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## Original Article

## Prevalence of peripheral arterial disease among type 2 diabetes mellitus in coastal Karnataka

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## ABSTRACT

Peripheral Arterial Disease (PAD) is one of the leading complications of Type 2 Diabetes Mellitus (T2DM). According to American Heart Association, PAD is defined as, “a narrowing of peripheral arteries to the legs, stomach, arms and the head—most commonly the arteries of leg.” The global prevalence for PAD with age adjusted prevalence is approximately 12%, and it affects relatively 8 to 12 million British people. The prevalence of PAD is 2–3 times higher in person with v/s without type 2 diabetes mellitus (T2DM). Various subjective and objective methods are available to diagnose PAD, which includes questionnaires for pain and quality of life as subjective and Ankle Brachial Index (ABI), toe brachial index (TBI), arterial doppler for objective. ABI is one of the most reliable and easy to carry out method in clinical setups to diagnose PAD. The normal range for ABI is 0.9–1.29, 0.91 to 0.99 are considered as borderline, 0.41 to 0.91 are considered as mild to moderate diseased and below 0.4 is severe PAD. The objective of the study is to estimate the prevalence of peripheral arterial disease with type 2 diabetes mellitus in coastal Karnataka. *Methodology:* A total of 317 participants were recruited for the study based on inclusion criteria. Ethical clearance was taken from the Institutional Ethics Committee. Participants were explained about the study and informed consent was obtained from the participants. Inclusion criteria was any individual with T2DM on medication. A subjective questionnaire specific to PAD was administered to the participants. Along with this the objective measure, ABI was done on the individuals.

*Result:* The mean age of all the participants was  $57.36 \pm 10.43$  in years. The average Body Mass Index (BMI) was  $24.62 \pm 11.80$  in Kg/m<sup>2</sup>. The mean duration of diabetes was found to be  $9.13 \pm 6.56$  in years. The prevalence of peripheral arterial disease was found to be 8.52% in the study population.

*Conclusion:* The prevalence of peripheral arterial disease was found to be 8.52% in the study population.

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## 1. Introduction

Type 2 Diabetes Mellitus (T2DM) is one of the emerging concerns for the world. According to International Diabetes Federation (IDF), 82 million people were diagnosed as T2DM in the year 2017 which is expected to rise by 45 million in the year 2045. India may become the top most country with majority of T2DM by year 2045, if no preventive measures are taken [1]. With T2DM various macro and micro complications co-exist. Micro complications include

peripheral neuropathy, peripheral retinopathy, peripheral nephropathy, diabetic foot. Macro vascular complications includes coronary artery disease, cerebrovascular accident and peripheral arterial disease [2]. These macro vascular complications are a consequence to atherosclerosis of the arteries. Among these Peripheral Arterial Disease (PAD) is one of the most well-established and predominant complication of diabetes. According to American Heart Association (AHA), Peripheral Arterial Disease (PAD) is defined as, “a narrowing of peripheral arteries of the legs, stomach, arms and the head—most commonly involving the arteries of leg.” PAD is also responsible for higher mortality and disability including amputation especially in individuals with T2DM [3].

The global prevalence is estimated to be 202 million for PAD [4].

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The prevalence for PAD with age adjusted is approximately 12%, and it affects relatively 8 to 12 million British people. The prevalence increases as the age advances. The prevalence of PAD is 2–3 times higher in diabetic individuals compared to non-diabetic individuals. In South India, prevalence rate was found to be 16.5% and 3.2% more in diabetic population [5]. There are various risk factors that strongly focus on the PAD with T2DM which includes increasing age, gender, duration of diabetes mellitus, degree of hyperglycaemia, smoking, hypertension, dyslipidaemia, increased serum lipoprotein, obesity, insulin resistance, micro albuminuria [6]. Among this T2DM plays a major role and is one of the leading sources of mortality among individuals [7].

The primary symptom for PAD includes intermittent claudication pain. It is described as irritation in the muscle which is caused by walking and is stopped immediately after exercise [8]. This is one of the major clinical finding seen in PAD but due to lack of awareness in the general population majority may neglect this symptom and thus only a subset of population may report this.

There are various subjective and objective method available for the diagnosis of PAD. The subjective methods include the questionnaires such as Edinburg Claudication Questionnaire, Rose Questionnaire, Aberdeen Varicose Vein Questionnaire which can be administered to the patient to know the involvement of the arterial or venous disorders. These questionnaires have high sensitivity and specificity values making it universal and can be easily administered. The objective method includes Ankle Brachial Index (ABI) and Toe Brachial Index (TBI), doppler and ultrasound imaging, computed tomographic angiography, magnetic resonance angiography and angiography [9]. Among these ABI and TBI are common, non-invasive and easy to perform diagnostic method for PAD. ABI is defined as the ratio of systolic pressure of ankle to systolic pressure of arm. The normal range for ABI is 1.00–1.29. The lower the value the higher the involvement of disability. Toe brachial index compares the toe systolic pressure to brachial systolic pressure. A cut-off value of  $>0.7$  is considered to be normal. Values in range of 0.64–0.7 is considered as borderline. And values  $<0.64$  is abnormal indicating arterial disease. [10].

As PAD is usually accompanied with diabetes, the clinicians should perform a thorough evaluation for PAD as well as diabetic foot syndrome. For diabetic foot, the clinicians focus on examination of legs and feet, light and deep sensation, pressure. Similarly, for vascular assessment one should include general observation, pulsation, blood flow to lower limb.

However, not many of the studies focus in combination of these two life threatening conditions which may be a major cause for disability in an individual. Therefore, this study was conducted to estimate the prevalence of Peripheral Arterial Disease with Type 2 Diabetes Mellitus individuals in Coastal Karnataka.

## 2. Methods

This was a cross sectional study which was conducted between January 2018 to September 2018. Ethical clearance from the Institutional Ethics Committee was obtained before commencing the study. A total of 317 participants were recruited for the study with 30% of non-respondent rate. The inclusion criteria were both male and female above 30 years of age with diagnosed T2DM and are on medication or insulin. Exclusion criteria were any neuromuscular disorders, established ulcers, patients with unstable or exertional angina, resting limb pain, patient underwent recent surgical intervention, recent orthopaedic surgery or musculoskeletal disorders. All voluntary participants were explained about the procedure and informed consent were obtained from them. Basic demographic details were recorded along with microvascular assessment for diabetic foot was also done which included

recording vibration perception threshold by standard Biothesiometer, sensation by 10 gm Semmes Weinstein monofilament. A subjective questionnaire (Edinburg Peripheral Arterial Questionnaire) was administered to the participants. The questionnaire consisted of 8 questions focussing on the pain in the lower limb. And if any one answer being “yes” was considered to have risk of peripheral arterial disease. Along with this for the objective measure, ABI was done on the individuals. The participants were instructed to rest for 5 min before performing the ABI. The standard sphygmomanometer was used to record the systolic blood pressure for arms and legs. The dominant side of the participant was considered. The systolic blood pressure of arms and legs was recorded and analysed.

## 3. Results

A total number of 317 participants were included in the study. Among them 193 participants (60.88%) were male and 124 participants (39.12%) were females. Demographic details are shown in Table 1. For assessing PAD, questionnaire, pedal pulse and ABI were taken. Among 317 participants, the prevalence is mentioned in Table 2 and Table 3.

As mentioned in Table 2, only 2.21% of individuals had PAD and 6.31% of participants were at the risk of having PAD. 65.30% of individuals were in the normal ABI range. We compared the duration of diabetes with the prevalence of PAD which showed that with every year increase in duration of diabetes there is 1.2 times more risk of developing PAD. Similarly, when we compared the diabetic neuropathy which was confirmed with the help of vibration pressure threshold and the prevalence of ABI, it showed that there is 1.19 times more risk of developing PAD with decreasing in ABI.

Also 8.5% of participants reported “yes” to the questionnaire actually had their ABI values between 0.40 and 0.99 (8.5%) suggesting that the questionnaire was correlating with decreased ABI values suggesting diagnosis of PAD.

**Table 1**  
Demographic details.

| Demographics                 |                                 |
|------------------------------|---------------------------------|
| Age (years)                  | 57.36 ± 10.43 years             |
| Body Mass Index (BMI)        | 24.62 ± 11.80 kg/m <sup>2</sup> |
| Duration of Diabetes (years) | 9.13 ± 6.56 years               |

**Table 2**  
of individuals diagnosed with PAD by various assessing methods.

| Method  |          | Number of participants<br>(Percentage) N = 317 |
|---|----------|--|
| Questionnaire (Edinburg Claudication Questionnaire) | Yes      | 27(8.52%)                                      |
|   | No       | 290(91.48%)                                    |
| Bilateral Pulse (Dorsalis Pedis)                    | Feeble   | 15(4.73%)                                      |
|   | Palpable | 302(95.27%)                                    |
| Ankle Brachial Index                                | PAD      | 27(8.52%)                                      |
|   | Non-PAD  | 290(91.48%)                                    |

**Table 3**  
Prevalence of PAD.

| ABI       | Number of participants(percentage) N = 317 |
|-----------|--|
| 0.41–0.99 | 27(8.52%)                                  |
| 1–1.29    | 207(65.30%)                                |
| 1.30–1.49 | 69(21.77%)                                 |
| 1.50–1.79 | 14(4.42%)                                  |

#### 4. Discussion

To our knowledge, this is the first study which used both objective and subjective method were used to diagnose PAD. Peripheral arterial disease is one of the major macro complications for diabetes mellitus affecting individual's quality of life and mortality. It also increases risk of stroke and coronary heart disease. In this study we attempted to detect the prevalence of PAD in T2DM in coastal Karnataka. For this a total of 317 participants were recruited and their ABI were recorded. Subjective method being less time consuming and easy to administer can be used in the field-based training and the individuals can be educated for the preventive measures for the same or can be called in a hospital setup for further investigation.

In our study the prevalence for PAD with T2DM was 2.21% and 6.31% were at the risk of being diagnosed as PAD. A study conducted in South India reported a prevalence rate was 16.5% with 3.2% higher in diabetic population. The study did not report the combined prevalence which may be a reason for varied prevalence.

Also, in the present study, duration of diabetes was compared with the involvement of claudication pain which showed that as the duration of diabetes increases the risk of developing PAD also increases. The result sustained with the association of diabetic complication which include diabetic neuropathy and involvement of ABI. This finding co-relates with the AHA statement which concluded that duration of diabetes plays a major role in development of PAD. The model proposed by Fowler concluded that hyperglycaemia is responsible for the complication of diabetes which include both micro and macrovascular complications [11].

In the present study, two different methods were used to estimate the prevalence of PAD which varied between 14.5 and 17%. The same individuals who reported claudication pain with the questionnaire had low ABI. Thus, in the field-based screening if ABI is not possible to perform then questionnaire can be a method to diagnose PAD. This could be one of the easier methods to screen patients in rural areas and create awareness among the individuals. Early identification of risk and prevention can be a better cost-effective method for diagnosis of PAD and its complication [7].

15 individuals among 317 participants had feeble pulse bilateral which correlated with the lower ABI values. Only dorsalis pedis artery was examined for the patients and was reported in the study which may be responsible for the variation in the values of ABI. The underestimation of prevalence of PAD by palpation may be due to various factors such as ambient temperature, anatomical variation [12].

Even though ABI has higher sensitivity level of above 90%, there may be inaccuracy due to incompressible artery or calcified which may give falsely elevated ABI values [13]. Also, oral hypoglycaemic drug half-life and time of performing the ABI may have given falsely elevated or reduced values of ABI.

#### 5. Conclusion

Thus, it can be concluded that both objective and subjective methods can be used in the field-based screening and can be useful in early screening and detection of PAD in T2DM individuals. Also, it is one of the feasible methods to perform on a larger population with a total prevalence of 8.52% in the study population.

#### Conflict of interest

The authors declare that they have no competing interest.

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dsx.2019.02.003>.

#### References

- [1] International Diabetes Federation. In: IDF diabetes atlas. eighth ed. Brussels, Belgium: International Diabetes Federation; 2017.
- [2] American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2014 Jan 1;37(Supplement 1):S81–90.
- [3] Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG. Inter-society consensus for the management of peripheral arterial disease (TASC II). *J Vasc Surg* 2007 Jan 1;45(1):S5–67.
- [4] Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE, Colvin MM, Drazner MH, Filippatos G, Fonarow GC, Givertz MM, Hollenberg SM. ACC/AHA/HFSA focused update on new pharmacological therapy for heart failure: an update of the 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Failure Society of America. *J Am Coll Cardiol* 2016;68(13):1476–88. 2016 Sep 27.
- [5] Eshcol J, Jebarani S, Anjana RM, Mohan V, Pradeepa R. Prevalence, incidence and progression of peripheral arterial disease in Asian Indian type 2 diabetic patients. *J Diabetes Complicat* 2014 Sep 1;28(5):627–31. <https://doi.org/10.1016/j.jdiacomp.2014.04.013>.
- [6] Jude EB, Eleftheriadou I, Tentolouris N. Peripheral arterial disease in diabetes—a review. *Diabet Med* 2010 Jan;27(1):4–14. <https://doi.org/10.1111/j.1464-5491.2009.02866.x>.
- [7] Soyoye DO, Ikem RT, Kolawole BA, Oluwadiya KS, Bolarinwa RA, Adebayo OJ. Prevalence and correlates of peripheral arterial disease in Nigerians with type 2 diabetes. *Advances in medicine* 2016. <https://doi.org/10.1155/2016/3529419>.
- [8] Hernando FJ, Conejero AM. Peripheral artery disease: pathophysiology, diagnosis and treatment. *Rev Esp Cardiol* 2007 Sep 1;60(09):969–82.
- [9] Pollak AW, Kramer CM. MRI in lower extremity peripheral arterial disease: recent advancements. *Current cardiovascular imaging reports* 2013 Feb 1;6(1):55–60. <https://doi.org/10.1161/CIRCIMAGING.111.970814>.
- [10] Høyer C, Sandermann J, Petersen LJ. The toe-brachial index in the diagnosis of peripheral arterial disease. *J Vasc Surg* 2013 Jul 1;58(1):231–8. <https://doi.org/10.1016/j.jvs.2013.03.044>.
- [11] Fowler MJ. Microvascular and macrovascular complications of diabetes. *Clin Diabetes* 2008;26:77–82.
- [12] Riles TS. The sensitivity, specificity, and predictive value of traditional clinical evaluation of peripheral arterial disease: results from noninvasive testing in a defined population: Criqui MH, Fronck A, Klauber MR, et al. *Circulation* 1985; 71: 516–22. *J Vasc Surg* 1986 Jun 1;3(6):942.
- [13] Ramos R, Quesada M, Solanas P, Subirana I, Sala J, Vila J, Masía R, Cerezo C, Elosua R, Grau M, Cerdón F. Prevalence of symptomatic and asymptomatic peripheral arterial disease and the value of the ankle-brachial index to stratify cardiovascular risk. *Eur J Vasc Endovasc Surg* 2009 Sep 1;38(3):305–11. <https://doi.org/10.1016/j.ejvs.2009.04.013>.