 (21.68)           |      |         |
| Drinking history                  |                     |                 |                       |      |         |
| No                                | 780 (91.23)         | 66 (92.96)      | 714 (91.07)           | 0.289| 0.591   |
| Yes                               | 75 (8.77)           | 5 (7.04)        | 70 (8.93)             |      |         |
| BMI (kg/m²)                       | 24.76 ± 3.85        | 23.99 ± 4.01    | 24.83 ± 3.83          | 1.775| 0.076   |
| FBG (mmol/L)                      | 8.89 ± 4.65         | 8.48 ± 4.27     | 8.93 ± 4.68           | 0.788| 0.431   |
| HbA1c (%)                         | 9.36 ± 2.69         | 9.03 ± 2.53     | 9.39 ± 2.70           | 1.081| 0.280   |
| TC (mmol/L)                       | 2.02 ± 2.21         | 1.89 ± 1.46     | 2.04 ± 2.27           | 0.549| 0.583   |
| TG (mmol/L)                       | 4.81 ± 1.36         | 4.97 ± 1.46     | 4.79 ± 1.35           | 1.049| 0.295   |
| HDL-C (mmol/L)                    | 1.02 ± 0.36         | 1.07 ± 0.74     | 1.01 ± 0.30           | 1.179| 0.239   |
| LDL-C (mmol/L)                    | 2.78 ± 0.93         | 2.98 ± 1.05     | 2.76 ± 0.92           | 1.935| 0.053   |

PAD, peripheral arterial disease; BMI, body mass index; FBG, fasting plasma glucose; HbA1c, hemoglobin A1c; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol.
| Variables                                      | Total (N = 855) (%) | PAD (N = 71) (%) | Non-PAD (N = 784) (%) | $\chi^2$ | p value |
|-----------------------------------------------|---------------------|------------------|-----------------------|----------|---------|
| Callus of foot (left)                        |                     |                  |                       |          |         |
| No                                            | 836 (97.78)         | 69 (97.18)       | 767 (97.83)           | 0.126    | 0.667   |
| Yes                                           | 19 (2.22)           | 2 (2.82)         | 17 (2.17)             |          |         |
| Callus of foot (right)                       |                     |                  |                       |          |         |
| No                                            | 770 (98.21)         | 70 (98.59)       | 840 (98.25)           | 0        | 1.000   |
| Yes                                           | 14 (1.79)           | 1 (1.41)         | 15 (1.75)             |          |         |
| Abnormal sensation (left)                    |                     |                  |                       |          |         |
| No                                            | 639 (74.74)         | 40 (56.34)       | 599 (76.40)           | 14.960   | 0.001   |
| Numbness                                      | 193 (22.57)         | 25 (35.21)       | 168 (21.43)           |          |         |
| Pain                                          | 23 (2.69)           | 6 (8.45)         | 17 (2.17)             |          |         |
| Abnormal sensation (right)                   |                     |                  |                       |          |         |
| No                                            | 639 (74.74)         | 39 (54.93)       | 600 (76.53)           | 16.635   | <0.001  |
| Numbness                                      | 193 (22.57)         | 26 (36.62)       | 167 (21.30)           |          |         |
| Pain                                          | 23 (2.69)           | 6 (8.45)         | 17 (2.17)             |          |         |
| Sense of temperature (left)                  |                     |                  |                       |          |         |
| Normal                                        | 756 (88.42)         | 58 (81.69)       | 698 (89.03)           | 3.426    | 0.064   |
| Abnormal                                      | 99 (11.58)          | 13 (18.31)       | 86 (10.97)            |          |         |
| Sense of temperature (right)                 |                     |                  |                       |          |         |
| Normal                                        | 757 (88.54)         | 56 (78.87)       | 701 (89.41)           | 7.127    | 0.008   |
| Abnormal                                      | 98 (11.46)          | 15 (21.13)       | 83 (10.59)            |          |         |
| Tuning fork vibration sensation (left)       |                     |                  |                       |          |         |
| Normal                                        | 765 (89.47)         | 53 (74.65)       | 712 (90.82)           | 18.071   | <0.001  |
| Abnormal                                      | 90 (10.53)          | 18 (25.35)       | 72 (9.18)             |          |         |
| Tuning fork vibration sensation (right)      |                     |                  |                       |          |         |
| Normal                                        | 770 (90.06)         | 55 (77.46)       | 715 (91.20)           | 13.716   | <0.001  |
| Abnormal                                      | 85 (9.94)           | 16 (22.54)       | 69 (8.80)             |          |         |
| Nylon pressure sense (left)                  |                     |                  |                       |          |         |
| Normal                                        | 772 (90.29)         | 52 (73.24)       | 720 (91.84)           | 25.689   | <0.001  |
| Abnormal                                      | 83 (9.71)           | 19 (26.76)       | 64 (8.16)             |          |         |
| Nylon pressure sense (right)                 |                     |                  |                       |          |         |
| Normal                                        | 770 (90.06)         | 53 (74.65)       | 717 (91.45)           | 20.539   | <0.001  |
| Abnormal                                      | 85 (9.94)           | 18 (25.35)       | 67 (8.55)             |          |         |
| Touch of dorsalis pedis tibial artery (left) |                     |                  |                       |          |         |
| Normal                                        | 768 (89.82)         | 47 (66.20)       | 721 (91.96)           | 47.292   | <0.001  |
| Abnormal                                      | 87 (10.18)          | 24 (33.80)       | 63 (8.04)             |          |         |
| Touch of dorsalis pedis tibial artery (right) |                     |                  |                       |          |         |
| Normal                                        | 768 (89.82)         | 48 (67.61)       | 720 (91.84)           | 41.822   | <0.001  |
| Abnormal                                      | 87 (10.18)          | 23 (32.39)       | 64 (8.16)             |          |         |
| Touch of posterior tibial artery (left)       |                     |                  |                       |          |         |
| Normal                                        | 698 (81.64)         | 40 (56.34)       | 658 (83.93)           | 33.060   | <0.001  |
| Abnormal                                      | 157 (18.36)         | 31 (43.66)       | 126 (16.07)           |          |         |
| Touch of posterior tibial artery (right)      |                     |                  |                       |          |         |
| Normal                                        | 700 (81.87)         | 42 (59.15)       | 658 (83.93)           | 29.278   | <0.001  |
| Abnormal                                      | 155 (18.13)         | 29 (40.85)       | 126 (16.07)           |          |         |
| Sensory nerve conduction threshold (left)     | 3.19 ± 4.07         | 5.26 ± 4.68      | 3.00 ± 3.96           | 4.532    | <0.001  |
| Sensory nerve conduction threshold (right)    | 3.18 ± 4.07         | 5.32 ± 4.73      | 2.98 ± 3.95           | 4.702    | <0.001  |
| Vibration sensation threshold (left) (V)      | 17.10 ± 12.27       | 24.32 ± 15.96    | 16.45 ± 11.68         | 5.252    | <0.001  |
| Vibration sensation threshold (right) (V)     | 17.70 ± 12.55       | 23.92 ± 15.59    | 17.14 ± 12.09         | 4.405    | <0.001  |
| ABI (left)                                    | 1.11 ± 0.12 (median 1.13) | 0.82 ± 0.17 (median 0.84) | 1.13 ± 0.08 (median 1.14) | 29.278   | <0.001  |
| ABI (right)                                   | 1.10 ± 0.13 (median 1.12) | 0.81 ± 0.19 (median 0.81) | 1.13 ± 0.08 (median 1.13) | 26.949   | <0.001  |

PAD, peripheral arterial disease.
should be given to asymptomatic patients in order to reduce the missed diagnosis rate of PAD.

In this study, the mean age was significantly higher in the PAD group than in the non-PAD groups (69.24 ± 13.71 vs. 58.42 ± 13.41 years). Multivariate logistic regression analysis indicated that age is an independent associated factor for the occurrence and development of PAD in diabetic patients. A study of 2,512 diabetic patients suggested that age is a predictor for PAD [22]. The PAD prevalence was positively correlated with age [26]. Age is an uncontrollable risk factor for diabetic patients, and with the degree of atherosclerosis being gradually aggravated as patients age, PAD can be regarded as a precursor to atherosclerosis [27]. In addition, elderly patients have a greater risk of vascular disease of the lower extremities due to decreased vascular compliance, decreased systemic metabolic function, increased blood pressure, and abnormal blood lipid metabolism [28]. Elderly patients often ignore their own diseases, and fail to be screened, diagnosed, and treated in time. The routine screening of PAD in clinical nursing is therefore vital for diabetic patients older than 50 years. Regardless of their age, diabetic patients with foot ulcers and gangrene should receive a comprehensive examination and evaluation of arterial lesions.

In this study, the LDL-C level was higher in the PAD group than in the non-PAD groups (2.98 ± 1.05 vs. 2.76 ± 0.92 mmol/L, p = 0.053). Multivariate logistic regression analysis indicated that LDL-C level was also an independent factor associated with PAD in diabetic patients (OR = 1.510, 95% CI = 1.152 to 1.980, p = 0.003). This finding is consistent with Cardoso et al.’s report that LDL-cholesterol was associated with PAD development/progression in patients with type 2 diabetes [12]. It is known that low levels of low-density lipoprotein cholesterol can effectively reduce the risk of vascular events [29]. The National Cholesterol Education Program (NCEP) guidelines recommend that LDL-C should be the primary target of cholesterol-lowering therapy, and PAD patients achieve a serum LDL cholesterol concentration of less than 100 mg/dL (2.6 mmol/L) [30]. For PAD patients, some experts recommend lowering the goal of LDL-C therapy to 70 mg/dL [31].

Significant differences were found in DPN incidence between the PAD and non-PAD groups, despite logistic regression analysis suggesting that it was not an associated factor for diabetic PAD. Abnormal sensation such as numbness or pain was present in 45.1% and 23.1% of patients in the PAD and non-PAD groups, respectively. Most patients felt numbness and tingling of the lower limbs, which is also one of the most common reasons for visiting a doctor. This feeling usually indicates that patients already have DPN or peripheral vascular disease, which should be taken seriously [32]. As one of the main symptoms of DPN, pain may be caused by damage to nerve endings or small fibers during the early stages, causing subsequent abnormal sensation [8]. The Foundation for Peripheral Neuropathy and the American Diabetes Association recommend the Quantitative Sensory Test (QST) as the diagnostic criteria for DPN [33]. QST is a neurophysiological test that stimulates skin receptors through vibration, current, cold, and heat to quantitatively

| Groups | Cases | Diabetic retinopathy | Diabetic nephropathy | DPN | Diabetic foot |
|--------|-------|----------------------|---------------------|-----|--------------|
| PAD, N (%) | 71   | 13 (18.31)           | 14 (19.72)          | 40 (56.34) | 9 (12.68) |
| Non-PAD, N (%) | 784  | 204 (26.02)         | 121 (15.43)         | 322 (41.07) | 19 (2.42) |
| χ²       | 2.044 | 0.899                | 6.215               | 21.604 |
| p value  | 0.153 | 0.343                | 0.013               | <0.001 |

PAD, peripheral arterial disease; DPN, diabetic peripheral neuropathy.

* Diabetic foot was defined as infection, ulceration, or destruction of deep tissues below ankles in diabetic patients.

| Variables                           | Odds ratio | 95% confidence interval | p value |
|-------------------------------------|------------|-------------------------|---------|
| constant                            | 0.001      |                         | <0.001  |
| Age (years)                         | 1.062      | 1.037 to 1.087          | <0.001  |
| LDL-C (mmol/L)                      | 1.510      | 1.152 to 1.980          | 0.003   |
| Touch of dorsalis pedis tibial artery (left) | 2.997     | 1.617 to 5.555          | <0.001  |
| Sensory nerve conduction threshold (right) | 1.116     | 1.052 to 1.184          | <0.001  |

PAD, peripheral arterial disease.
analyzes the sensory-current threshold and the degree of neuropathy. In this study, there was also significant difference in the sensory-current threshold between the two groups, and increased sensory-current threshold was an independent factor associated with PAD. Consistent with this finding, Du et al. also reported that diabetic patients who had higher current perception threshold (CPT) were more likely to develop diabetic foot [34]. Sensory-current threshold is a reliable quantitative screening technique for early and asymptomatic DPN [35]. DPN and PAD often co-exist, which further hides PAD symptoms and presents them as atypical [3]. Interactions between neuropathy and angiopathy in diabetes patients may be related to vascular endothelial cell dysfunction caused by long-term hyperglycemia, damage to blood vessels, and insufficient nutritional supply to neurons. Preventing, controlling, and treating diabetic PAD and DPN are important in the prevention and control of diabetic foot. The most common treatment for PAD is interventional therapy, which has a wide range of indicators, is safe, has a high success rate, and few possible complications. Economic pressures have resulted in a low rate of stent utilization in China, which needs to be addressed. Interventional therapy itself also has some disadvantages, such as postoperative restenosis, which must be further studied in clinical settings.

In this study, abnormal dorsalis pedis artery pulsation was present in 33.8% and 7.7% of cases in the PAD and non-PAD groups, respectively. Logistic regression analysis indicated that dorsalis pedis artery pulsation was an independent associated factor for PAD in diabetes patients. Diabetic PAD has unique characteristics, with many types of lesions, including not only the large arteries and middle-sized arteries, but also the middle and small arteries below the knee, and is usually characterized by intima-media calcification, segmental stenosis, or occlusion [36]. Distal arterial disease of the lower extremities often causes lower limb ischemia and can lead to diabetic foot. Palpation of the dorsalis pedis artery is useful for the early detection of arterial disease in the lower extremities and for preventing diabetic foot. Comprehensive palpation of ankle artery pulsations and femoral artery murmurs in the diagnosis or exclusion of PAD produced accurate findings in 93.8% of cases. If the ankle artery pulsation of the extremities in both lower limbs was normal and femoral artery murmurs were not found during auscultation, the specificity and negative predictive value of excluding PAD were as high as 98.3% and 94.9%, respectively [37]. Most Chinese hospitals have not invested sufficiently in the prevention and management of diabetic foot, with uneven development of medical institutions at different levels, characterized by comparatively high development levels in tertiary hospitals. Primary and secondary hospitals still have problems, such as poor diagnostic and treatment technology, and a lack of screening tools. Pulse palpation of the distal foot, posterior tibia, popliteal artery, and femoral artery is a simple and inexpensive clinical examination method that should be applied systematically to diabetes patients, especially in smaller hospitals that lack advanced medical equipment [8].

The study was subject to some limitations. First, the use of a cross-sectional design meant that causality could not be determined. Second, all subject data came from a single hospital with a limited choice of patients, and so the generalizability of the present results is limited. Third, there are some confounding factors not considered in this study and should be clarified in future work. These confounding factors include ‘ever smoking’, hypertension/hyperlipidemia and its treatment, diabetic kidney disease (DKD) stages, hemodialysis, living with family, cerebrovascular disease (CBD) and cardiovascular disease (CVD).

In summary, the prevalence of PAD is high in hospitalized diabetic patients in China. Patients who are older, experience foot numbness or pain, abnormal dorsalis pedis artery pulsation, or abnormal sensory-current threshold are associated factors of developing PAD.

Disclosure Statement

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