Prevalence of peripheral arterial disease in patients with type 2 diabetes mellitus (a comparative study between patients of Asian and African ethnicities in Dar es salaam, Tanzania)

Amar Swali, MD

MMed (Internal Medicine) Dissertation
Muhimbili University of Health and Allied Sciences
October, 2017

PREVALENCE OF PERIPHERAL ARTERIAL DISEASE IN PATIENTS WITH TYPE 2 DIABETES MELLITUS (A COMPARATIVE STUDY BETWEEN PATIENTS OF ASIAN AND AFRICAN ETHNICITIES IN DAR ES SALAAM, TANZANIA)

By

Amar Swali

A Dissertation Submitted in (Partial) Fulfillment of the Requirements for the Degree of Master of Medicine (Internal Medicine) of Muhimbili University of Health and Allied Sciences

Muhimbili University of Health and Allied Sciences
October, 2017

CERTIFICATION

The undersigned certifies that he has read and hereby recommended for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled: **‘‘Prevalence of Peripheral Arterial Disease in patients with Type 2 Diabetes Mellitus (A comparative study between patients of Asian and African Ethnicities in Dar es Salaam, Tanzania)’’,** in (partial) fulfillment of the requirements for the degree of Master of Medicine (Internal Medicine) of Muhimbili University of Health and Allied Sciences.

_____

Dr. Paschal Ruggajo

Supervisor

_____

Date

DECLARATION AND COPYRIGHT

I, **Amar Swali**, declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature…… **Date**……..

ACKNOWLEDGEMENT

I would like to thank the Almighty for His endless blessings and the numerous opportunities He has given me all my life, including for this degree program, and particularly during this dissertation process.

To my late father, Mragheshchandra S. Swali, for watching over me, while I become the man he would have wished me to be, were he here.

To my mother, Jyoti M. Swali, my strongest pillar and my most faithful supporter, for her endless love, for her fight against countless odds and never leaving a stone unturned to make sure that all my dreams become a reality.

To my brother, Rahul, and my sister, Honey, for without their endless sacrifices, I would never have been where I am today.

To Dr. Kaushik Ramaiya, my inspiration and my mentor, for every stepping stone he has provided for my ascent to success, for every minute that he has spent being a father-figure and friend during my most troubled times, and without whose tireless efforts and teachings, I would have had no direction in life, and the person I dream of becoming, some day.

To Dr. Pashcal Ruggajo, for being my guiding light, during this stormy voyage that has been MMed, an inspiration to look up to, and for his patience and faith in me when I was at my most vulnerable.

To my friend and brother, Dr. Sibtain Moledina, without whom completing this dissertation would have been impossible.

To Mr. Gibson Kagaruki, whose statistical advice and guidance was invaluable.

Thanks also go out to the faculty members in the Department of Internal Medicine (MUHAS), for their constructive criticisms which has made this dissertation project better.

My appreciation also goes to Dr. Insiyah Amiji and the nurses at Shree Hindu Mandal Hospital, for their help in collection of data, and the entire management at the hospital for hosting me for the duration of the study.

Sincere acknowledgement to the study participants for agreeing to be included in the study.

And finally to my furry baby, Champ, who made me smile when times were difficult, with his the nudge of his paw and the wag of his tail.

DEDICATION

To My Mother, Jyoti, and KLR.

ABSTRACT

Background: The worldwide prevalence of lower extremity peripheral artery disease (PAD) is between 3-12%. In 2010, 202 million people around the world were living with PAD. In Europe and North America, an estimated 27 million individuals are affected with approximately 413,000 inpatient admissions annually attributed to PAD. The majority of individuals with PAD (70%) live in low/middle income regions of the world. Diabetes Mellitus, together with smoking, is the main risk factor for PAD. Despite this, the current prevalence of PAD in Tanzania remains unknown. Different studies have identified various risk factors for adverse outcomes such as poorly-healing diabetic foot ulcers, critical limb ischemia and lower limb amputations as feared complications of PAD, and hence early detection and intervention of the disease would significantly help to reduce morbidity and mortality among people living with the disease.

Objective: To determine and compare the prevalence and factors associated with PAD among Type 2 diabetes mellitus patients of Asian and African ethnicities in Dar-es-Salaam.

Methodology: A descriptive cross-sectional study was conducted at the Diabetes Clinic at Shree Hindu Mandal Hospital between September and December 2016. 367 patients (189 Africans and 178 Asians) with T2DM who are attending the clinic were consecutively enrolled. Data was collected using a structured questionnaire. The Ankle-Brachial Index (ABI) determination using a Huntleigh Dopplex MD2 bidirectional doppler was done to assess peripheral arterial circulation, patients were categorized as having normal or abnormal ABI according to standard ABI scores (<0.9 and >1.3 being considered as abnormal), along with determination of laboratory values of glycated hemoglobin and lipid profile (serum values of triglycerides, HDL, LDL and total cholesterol). Logistic regression was performed to determine the effect of various predictors on peripheral arterial circulation.

Results: Of the 368 recruited type 2 diabetic subjects, 112 (30.7%) were found to have peripheral arterial disease; 71 Africans (38%) and 41 Asians (23%); showing a higher prevalence of the disease in the African ethnicity. Symptomatic PAD was observed in two-thirds of the detected patients. In both ethnicities, an age of over 45 years, a duration of T2DM of more than 10 years (Asians: AOR 2.0 (95% CI 1.1-3.8), Africans: AOR 2.5 (95% CI 1.0-6.2)),suboptimal-poor glycemic control represented by HbA1c level of >7% (Asians: AOR 6.5 (95% CI 2.3-18.5), Africans: AOR 12.6 (95% CI 2.9-53.8)) and a history of leg pain (Asians: AOR 4.3 (95% CI 2.2-8.2), Africans: AOR 2.2 (95% CI 1.0-4.9) were observed as strong determinants of PAD, and additionally for the African ethnicity, a raised level of serum total cholesterol was seen as a strong determinant of PAD (AOR 4.0(95% CI 1.2-13.2)).

Conclusion and Recommendations: This study explicitly reveals that there is a higher prevalence of PAD in type 2 diabetics of African ethnicity as compared those of the Asian ethnicity. This study should prompt care-givers to screen any diabetic patient with an older age, or duration of DM for more than 10 years, or with poor glycemic control or a history of any form leg pain for PAD. This will allow timely appropriate measures to be taken to reduce the health and economic burden of PAD complications.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABI	Ankle-Brachial Index
ACC	American College of Cardiology
AHA	American Heart Association
AOR	Adjusted Odds Ratio
BMI	Body-Mass Index
CAD	Coronary Artery Disease
CI	Confidence Interval
COR	Crude Odds Ratio
CVD	Cardiovascular Disease
DM	Diabetes Mellitus
DSM	Dar-es-Salaam
ECQ	Edinburgh Claudication Questionnaire
NHANES	National Health and Nutrition Examination Survey
OR	Odds Ratio
PAD	Peripheral Arterial Disease
T2DM	Type 2 Diabetes Mellitus
TDA	Tanzania Diabetes Association
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

Diabetes mellitus is defined as a group of metabolic diseases whose common feature is chronic hyperglycemia [(1)]. Chronic hyperglycemia is associated with the long-term consequences of diabetes mellitus that include damage and dysfunction of multiple organ systems including; cardiovascular, eyes, kidneys and nerves. These multiple chronic complications of diabetes are often broadly divided into two major groups: microvascular complications (retinopathy, nephropathy and neuropathy) and macrovascular complications (ischemic heart disease, stroke and peripheral vascular disease).

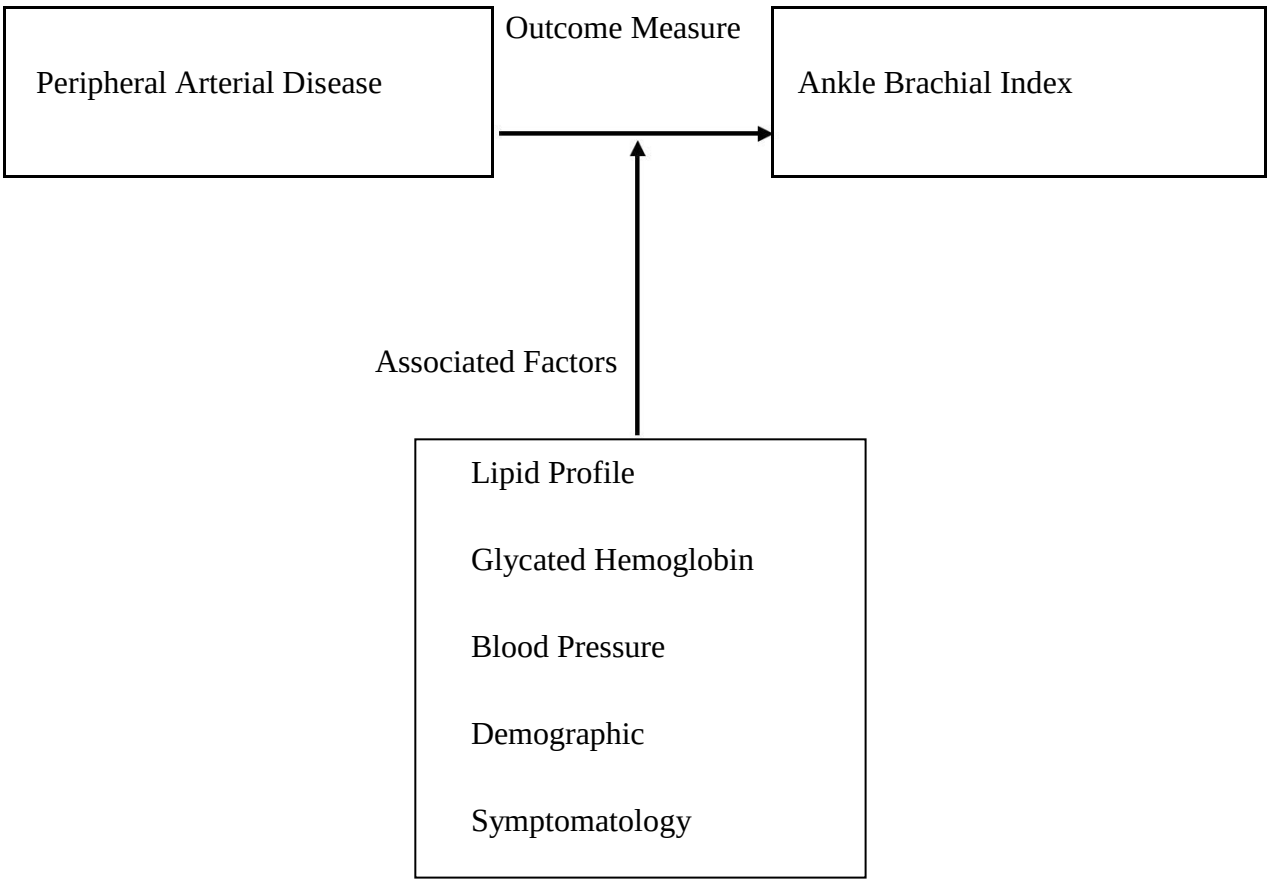
a) The current WHO classification of diabetes mellitus is as follows[(2)]:
b) Type 1 diabetes mellitus (pancreatic beta-cell destruction leading to absolute insulin deficiency)
c) Type 2 diabetes mellitus (insulin resistance and relative insulin deficiency)
d) Other specific types of diabetes mellitus
e) Gestational diabetes mellitus

In most populations glucose levels are distributed in a continuous manner. Therefore an approximate threshold at which markedly increased risk of microvascular complications occur has been used to define diabetes mellitus. The World Health Organization (WHO) revised diagnostic criteria for diabetes mellitus which is therefore currently based on a fasting plasma glucose of > 7.0 mmol/l. The 2 hour glucose level is still considered by the WHO as the gold standard for diagnosis of diabetes mellitus but a fasting plasma glucose of > 7.0 mmol/l is accepted as satisfactory to make a diagnosis[(3)].

Peripheral arterial disease is a caused as a result of long-term build of atherosclerotic plaque and vascular stiffness with resultant reduction in blood supply via the vasculature to the lower limbs. People living with DM are at high risk for PAD which unfortunately is often associated with poor prognosis of foot ulceration and limb amputation, and though many studies have

been aimed at addressing the prevalence and outcomes of most complications of T2DM, the prevalence of PAD remains poorly investigated in comparison, and hence warrants to be addressed.

1.1 Conceptual Framework



CHAPTER TWO

2.0 LITERATURE REVIEW

Worldwide, T2DM makes up for almost 85% to 90% of all cases of diabetes mellitus[4]. T2DM is a condition that predominantly affects middle-aged and older people but the prevalence has been increasing even among children and young adults in countries with a high prevalence of obesity.

A number of studies have been done to estimate the prevalence of diabetes mellitus and to make projections of the future burden of the disease. In 1998, a study by King et al suggested that, between the years 1995 and 2025, the global adult population would increase by 64%, the prevalence of diabetes mellitus in adults would increase by 35%, and the absolute number of people with diabetes would increase by 122%. In the same study, it was noted that for developed countries, there would be an 11% increase in the adult population, a 27% increase in the prevalence of adult diabetes, and a 42% increase in the number of people with diabetes[5].

On the other hand, the picture was more alarming for developing countries. It was noted that there would be an 82% increase in the adult population, a 48% increase in the prevalence of adult diabetes, and a 170% increase in the number of people with diabetes.

These estimates were made again in 2004 by Wild et al using newer data and different methods for estimating age-specific prevalence. The most notable of these newer estimates were the greatest relative increases that would occur in the Middle Eastern Region, sub-Saharan Africa, and India[6].Of the 333 million people around the globe predicted to have diabetes by 2025, 80% will live in low- and middle-income countries. The two studies have shown consistently the disproportionate increase of diabetes in developing countries.

An updated estimate in 2006 indicated that there were estimated 246 million people worldwide with diabetes and an anticipated 380 million by the year 2025. These updated estimates were based principally on the same studies as the two previous studies cited above,

but with 34 newer studies being included to further refine the estimates. In 2010, it was estimated that around 12 million people with diabetes mellitus were in sub-Saharan Africa. This accounted for 4% of the total global estimate of 285 million people with diabetes. In 2011, the prevalence of diabetes in SSA rose to 14.7 million. It has been projected that by the year 2030 the prevalence of diabetes in SSA will have increased by 90%. This will bring the number of Africans with diabetes to be around 28 million [(4)], and this would attributable to the increased urbanization and associated rapid changes in lifestyle that would be involved.

Peripheral arterial disease (PAD) is resulted by narrowing of the caliber of the medium-sized arteries and its broader definition encompasses all extracoronary and extracerebrovascular disease. However, the term PAD is usually restricted to involvement of the lower limbs, particularly in the iliac bifurcation, and the iliofemoral and popliteal arteries[(7)].The main cause of arterial stenosis in developed countries is atherosclerosis.

PAD is more prevalent in older individuals, men, certain ethnic populations, families with atherosclerosis, and in those with risk factors for cardiovascular disease. Risk factors that favor the development of peripheral artery disease (PAD) are similar to those that promote the development of coronary atherosclerosis and include smoking, hypertension, diabetes, hyperlipidemia, homocysteinemia, and metabolic syndrome[(8-11)]. The American College of Cardiology/American Heart Association (ACC/AHA) guidelines on PAD identified the following groups at risk[(12-15)]:

- Age ≥70 years
- Age 50 to 69 years with a history of smoking or diabetes
- Age 40 to 49 with diabetes and at least one other risk factor for atherosclerosis
- Leg symptoms suggestive of claudication with exertion or ischemic pain at rest
- Abnormal lower extremity pulse examination
- Known atherosclerosis at other sites (eg. coronary, carotid, renal artery disease)

Patients with diabetes have more advanced arterial disease at initial diagnosis and poorer outcomes than non-diabetic patients[(15, 16)].

The NHANES study found an increased risk for PAD in patients with diabetes (odds ratio [OR] 2.71, 95% CI 1.03-7.12), a level of risk exceeded only by smokers (OR 4.46, 95% CI 2.25-8.84)[17].

A prospective cohort study with more than 20 years follow-up found an increased risk of death (hazard ratio 2.9, 95% CI 1.3-4.0) for patients with diabetes and PAD, compared with those without diabetes[18].

Poor glycemic control also incrementally increases the risk of atherosclerosis. A systematic review identified 13 studies evaluating hyperglycemia and cardiovascular risk, and found a 26 percent increase in risk for every 1 percent increase in HbA1c[19].

Diabetes also increases the risk for developing symptomatic PAD (OR 2.6) in the Framingham Heart Study, which followed subjects for 38 years[11]. The effect of diabetes on graft patency has varied between studies, with the majority finding no difference in patency rates[20, 21]. However, retrospective reviews have reported increased mortality and amputation in patients with diabetes[22, 23]. In one study, the mortality rate for patients with diabetes following aortic or lower extremity revascularization was 9.6 percent compared with 2.2 percent for those without diabetes[23]. Although the risk of amputation in patients with diabetes is related to the severity of PAD, infection and neuropathy are also contributing factors.

In other studies, variable burdens of macrovascular complications of diabetes were reported in Africa[24, 25, 26, 27]. Coronary heart disease was estimated to affect 5–8% of type 2 diabetic patients and cardiomyopathy up to 50% of all patients. Lower extremity amputation varied from 1.5 to 7%, and about 12% of all hospitalized diabetic patients had foot ulceration. Neuropathy underlies diabetic foot more often than peripheral vascular disease.

Diabetes, together with smoking, is the main risk factor for PAD[28]. Of patients who attended an angiology office in Spain due to intermittent claudication and who underwent arterial surgery or had an ABI $\leq$ 0.9; two-thirds had diabetes mellitus[29].

Low ABI was independently associated with a high risk of all-cause and CVD mortality in Chinese patients with T2DM. Mortality surveillance was completed from November 2004 to January 2006. Among 1,647 participants with type 2 DM at baseline, one-third were in the low-ABI group. Older age, female gender, higher serum level of total cholesterol, longer duration of DM and a history of smoking were associated with low ABI. During the 13-month follow-up, there were 132 deaths, around one-third of which were from CVD. Low ABI was associated with mortality from all-cause and CVD, the adjusted relative risk of which was 1.851 (95% confidence interval 1.280–2.676) and 3.211 (1.703–6.053), respectively, in Cox regression models. The survival rate was significantly lower in the low-ABI group than in the normal-ABI group[30].

In a study done in India, the prevalence of PAD was 14.4% with women having a slightly higher prevalence (14.9%), as compared to men (13.9%) (p=0.864). Age, duration of diabetes, smoking, systolic and diastolic blood pressures and an HbA1c >7% were significant predictors of PAD. There was no correlation between obesity and PAD. Older age (p=0.01), higher HbA1c levels (p=0.02), microalbuminuria (p=0.03) and deranged lipid profile (total cholesterol, HDL, triglycerides) were found to be significant predictors of CAD. Using ankle brachial index, evidence of PAD in 14.3% of type 2 diabetics was found. Risk factors significantly associated with PAD were--higher age, longer duration of diabetes, higher systolic and diastolic blood pressure, smoking, higher HbA1c levels and CAD. The prevalence of CAD was higher in patients with PAD (52.38% vs. 24% in those without PAD; p=0.007)[31].

In a study to observe the prevalence of PAD in Pakistan, 830 patients; almost one-third of all the patients involved had PAD. There was no significant difference in the proportion of low ABI between males and females, with around one-third of both sexes having the disease. ($p = 0.29$). The females were younger and had a higher body mass index (BMI) ($p < 0.001$); and patients with low ABI were found to have significantly higher BMI ($p = 0.02$) and waist circumference ($p = 0.001$). The most common symptom in the patients with low ABI was pain on walking which was seen in almost all the patients, followed by numbness of the feet, which

was reported by two-thirds of the patients. There was a significant difference in the reporting of all the symptoms ($p < 0.05$) except for numbness of the feet ($p = 0.57$) as compared to patients with normal ABI. No association was found between low ABI and duration of diabetes mellitus or cigarette smoking. There was no significant association between cardiovascular conditions and low ABI[32].

In a 2007 Italian study, a study was done to evaluate the prevalence of PAD in T2DM and its association with traditional and non-traditional cardiovascular (CV) risk factors. PAD prevalence was seen in almost one-fifth of the population included; increased with age, diabetes duration, HbA1c levels, and previous CV events. There were no significant differences in the prevalence of traditional CV risk factors between patients with and without PAD [33].

In another 2006 Indian study including 100 diabetic subjects and 50 non-diabetic subjects (controls) to determine the prevalence of PAD; the disease was observed in less than one-tenth of the controls and a quarter of the diabetics. Almost two-thirds of the diabetics were greater than 60 years of age; as almost three-quarters of the controls. Almost three-quarters of the diabetics and just over half the controls were male. According to mode of therapy, the prevalence of PAD was found in one-fifths of the diabetics taking oral hypoglycemic agents and insulin, almost one-third on only oral hypoglycemic agents, and a quarter on only insulin therapy. This study suggests that there is a higher prevalence of PAD in diabetics as compared with controls. The prevalence of PAD is directly proportional to the duration of diabetes and age of the person [34]

A 2005 study by the British Diabetic Association to evaluate the prevalence of peripheral arterial disease (PAD) with the ankle-brachial index (ABI) in 2559 newly diagnosed Type 2 diabetic subjects, an ABI < 0.9 was found in one-fifth of the patients. Claudication was present and femoral and popliteal pulses were absent in almost one-tenths, tibial and dorsalis pedis pulses were absent in around one-fifth of the subjects involved. Foot cyanosis was observed in a minority, while cold foot was observed just over one-tenths and skin thinning in almost one-

fifths. Hair anomalies were observed in one-third of the patients. PAD, as represented by ABI < 0.9, is common in newly diagnosed Type 2 diabetic patients[35].

To assess the relation between the duration of diabetes and the risk of peripheral arterial disease among men, another 2005 study; a total of 48,607 men in the Health Professionals Follow-up Study who returned a questionnaire in 1986 were followed for 12 years. Peripheral arterial disease (intermittent claudication or surgery for peripheral arterial diseases in the lower extremities) was ascertained by biennial questionnaire and confirmed by medical record review. Diabetes status and other cardiovascular risk factors were also ascertained. 387 cases of peripheral arterial disease were documented. After adjusting for cardiovascular risk factors, the relative risk of developing peripheral arterial disease among men with diabetes compared with men without diabetes was 2.61 (95% CI: 1.98 to 3.45). Compared with men without diabetes, the relative risk of peripheral arterial disease among men with diabetes increased with duration of disease, even after adjusting for cardiovascular risk factors: 1.39 (95% CI: 0.82 to 2.36) for 1 to 5 years of diabetes, 3.63 (95% CI: 2.23 to 5.88) for 6 to 10 years, 2.55 (95% CI: 1.50 to 4.32) for 11 to 25 years, and 4.53 (95% CI: 2.39 to 8.58) for >25 years of diabetes (P for trend < or =0.0001)[36].

Black ethnicity was a strong and independent risk factor for PAD, which was not explained by higher levels of diabetes, hypertension, and body mass index, as shown in a another 2005 study. Ethnic-specific PAD prevalence rates were determined in a randomly selected defined population that included 4 ethnic groups; NHWs, blacks, Hispanics, and Asians. A total of 2343 participants aged 29 to 91 years were evaluated. There were 104 cases of PAD (4.4%). In weighted logistic models with NHWs as the reference group and containing demographic factors only, blacks had a higher PAD prevalence than NHWs (OR=2.30, P<0.024), whereas PAD rates in Hispanics and Asians, although somewhat lower, were not significantly different from NHWs. Blacks had significantly more diabetes and hypertension than NHWs and a significantly higher body mass index. Inclusion of these variables and other PAD risk factors in the model did not change the effect size for black ethnicity (OR=2.34, P=0.048)[37].

In the 1999 Edinburgh arterial study; 1592 men and women aged 55-74 years were selected from the general population. They underwent an assessment for PAD and a glucose tolerance test. Almost one-fifth of the study subjects were identified as having diabetes or impaired glucose tolerance (IGT). Among the diabetes/IGT group, median levels of fibrinogen, von Willebrand factor (VWF), tissue plasminogen activator (t-PA), fibrin D-dimer and plasma viscosity were higher in subjects with PAD than those without PAD (P </= 0.05). The prevalence of PAD was higher in those with diabetes/IGT (one-fifth) compared to those with normal glucose tolerance (one-eighth) (odds ratio 1.64; 95% CI 1.17, 2.31). Increased levels of haemostatic factors (fibrinogen, VWF, t-PA, fibrin D-dimer, leucocyte elastase, plasma viscosity and haematocrit) may partly explain the higher prevalence of PAD in diabetic/IGT subjects compared to normal glucose-tolerant subjects[38].

Prevalence of PAD in diabetics in Africa:

In a 2014 study to assess PAD among adult diabetic patients attending a large outpatient diabetic clinic at a National Referral Hospital in Uganda, documented a high prevalence of PAD in diabetics. 146 ambulatory diabetic patients were studied; PAD was prevalent in two-fifths of study participants. Of these, three-fifth had symptomatic PAD[39].

A 2012 Nigerian study to assess the prevalence of PAD in diabetic subjects in South-West Nigeria, revealed a prevalence in just over half (and almost three-quarters were asymptomatic) in the 219 patients involved. There were a number of associations with PAD which included, age, sex, and marital status (each with $p < 0.05$)[40].

In a 2011 review article on Chronic Diabetic Complications in Africa, a prevalence of PAD in Tanzania in 2002 was one-fifth among 92 diabetic patients[41], while the prevalence was seen among two-fifths among 185 patients in Zambia (2003), around one-tenth of the patients in South Africa (1997-300 patients), Ethiopia (1995-43 patients), Sudan (1995-128 patients) and Malawi (1991-100 patients) and just over half of the patients in Nigeria (1990-50 patients)[42].

Recent studies focusing on the African ethnicity and the Asian ethnicity:

In a 2014 South Western Ugandan study, of the enrolled 229 diabetes patients, almost a quarter had PAD (ABI of≤ 0.9); most of whom had mild PAD (ABI 0.71-0.9) while just over one-tenth had moderate to severe PAD (ABI < 0.7). Amongst those with PAD, just under half reported claudication by the ECQ. Correlates of PAD included female sex (AOR 2.25, 95% CI 1.06 - 4.77, p = 0.034), current high blood pressure (AOR 2.59, 95% CI 1.25-5.33, p = 0.01), and being on a sulfonylurea–glibenclamide (AOR 3.47, 95% CI 1.55 - 7.76,p = 0.002)[43].

In a 2014 Indian study, 2512 T2DM patients were followed for an average of 7 years. Just under one-tenth of the study population had PAD in 2001 [women-11.8%, men- 5.1%] (AOR 3.09 [CI: 1.9- 4.9]) for women. Prevalent PAD was associated with increased mortality [Hazards ratio (HR) 3.3, CI: 1.4-7.7]. 280 new patients of PAD were identified- crude incidence, 17/1000 patient years with higher rates in females [HR 1.94, CI:1.4-2.7]. Age and duration of diabetes were the other predictors of incident PAD. Progression of PAD was seen in about one-fifth of the patients, with age (p=0.002) and HbA1c (p= 0.022) being the predictors[44].

In a 2015 Nigerian study, a total of 225 persons living with DM who met inclusion criteria were recruited consecutively over a 3 month period. Age range was 28–87 years with the mean [61.4 (10.8)] and median (63) years respectively. Two-fifths of the patients were symptomatic for neuropathy and PAD respectively in the study population. An older age of >60 years and poor glycemic control were potential predictors of neuropathy. Neuropathy and PAD occurred commonly in the seventh decade of life[45].

In 2016, in another Nigerian study, 150 type 2 diabetics and an equal number of age- and sex-matched apparently healthy controls were studied. Assessment of PAD was made using history, palpation of lower limb vessels, and measurement of ankle-brachial index (ABI). Prevalence of PAD using ABI was seen in almost two-fifths and just under one-tenth among diabetic and nondiabetic populations, respectively. PAD was associated with age, male gender, waist circumference, and high-sensitivity C-reactive protein. This study highlighted

the high prevalence of PAD in people with type 2 diabetes mellitus and in apparently healthy controls; age, male gender, abdominal obesity, and high hs-CRP values were the associated risk factors[46].

The bigger picture; in a systematic review of 34 studies done since 1997-2010, published in 2013 to compare global estimates of prevalence and risk factors for peripheral artery disease, revealed that of the 112 027 participants, of which just under one-tenth had PAD. Sex-specific prevalence rates increased with age and were broadly similar in high income countries and low and middle income countries and in men and women. The prevalence in high income countries at age 45–49 years was observed a bare minimum in both sexes, but rose significantly at age 85–89 years, seen in almost two-fifths of both sexes. Again, a very low prevalence was observed in men aged 45-49 years in low and middle income countries than in high income countries, however an almost similar finding was observed in those aged 85–89 years, whereas higher rates were observed in women than in men in the same set-up, especially at younger ages (45–49 years). Smoking was an important risk factor in all, high income countries and low and middle income countries, followed by diabetes and hypercholesterolaemia. Globally, 202 million people were living with peripheral artery disease in 2010; almost three-quarters of them in low and middle income countries, including a quarter in both Southeast Asia and the western Pacific Region. During the preceding decade the number of individuals with peripheral artery disease increased by almost one-third in low and middle income countries and just over one-tenth in high income countries[47].

CHAPTER THREE

3.0 PROBLEM STATEMENT

Diabetes is associated with microvascular and macrovascular complications including PAD. It was estimated in the year 2014 that there were 36,065 deaths due to diabetes in Tanzania[4].

There is an increasing prevalence of diabetes mellitus in developing countries**,** Tanzania being one of them, with an increase in the burden of T2DM in urban Tanzania - from <2% in 1980 to 9.1% in 2012[48].

In a review article on Chronic Diabetic Complications in Africa (2011), the prevalence of PAD among T2DM patients in Tanzania (2002) was reported at 21%[42]. A prevalence of 15% of PAD was found in patients with diabetic foot attending public diabetic clinics in DSM, in a 2008 study[51].

Most Asians residing in Tanzania are of South-East Asian origin - India and Pakistan – where recent T2DM prevalence rates are ~12.5%[49] and 6.9%[50], and PAD prevalence rates are 14.4%[31] and 31.6% respectively[32].

In addition, prevalence of ischemic heart disease has been predicted to increase Sub-Saharan Africa due to the rising prevalence of associated risk factors such as hypertension, overweightness and obesity, physical inactivity, increased tobacco use and dyslipidaemia, which are usually coexisting in patients with diabetes mellitus. Different regions in the world and within Africa have reported varied burdens of the coronary heart disease in patients with diabetes mellitus[42].However little is known about the current local burden of peripheral arterial disease in patients with diabetes. Only one study has been done locally, and this was in the 2002[41]. Therefore there is lack of relevant local data which is necessary for necessary planning and provision of appropriate peripheral vascular care in patients with T2DM.

Understanding the burden and associated factors will help in planning of comprehensive management strategies in order to improve the peripheral vascular and overall care for patients with diabetes and putting in prevention strategies and control of risk factors.

3.1 Rationale

Unlike in other geographical regions, few studies in Sub-Saharan Africa have been done and published regarding PAD in diabetics.

Specifically, there is a gap in the knowledge of the current local burden of PAD in patients with diabetes. So far, only 1 study has been done locally and this was done 14 years ago [41].

Understanding the current local burden of the disease and the associated factors will help in further planning of diagnostic and management strategies in order to improve the care for patients with diabetes. Quantifying the burden of PAD among T2DM patients and determining the associated risk factors will equip clinicians, patients and caretakers with the necessary knowledge on prevention and appropriate intervention before complications ensue.

Furthermore, identifying the risk factors for adverse outcomes will help in prognosticating the patient in a more evidence-based manner. This will influence the type and aggressiveness of management of such patients, which can lead to better outcomes. Better management will also help in reducing risks of mortality or harboring a life-long disability to the patient and the cost of health services to the patient and the hospital. The aim of this study is to determine and compare the prevalence of PAD among T2DM patients of Asian and African ethnicity and its associated factors, the outcome of which will provide an insight on the magnitude of peripheral artery disease among adults with T2DM and also a guide on who to screen. This information is important for addressing PAD and therefore improving the outcome of adult T2DM patients.

3.2 Research Questions

1. What are the sociodemographic characteristics of type 2 diabetics of Asian and African ethnicity in DSM?
2. What is the prevalence of PAD in type 2 diabetics of Asian and African ethnicity?
3. What are the factors involved with PAD among patients with T2DM of both ethnicities?
4. What is the prevalence of comorbidities (hypertension and dyslipidemia) among patients of Asian and African ethnicity who are detected in PAD?
5. What are the types of PAD present among these type 2 diabetics? Symptomatic or asymptomatic?
6. What are the signs associated with PAD among T2DM patients of Asian and African in DSM.

3.3 Objectives

3.3.1 Broad Objective

To determine and compare the prevalence and factors associated with PAD among T2DM patients of Asian and African ethnicities in Dar-es-Salaam.

3.3.2 Specific Objectives

1. To describe the sociodemographic factors among T2DM patients of Asian and African ethnicity in DSM.
2. To determine the prevalence of PAD among T2DM patients of Asian and African ethnicity in DSM.
3. What are the factors involved with PAD among patients with T2DM of both ethnicities?
4. To determine co-morbidities among T2DM patients of Asian and African ethnicity with PAD in DSM.
5. To determine the proportion of T2DM patients of Asian and African ethnicity with symptomatic PAD.

6. To determine signs associated with PAD among T2DM patients of Asian and African in DSM.

3.4 Hypothesis

Null Hypothesis: The prevalence of PAD in T2DM patients of African ethnicity is not different from that of patients of Asian ethnicity.

Alternative Hypothesis: The prevalence of PAD in T2DM patients of African ethnicity is different from that of patients of Asian ethnicity.

CHAPTER FOUR

4.0 METHODOLOGY

4.1 Study Design

This was a cross-sectional, descriptive, comparative study.

4.2 Study Site

This study was conducted in Dar-es-Salaam at the diabetes clinic at Shree Hindu Mandal Hospital (a private hospital, with a 40 bed capacity) located in the City Center area along Chusi Street; as it is the hospital in Dar-es-Salaam that caters to the majority of the Asian T2DM patient population. The clinic is conducted from 8.30am and 4.30pm on all weekdays and caters for an estimated 500 clients per month (both type 1 and 2 Diabetes Mellitus) and was, therefore, suited for achieving the target sample size in the limited duration of time allocated for data collection.

4.3 Study population

The target population were all patients of Asian and African ethnicity with T2DM. All booked and newly registered patients attending the diabetic clinic who satisfied the inclusion criteria were eligible for the study.

4.4 Sampling Technique

Participants were enrolled in a consecutive manner at the time of data collection.

4.5 Study Duration

Data was collected for a period of six months, September 2016 to February 2017.

4.6 Inclusion Criteria

All study participants included were type 2 diabetic patients attending diabetic clinic, with the following criteria:

- Age ≥ 18 years.
- Consenting to participate in the study.

4.7 Exclusion Criteria

1. Patients with amputation of both lower limbs.
2. Patients with foot deformities (pes cavus, talipelis equinovarus).

4.8 Sample Size

Prevalence of PAD in Africans was assumed to be 45%, based on recent studies from Uganda and Nigeria, and 23% in Asians as based on recent studies conducted in India and Pakistan.

$$n = f(\alpha,\beta) * \frac{p_1(1-p_1) + p_2(1-p_2)}{(p_2-p_1)^2}$$

Where:

n = sample size

α = level of significance (5%)

β = power of the sample size calculation (80%)

p_1 = presumed prevalence of PAD in African ethnicity (45%)

p_2 = presumed prevalence of PAD in Asian ethnicity (23%)

Using the above formula, the calculated sample size was 93 patients.

With adjustment for 20% non-response, adjusted sample size for African ethnicity was 116 patients.

As this was a comparative study, the number of calculated African patients were compared to an equal number of Asian patients, hence the estimated sample size was 232 patients.

4.9 Data Collection

Data was collected over a 6 month period using a structured questionnaire and ABI Doppler (Huntleigh MD2 Doppler).

An English questionnaire (attached in the Appendices) was completed for each patient by information received by the principal investigator. Name, sex, date, age, and age at diagnosis of diabetes were recorded. Details of current treatment were also recorded. To document the presence or absence of the symptoms of intermittent claudication i.e. leg muscle discomfort on exertion that is relieved with rest, the Edinburgh intermittent claudication questionnaire was used.

Physical examination was done by the investigator. Blood pressure was measured immediately after the questionnaire is completed. An automated blood pressure machine was used. The blood pressure was measured on the right arm. All readings were recorded in mmHg. Patients were defined as hypertensive according to JNC 7 guideline.

The height of each patient without shoes was recorded in cm and the weight without coat or shoes recorded in kg. The body mass index (BMI) was calculated according to the formula BMI = weight (kg) divided by the height ($m^{2)}$.

A physical examination of the peripheral lower limb was also be performed (clinical inspection for any skin color, nail changes, and for presence of ulcerations and gangrene).

A resting ABI for each lower limb was determined in supine position using a portable Doppler machine with a probe for deep lying vessels, edematous limbs and peripheral vessels. Blood pressure cuffs will be placed bilaterally on the upper arm (brachial pressure) and at the ankle just above the medial malleoli.

An ultrasound transducer was used to locate the arterial Doppler signals distal to the blood pressure cuffs. The Doppler signal from the brachial artery was used to obtain the arm pressure while that from the dorsalis pedis and posterior tibial arteries was used to obtain the ankle pressure. The higher systolic pressure of the anterior dorsalispedis or posterior tibial

measurement for each foot was divided by the highest brachial systolic pressure to obtain the ABI for each limb.

All patients underwent laboratory measurement of the HbA1c and fasting lipid profile. Biochemical analyses were performed at the laboratory at Shree Hindu Mandal Hospital.

4.10 Study definitions

PAD is defined as an ABI <0.9 or >1.3. A value of 0.9–1.3 is defined as a normal ABI.
Normal BMI, overweight and obesity is defined as BMI of 18–24.9, 25–29.9 and ≥ 30 kg/m2 respectively.

Asian ethnicity in this study is defined as Asian individuals of African origin.

Hypertension, as per the JNC 7 criteria, is defined as a blood pressure of ≥140/90 mmHg or being on anti-hypertensive treatment.

Dyslipidemia is described as one as or more than one of the following:

- Serum triglycerides level >1.70 mmol/L
- Low density lipoprotein (LDL) level >4.20 mmol/L
- High density lipoprotein (HDL) level <0.9 mmol/L or >1.80mmol/L
- Total Cholesterol level of >5.2 mmol/L

Classic claudication is defined as exertional cramping pain or aching in the calves, thighs or buttocks, causes the patient to stop walking, and resolves within 10 minutes of rest.

4.11 Validity and reliability of Research Tools

The questionnaire was pretested among 10 patients with T2DM at the MNH Diabetes Clinic to enhance clarity of questions prior to the study.

4.12 Data Analysis Plan

Data entry was made on a spreadsheet on Epidata 3.0. The spreadsheet was then preprogrammed to provide for appropriate skips and checks and predefined response limits while performing data entry. Once data had been entered in this file, it was imported into SPSS 20 statistical software for additional cleaning and analysis.

Data analysis included running frequencies and generating appropriate tables. Means and proportions were calculated for numerical and categorical data respectively. The Chi square test and t test were used to determine associations between variables. If more than 20% of the cells had an expected frequency of <5, categories that were related by the P.I's judgment were combined in order to validate the result of Chi square testing. If combining the categories did not solve the problem then Fischer's exact test was be used instead. Statistically significant results will be considered when $p < 0.05$.

For logistic regression analysis, the dependent variable will be 'abnormal ABI'.

Responses will be categorized as 'Normal', 'Mild', 'Moderate', 'Severe' and 'Poorly Compressible'. Once the relevant prevalence of each of these groups were calculated, these groups were transformed to contain only 2 categories i.e. 'Normal' and 'Abnormal', whereby 'Abnormal' included 'Mild', 'Moderate', 'Severe' and 'Poorly Compressible' subgroups. Thus, 'Abnormal ABI' were used as the dependent variable and ran in a step wise approach against several independent (predictor) variables in logistic regression models.

4.13 Ethical consideration

Ethical clearance for conducting the study was obtained in writing from the MUHAS Institutional review board. The informed consent form was prepared, and was issued to the participants in order to guarantee their voluntary participation, confidentiality, benefits and maintenance of privacy of all participants in the study. Having originally made this form in English, it was translated to Kiswahili to provide for the non-English speaking population. Permission from the study site was also be obtained.

Voluntary participation and the right to withdraw from the study at any time was emphasized. In order to ensure confidentiality, each participant was given a unique participant identifier number. The purpose and procedures of the study were explained to the participants. Time was to them to ask questions or clarify any doubts. The consent forms had the relevant contact details. Participants were asked to sign a consent form to indicate their approval for participation. For patients who could not read, the consent form was read to them and elaborated and their thumb print was taken to imply consent for participation in presence of a witness. The data collected has been stored safely under lock and key at an office which was allotted to the principal investigator and will be discarded after a period of 5 years.

The participants were provided with their ABI results. Patients with Impaired ABI requiring management were referred to the cardiovascular surgery team at MNH. At the end of the data collection process, the participant was thanked, and the questionnaires and signed consent forms were taken and kept safely by the Investigator.
Precautionary measures in using the Doppler were to include the use of methylated spirit to clean the probe before use on every patient.

4.14 Study Mitigation

The study was prone to recall bias due to participant subjectivity in recalling accurately the information required in the questionnaire. Mitigation was done by framing questions to aid accurate recall in the questionnaire. Where possible, other details were corroborated by cross checking patients' clinical records.

4.15 Dissemination Plan

The results of the study will be disseminated by way of:

1. Presentation at the Muhimbili University of Health and Allied Sciences (MUHAS) Internal medicine department or any other department in the university.
2. Publication of the paper in a peer-review scientific journal.
3. The paper may be presented to local and international scientific conferences as the opportunity arises.

4. A hard copy of this paper will be provided to the TDA in Dar es Salaam.
5. Submission of a document containing a summary of key findings at the study site.
6. If a request is made by a study participant about the findings of this research, a document containing a summary of key findings will also be provided

CHAPTER FIVE

5.0 RESULTS

5.1 Socio-demographic characteristics of T2DM patients of Asian and African ethnicity in DSM

A total of 367 (Asians=178 and Africans=189) consenting diabetes patients were recruited from diabetes clinic at Shree Hindu Mandal Hospital for the study.

The mean age of participants was 54.4(53.2-55.7) years (at 95%CI).

The mean ages of Asians and Africans were 58.8(52.9-56.7) and 54.0(52.1-55.9) years (at 95%CI respectively), however, there was no significance difference in mean age between Asians and Africans.

Table 1 shows that 59% of the Asian and 55% of the African of the study subjects were aged 45 to 65 years, about 60% were males in both groups. In both groups about three quarters were married, and nearly more than 55% had secondary or postsecondary level of education. About one third of the participants in both groups had been diagnosed with T2DM for 10 years or more. Nearly 58% of the all the patients who were known to be hypertensive reported to be well-controlled. Nearly 60% had a history of dyslipidemia, but only 46% were on medication for it.

Table 1: Characteristics of T2DM patients by ethnicity

Characteristics	Total, n(%)	Asians, n(%)	Africans, n(%)	P-value
Age group				
<45	87(23.7)	39(21.9)	48(25.4)	0.693
45-65	209(56.9)	105(59.0)	104(55.0)	
>65	71(19.3)	34(19.1)	37(19.6)	
Sex				
Male	214(58.3)	106(59.6)	108(57.1)	0.359
Female	153(41.7)	72(40.4)	81(42.9)	
Location				
Ilala	216(58.9)	161(90.4)	55(29.1)	p<0.0001
Kinondoni	65(17.7)	5(2.8)	60(31.7)	
Temeke	54(14.7)	2(1.1)	52(27.5)	
Others(outside of Dar)	32(8.7)	10(5.6)	22(11.6)	
Marital status				
Married/living together	272(74.1)	129(72.5)	143(75.7)	0.282
Others(single, divorced, widower)	95(25.9)	49(27.5)	46(24.3)	
Education				
None/Primary	140(38.1)	57(32.0)	83(43.9)	0.013
Secondary/post secondary	227(61.9)	121(68.0)	106(56.1)	
Occupation				
Peasant	10(2.7)	1(0.6)	9(4.8)	0.077
Employed	86(23.4)	40(22.5)	46(24.4)	
Self-employed	122(33.2)	64(36.0)	58(30.7)	
Others (homemaker, students, retired)	149(40.6)	73(41.0)	76(40.2)	
Duration since diagnosis with T2DM				
<10 Years	242(65.9)	128(71.9)	114(60.3)	0.013
10+ Years	125(34.1)	50(28.1)	75(39.7)	
Hypertension				
Well Controlled	212(57.8)	109(61.2)	103(54.5)	0.087
Poorly Controlled	45(12.3)	15(8.4)	30(15.9)	
Non HTN	110(30.0)	54(30.3)	56(29.6)	
Hyperlipidemia				
Naive, Not on Rx	145(39.5)	59(33.1)	86(45.5)	p<0.0001
Aware ,On Rx	170(46.3)	103(57.9)	67(35.4)	
Aware, Not on Rx	52(14.2)	16(9.0)	36(19.1)	

5.2 Prevalence of PAD among T2DM patients of Asian and African ethnicity in DSM

The prevalence of peripheral arterial disease (PAD) among diabetes patients was 30.7% and it was significantly high among Africans than the Asian group (38% vs 23%, p=0.001) (**Table 2**).

Table 2: Level and prevalence of PAD among T2DM patients of Asian and African ethnicity in DSM

ABI level/Prevalence PAD	Total, n(%)	Asians, n(%)	Africans, n(%)	P-value
Prevalence of PAD				
Left Leg only				
Abnormal (<0.9 and >1.3)	17(4.7)	5(2.8)	12(6.4)	0.082
Right Leg only				
Abnormal (<0.9 and >1.3)	33(9.0)	9(5.1)	24(12.8)	0.007
Both legs				
Abnormal (<0.9 and >1.3)	62(17.0)	27(15.2)	35(18.7)	0.223
Overall prevalence				
Abnormal (<0.9 and >1.3)	112(30.7)	41(23.0)	71(38.0)	0.001

5.3 Determinants of PAD among diabetes patients

Table 3 shows that age (45-54, 55-64 and 65+), education (none/primary), duration since being diagnosed with T2DM (10+ years), HbA1C% level (poor control >10% and acceptable 7-10%) and a positive history of leg pain were significant determinants of prevalence of PAD among Asians. While for African group the determinants of prevalence of PAD included age (45-54, 55-64 and 65+), duration since being detected with T2DM (10+ years), having checked HbA1C% in the last 12 months, HbA1C% level (poor control >10%), raised total cholesterol ((≥5.2 mmol/L) and a positive history of leg pain.

Table 3: Determinants of prevalence of PAD among T2DM patients by ethnicity in DSM

Determinant	Asians				Africans			
	Total, n(%)	WithPAD, n(%)	COR (95%CI)	AOR (95%CI)	Total, n(%)	WithPAD, n(%)	COR (95%CI)	AOR (95%CI)
Age group								
<45	39(21.9)	2(4.9)	1	1	48(25.7)	4(11.8)	1	1
45-54	41(23.0)	2(4.9)	1.0(0.1-9.1)	2.4(0.7-7.9)	46(24.6)	14(30.4)	4.8(1.5-16.0)	3.2(0.7-14.7)
55-64	56(31.5)	15(26.8)	6.8(1.5-31.6)	3.5(1.1-11.2)	52(27.8)	23(44.0)	8.7(2.7-27.8)	3.3(0.7-16.4)
65+	42(23.6)	22(52.4)	20.4(4.3-95.5)	6.3(1.7-22.7)	41(21.9)	30(73.2)	30.0(8.7-103.1)	9.1(1.6-52.9)
Sex								
Male	106(59.6)	23(21.7)	1		107(57.2)	46(43.0)	1	
Female	72(40.4)	18(25.0)	1.2(0.6-2.4)		80(42.8)	25(31.2)	0.6(0.3-1.1)	
Education								
Secondary/post-secondary	121(68.0)	16(13.2)	1	1	106(56.7)	31(29.2)	1	1
None/primary	57(32.0)	25(43.9)	5.1(2.4-10.8)	2.1(1.1-3.9)	81(43.3)	40(49.4)	2.4(1.3-4.3)	2.2(0.9-5.5)
Occupation								
Employed/Self employed/business	104(58.4)	14(13.5)	1	1	103(55.1)	37(35.9)	1	1
Others(students, farmers, homemakers)	47(26.4)	9(19.1)	1.5(0.6-3.8)	0.7(0.3-1.5)	56(29.9)	14(25.0)	0.6(0.3-1.2)	0.3(0.1-1.0)
Retired	27(15.2)	18(66.7)	12.9(4.8-34.2)	1.4(0.5-4.0)	28(15.0)	20(71.4)	4.5(1.8-11.1)	1.1(0.2-4.8)
Hypertension								
Well Controlled	109(61.2)	20(18.3)	1	1	102(54.5)	43(42.2)	1	
Poorly Controlled	15(8.5)	11(73.3)	12.2(3.5-42.4)	1.7(0.7-4.3)	29(15.5)	16(55.2)	1.7(0.7-3.9)	

No HTN	54(30.3)	10(18.5)	1.0(0.4-2.3)	1.1(0.5-2.6)	56(29.9)	12(21.4)	0.4(0.2-0.8)	
Hyperlipidemia								
Naive, Not on Rx	60(33.7)	13(22.0)	1	1	83(44.4)	23(27.7)	1	1
Aware ,On Rx	102(57.3)	19(18.4)	0.8(0.4-1.8)	0.7(0.4-1.6)	68(36.4)	30(44.1)	2.1(1.1-4.1)	1.2(0.4-3.3)
Aware, Not on Rx	16(9.0)	9(56.2)**	4.7(1.5-14.9)	1.3(0.5-3.1)	36(19.3)	18(50.0)	2.6(1.2-5.9)	1.1(0.3-3.4)
Current smoker								
No	138(77.5)	32(23.2)	1		130(69.5)	44(33.8)	1	1
Yes	40(22.5)	9(22.5)	1.0(0.4-2.2)		57(30.5)	27(47.4)	1.8(0.9-3.3)	0.8(0.3-2.3)
Duration since diagnosed with T2DM								
<10 years	128(71.9)	20(15.6)	1	1	113(60.4)	26(23.0)	1	1
10+years	50(28.1)	21(42.0)	3.9(1.9-8.2)	2.0(1.1-3.8)	74(39.6)	45(60.8)	5.2(2.7-9.8)	2.5(1.0-6.2)
Ever checked HbA1C% in the last 12 months?								
Yes	26(14.6)	6(23.1)	1		41(21.9)	9(22.0)	1	1
No	152(85.4)	35(23.0)	1.0(0.4-2.7)		146(78.1)	62(42.5)	2.6(1.2-5.9)	4.1(1.2-13.6)
Body mass index								
Underweight/Normal	84(47.2)	16(19.0)	1		75(40.1)	22(29.3)	1	1
Overweight/Obesity	94(52.8)	25(26.6)	1.5(0.8-3.1)		112(59.9)	49(43.8)	1.9(1.0-3.5)	1.1(0.4-3.1)
HbA1c% level								
Normal (<7%)	69(39.0)	4(5.8)	1	1	56(29.9)	9(16.1)	1	1
Suboptimal (7-10%)	96(54.2)	29(30.2)	7.0(2.3-21.1)	3.4(1.5-76)	97(51.9)	38(39.2)	3.4(1.5-7.7)	2.6(0.9-7.6)
Poor Control (>10%)	12(6.8)	7(58.3)	22.8(4.9-104.9)	6.5(2.3-18.5)	34(18.2)	24(70.6)	12.5(4.5-35.0)	12.6(2.9-53.8)
S.Triglycerides								
Normal (<1.7 mmol/L)	121(68.4)	18(14.9)	1	1	130(69.5)	45(34.6)	1	1
High(1.7+mmol/L)	56(31.6)	22(39.3)	3.7(1.8-7.7)	0.9(0.4-1.7)	57(30.5)	26(45.6)	1.6(0.8-3.0)	0.4(0.1-0.9)

LDL level								
Normal (<4.2 mmol/L)	145(81.9)	25(17.2)	1	1	139(74.3)	45(32.4)	1	1
High (4.2+mmol/L)	32(18.1)	15(46.9)	4.2(1.9-9.6)	1.3(0.6-2.8)	48(25.7)	26(54.2)	2.5(1.3-4.8)	0.8(0.3-2.2)
HDL level								
Normal (0.9-1.8 mmol/L)	124(70.1)	20(16.1)	1	1	125(66.8)	39(31.2)	1	1
Abnormal(<0.9 or >1.8 mmol/L)	53(29.9)	20(37.7)	3.2(1.5-6.6)	1.2(0.6-2.3)	62(33.2)	32(51.6)	2.4(1.3-4.4)	2.1(0.9-5.1)
Total Cholesterol								
Normal (<5.2 mmol/L)	140(79.1)	23(16.4)	1	1	151(80.7)	49(32.5)	1	1
Abnormal(≥5.2 mmol/L)	37(20.9)	17(45.9)	4.3(2.0-9.5)	1.7(0.7-3.7)	36(19.3)	22(61.1)	3.3(1.5-6.9)	4.0(1.2-13.2)
History of leg pain								
No	133(74.7)	11(8.3)	1	1	113(60.4)	27(23.9)	1	1
Yes	45(25.3)	30(66.7)	22.2(9.3-53.2)	4.3(2.2-8.2)	74(39.6)	44(59.5)	4.7(2.5-8.8)	2.2(1.0-4.9)

5.4 Prevalence of co-morbidities (T2DM and HTN or Dyslipidemia or both) among T2DM patients of Asian and African ethnicity with PAD in DSM

There was an 86.4 % (Asians=87.1% and Africans =85.7%) prevalence of co-morbidities with T2DM; and the difference in prevalence between Asians and Africans was not significant (**Figure 1**).

Figure 2 shows that 98.2% (Asians=100% vs Africans=97.2%) of T2DM patients with PAD had co-morbidities, with an almost overall similar 72% presence of hypertension and 80% dyslipidemia in both ethnic groups.

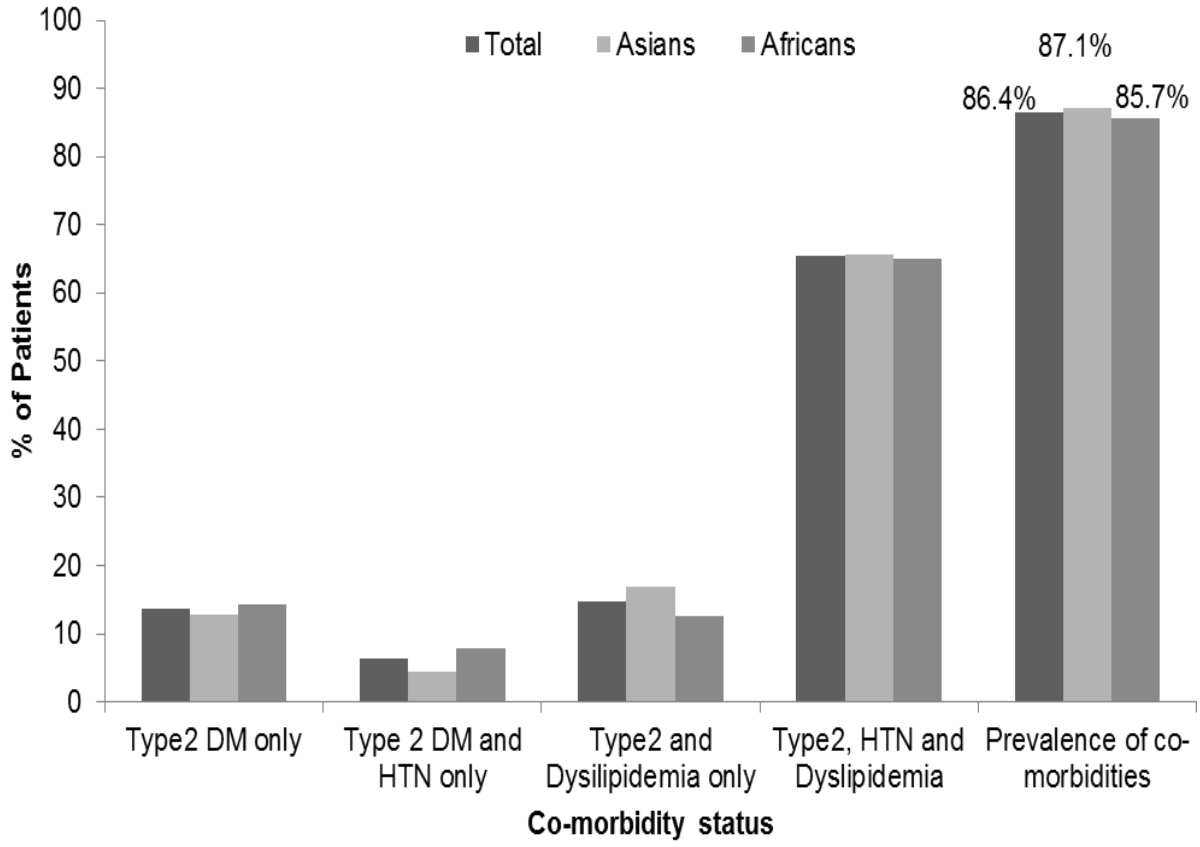


Figure 1: Distribution of T2DM only, the co-morbidities and overall prevalence of co-morbidity by ethnicity (n=367).

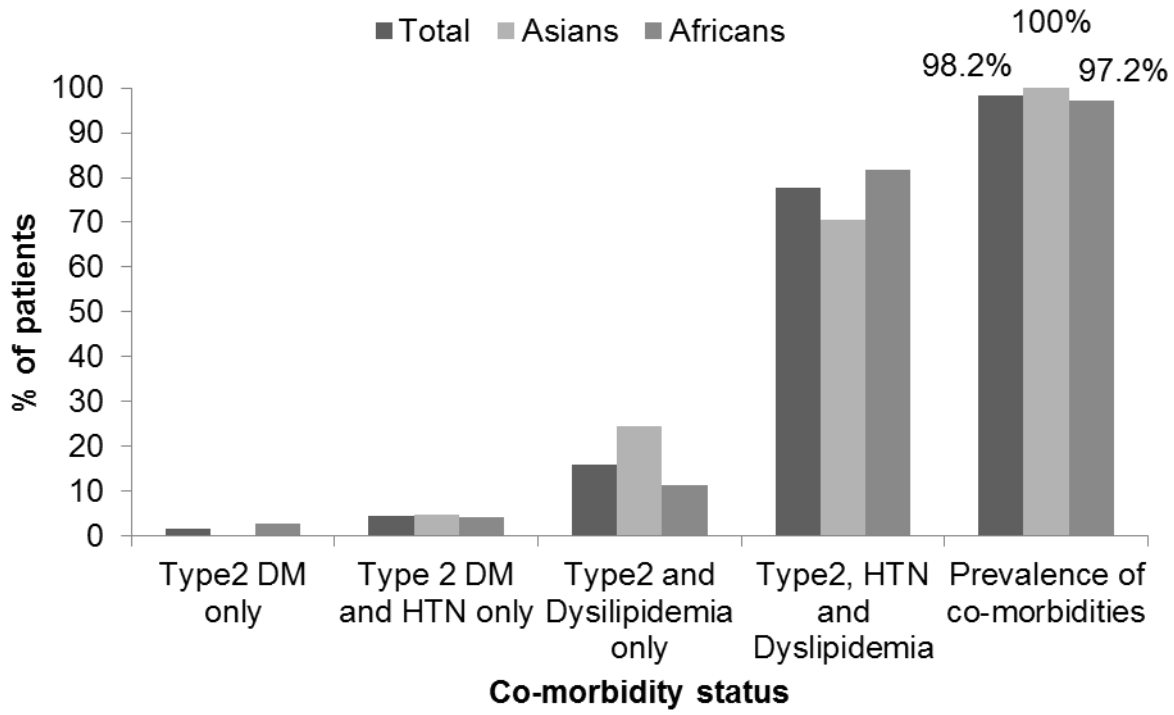


Figure 2: Distribution of T2DM only, the co-morbidities and overall prevalence of co-morbidity in PAD patients by ethnicity (n=112).

Table 4: Comorbidities associated with T2DM with consequent laboratory values.

Variable	Total, n(%)	Asians, n(%)	Africans, n(%)	P-value
Hypertension				
Well Controlled	212(57.8)	109(61.2)	103(54.5)	0.087
Poorly Controlled	45(12.3)	15(8.4)	30(15.9)	
No HTN	110(30.0)	54(30.3)	56(29.6)	
Hyperlipidemia				
Naïve, Not on Rx	145(39.5)	59(33.1)	86(45.5)	p<0.0001
Aware ,On Rx	170(46.3)	103(57.9)	67(35.4)	
Aware, Not on Rx	52(14.2)	16(9.0)	36(19.0)	
S. Triglycerides				
Normal (<1.7 mmol/L)	253(69.1)	121(68.4)	132(69.8)	0.423
High(1.7+mmol/L)	113(30.9)	56(31.6)	57(30.2)	
LDL level				
Normal (<4.2 mmol/L)	286(78.1)	145(81.9)	141(74.6)	0.058
High (4.2+mmol/L)	80(21.9)	32(18.1)	48(25.4)	
HDL level				
Normal (0.9-1.8 mmol/L)	250(68.3)	124(70.1)	126(66.7)	0.280
Abnormal(<0.9 or >1.8 mmol/L)	116(31.7)	53(29.9)	63(33.3)	
Total Cholesterol				
Normal (<5.2 mmol/L)	293(80.1)	140(79.1)	153(81.0)	0.377
Abnormal(<0.9 or >1.8 mmol/L)	73(19.9)	37(20.9)	36(19.0)	
Overall Prevalence of Hyperlipidemia*	294(80.1)	147(82.6)	147(77.8)	0.153
Overall Prevalence of Hypertension**	263(71.7)	125(70.2)	138(73.0)	0.317

**Hyperlipidemia: abnormal lipid profile or aware of having hyperlipidemia and on Rx or aware but not of Rx*

***Hypertension: Well controlled, poorly controlled or BP level >=140/90 mmHg*

5.5 Determinants of T2DM co-morbidities among diabetes patients

Table 5 shows that age (45-54, 55-64 and 65+ years), marital status (single, widower, divorced), and mode of diagnosis (incidental or symptomatic) of T2DM were significant determinants of prevalence of PAD among Asians. While for the Africans age (45-54) was the only determinant of PAD.

Table 5: Factors associated with the prevalence co-morbidities (T2DM and HTN or Dyslipidemia) among T2DM patients of Asian and African ethnicity with PAD in DSM

Factor	Asians			Africans		
	With co-morbidities n(%)	COR (95%CI)	AOR (95%CI)	With co-morbidities n(%)	COR (95%CI)	AOR (95%CI)
Age group						
<45	22(56.4)	1	1	26(54.2)	1	1
45-54	38(92.7)	9.8(2.6-37.2)	16.3(2.8-94.4)	42(91.3)	8.9(2.8-28.7)	11.0(2.4-50.8)
55-64	53(94.6)	13.7(3.6-51.3)	29.1(4.8-175.3)	53(100)	Empty	Empty
65+	41(97.6)	31.7(3.9-254.2)	39.3(3.5-446.4)	42(100)	Empty	Empty
Sex						
Male	95(89.6)	1	1	91(84.3)	1	
Female	59(81.9)	0.5(0.2-1.3)	0.7(0.2-2.2)	72(88.9)	1.5(0.6-3.6)	
Marital status						
Married/cohabiting	108(83.7)	1	1	127(88.8)	1	
Others	46(93.9)	3.0(0.8-10.5)	8.8(1.6-49.1)	36(78.3)	0.5(0.2-1.1)	
Education						
None/primary	104(86.0)	1		84(79.2)	1	
Secondary/post-secondary	50(87.7)	1.2(0.5-3.0)		79(95.2)	5.2(1.7-15.7)	
Occupation						
Employed/Self employed/business	90(86.5)	1		85(81.7)	1	1
Others(students, farmers, homemakers)	37(78.7)	0.6(0.2-1.4)		50(89.3)	1.9(0.7-5.0)	2.7(0.6-11.6)
Retired	27(17.5)	Empty		28(96.6)	6.3(0.8-48.9)	Empty

Smoking status						
No	121(87.7)	1		112(85.5)	1	1
Yes	33(82.5)	0.7(0.3-1.7)		51(87.9)	1.2(0.5-3.1)	0.5(0.1-2.3)
Duration since diagnosed with DMT2						
<10 years	106(82.8)	1	1	89(78.1)	1	1
10+years	48(96.0)	5.0(1.1-22.0)	1.6(0.3-9.9)	74(98.7)	20.8(2.8-157.1)	Empty
How DM was diagnosed?						
Symptomatic	82(82.8)	1	1	50(80.6)	1	
Incidental	72(91.1)	2.1(0.8-5.4)	6.6(1.5-29.0)	113(89.0)	1.9(0.8-4.5)	1.0(0.3-3.4)
Treatment status?						
Not on treatment/ On Life style control	17(73.9)	1	1	18(81.8)	1	
On treatment	137(88.4)	2.7(0.9-7.7)	0.9(0.2-4.0)	145(86.8)	1.5(0.5-4.7)	
Checked HbA1C% in the last 12 months						
Yes	20(76.9)	1	1	32(78.0)	1	1
No	134(88.2)	2.2(0.8-6.3)	1.9(0.5-8.0)	131(88.5)	2.2(0.9-5.3)	1.1(0.3-4.0)
Body mass index						
Underweight/Normal	68(81.0)	1	1	58(76.3)	1	1
Overweight/Obesity	86(91.5)	2.5(1.0-6.3)	1.9(0.6-6.3)	105(92.9)	4.1(1.7-9.9)	0.7(0.2-3.0)
HbA1c% level						
Normal(<7%)	52(75.4)	1	1	41(73.2)	1	1
Acceptable (7-10%)	90(93.8)	4.9(1.8-13.2)	2.2(0.6-8.3)	87(88.8)	2.9(1.2-6.9)	2.0(0.6-6.4)
Poor Control (>10%)	11(91.7)	3.6(0.4-29.9)	0.3(0.0-6.1)	35(100)	Empty	Empty
History of leg pain						
No	133(74.7)	1	1	92(80.7)	1	1
Yes	45(100)	2.6(0.7-9.3)	1.5(0.3-8.3)	71(94.7)	4.2(1.4-12.9)	0.8(0.2-4.8)

5.6 Proportion of T2DM patients of Asian and African ethnicity with symptomatic PAD

About 33% (Africans=39.7% and Asians=25.3%, p=0.007) had positive history of leg pain. Two third of those with symptomatic PAD, had bilateral leg pain and for those whose pain was unilateral, more than 56% participants reported that the pain was on right leg. Exertional leg pain for physically active T2DM patients was reported by 73(19.9%) and Africans were significantly likely to report the situation than Asians (26.5% vs 12.9%, p=0.001). Classic claudication was recorded among 55(15.0%) participants, the condition was more reported by Africans than Asians (20.6% vs 9.0%, p=0.001) (**Table 6**).

The location of pain in symptomatic patients included buttock and hips, thigh, upper two-thirds of calf and lower –third of calf. The above locations were significantly more reported by Africans than Asians (**Table 7**).

Table 6: Proportion of T2DM patients of Asian and African ethnicity with symptomatic PAD

Symptom	Total, n(%)	Asians, n(%)	Africans, n(%)	P-value
Positive history of leg pain	120(32.7)	45(25.3)	75(39.7)	0.007
Unilateral or Bilateral limb pain?				
Unilateral	39(32.5)	14(31.1)	25(33.3)	0.482
Bilateral	81(67.5)	31(68.9)	50(66.7)	
If unilateral, which limb is involved?				
Right	22(56.4)	6(42.9)	16(64.0)	0.173
Left	17(43.6)	8(57.1)	9(36.0)	
If bilateral, then:				
R=L	44(54.3)	17(56.7)	27(52.9)	0.122
R>L	25(30.9)	6(20.0)	19(37.3)	
L>R	12(14.8)	7(23.3)	5(9.8)	
Exertional leg pain, physically active				
Yes	73(19.9)	23(12.9)	50(26.5)	0.001
Exertional leg pain, physically inactive				
Yes	22(6.0)	7(3.9)	15(7.9)	0.081
Leg pain on both exertion and rest				
Yes	29(7.9)	15(8.4)	14(7.4)	0.433
Atypical exertional leg pain type II				
Yes	3(0.8)	1(0.6)	2(1.1)	0.523
Atypical exertional leg pain types I				
Yes	5(1.4)	3(1.7)	2(1.1)	0.472
Classic claudication				
Yes	55(15.0)	16(9.0)	39(20.6)	0.001
Pain at rest				
Yes	45(12.3)	19(10.7)	26(13.8)	0.230

Table 7: Location of pain in symptomatic patients by Ethnicity

Symptom	Total, n(%)	Asians, n(%)	Africans, n(%)	P-value
Buttock and Hip	18(4.9)	3(1.7)	15(7.9)	0.005
Thigh	39(10.6)	12(6.7)	27(14.3)	0.014
Upper two-thirds of calf	75(20.4)	25(14.0)	50(26.5)	0.002
Lower one-third of calf	96(26.2)	38(21.3)	58(30.7)	0.027
Foot	76(20.7)	36(20.2)	40(21.2)	0.463

5.7 Signs and symptoms associated with PAD among T2DM patients of Asian and African in DSM among PAD patients.

About 66% of patients with PAD (Asians=73.2% and Africans=62%) had history of leg pain; however, the difference between the groups was not significant. The leg pain was on unilateral to 30(40.5%) and bilateral 44(59.5%). The proportion of Asians with bilateral pain was significantly higher than Africans (73.3% vs 50%, p=0.038). Exertional leg pain for physically active was observed to 52(46.4%) while exertional leg pain for physically inactive was noted to 15(13.4%) among patients. Leg pain on both exertion and rest, classic claudication and pain at rest were symptoms which were respectively observed to 23(20.5%), 50(44.6%) and 29(25.9%) patients. There was no significant difference in proportion with the above symptoms between Asians and Africans (**Table 6**).

Symptoms including nail dystrophy 61(54.5%) and limb erythema 51(45.5%) prevailed among these patients. Ulcers were more observed among Africans than Asians (21.1% vs 7.3%, p=0.045) (**Table 8**).

Table 8: Common prevalent symptoms associated with PAD among those detected with PAD by ethnicity (n=112)

Symptom	Total, n(%)	Asians, n(%)	Africans, n(%)	P-value
Positive history of leg pain	74(66.1)	30(73.2)	44(62.0)	0.159
Unilateral or Bilateral limb pain?				
Unilateral	30(40.5)	8(26.7)	22(50.0)	0.038
Bilateral	44(59.5)	22(73.3)	22(50.0)	
If unilateral, which limb is involved?				
Right	17(56.7)	3	14(63.6)	0.195
Left	13(43.3)	5	8(36.4)	
If bilateral, then:				
R=L	29(65.9)	14(63.6)	15(68.2)	0.190
R>L	7(15.9)	2(9.1)	5(22.7)	
L>R	8(18.2)	6(27.3)	2(9.1)	
Exertional leg pain, physically active	52(46.4)	18(43.9)	34(47.9)	0.417
Exertional leg pain, physically inactive	15(13.4)	5(12.2)	10(14.1)	0.510
Leg pain on both exertion and rest	23(20.5)	11(26.8)	12(16.9)	0.156
Atypical leg pain	4	3	1	Nill
Classic claudication	50(44.6)	15(36.6)	35(49.5)	0.134
Pain at rest	29(25.9)	11(26.8)	18(25.4)	0.517

Table 9: Foot examination findings by ethnicity (n=367)

Examination/investigation	Total, n(%)	Asians, n(%)	Africans, n(%)	P-value
Food examination				
Integumentary				
Erythema	63(17.2)	19(10.7)	44(23.3)	0.001
Ulcer(s)	28(7.6)	9(5.1)	19(10.1)	0.053
Callus(es)	118(32.2)	65(36.5)	53(28.0)	0.052
Nail dystrophy	94(25.6)	35(19.7)	59(31.2)	0.008
Paronychia	24(6.5)	8(4.5)	16(8.5)	0.092
MS(Deformity)				
None	289(78.7)	156(87.6)	133(70.4)	p<0.0001
Claw/Hammer Toe	75(20.4)	22(12.4)	53(28.0)	p<0.0001
Bunion/Overlapping	19(5.2)	3(1.7)	16(8.5)	0.003
Rocker-bottom	9(2.5)	3(1.7)	6(3.2)	0.279

Erythema (23.3% vs 10.7%, p=0.001) and Nail dystrophy (31.2% vs 19.7%, p=0.008) were signs which were significantly observed among Africans than Asians. The proportion of Asians with no musculoskeletal deformities was significantly higher than the comparative group (87.6% vs 70.4%, p<0.0001). The symptoms of Claw or Hammer Toe (28% vs 12.4%, p<0.0001) and (8.5% vs 1.7%, p=0.003) were MS (deformity) symptoms which prevailed much among Africans than Asians (**Table 10**).

Table 10: Prevalence of signs in patients detected with PAD by ethnicity (n=112)

Sign	Total, n(%)	Asians, n(%)	Africans, n(%)	P-value
Erythema	51(45.5)	15(36.6)	36(50.7)	0.106
Ulcer	18(16.1)	3(7.3)	15(21.1)	0.045
Nail dystrophy	61(54.5)	21(51.2)	40(56.3)	0.371

CHAPTER SIX

6.0 DISCUSSION

This cross-sectional, descriptive study aimed at comparing the current burden of PAD in type 2 diabetic patients of Asian and African ethnicity and identifying and comparing the underlying magnitude of factors and comorbities that could contribute to the disease's progression, along with the presentation of symptoms and signs that were observable in these subjects, in a diabetes clinic run at a private hospital in Dar-es-Salaam.

This is the first comparative study highlighting the prevalence of PAD between type 2 diabetics of Asian and African ethnicities in Dar-es-Salaam. PAD was present in 30.7% of type 2 diabetics overall (23% in the Asian ethnicity and 38% in the African ethnicity) in this study, which is similar to the prevalence in other studies done around the world, i.e. 32% in the Li[30] study(China) and 31.6% in the Akram[32] (Pakistan) study, where as other studies have found variable prevalence, with variability in prevalence being seen in African countries i.e. 52.5% in the Oyelade[40], 40% in the Ogbera[45] and 22% in the Soyoye[46] studies (all three conducted in Nigeria), 39% in the Mwebaze[39] study and 24% in the Okello[43] studies (both in Uganda), as compared to a lower prevalence; 14.4% in the Agarwal[31] study and 24% in the Bembi[34] study (both in India), 21.1% in the Faglia[35] study (England) and 20.6% in the Lee[38] study (Scotland).

The prevalence of PAD in type 2 diabetics in Dar-es-Salaam was 21%, which was reported in the 2002 Abbas [41] study, which shows that there is a significant rise in prevalence of the disease in the last 14 years, which would reflect the increasing incidence of T2DM over the of years along with possible increase in incidence of associated comorbidities. Nevertheless, the prevalence of PAD remains significant in the T2DM patient population, solidifying the association between T2DM and PAD, and warrants appropriate attention. Older age, longer duration of T2DM, poor glycemic control, and a positive history of leg pain were found to be strong predictors of PAD, along with raised total cholesterol being a predictor in the African ethnicity.

Characteristics of type 2 diabetics of Asian and African ethnicities

Of the 367 participants included in this study, just over three-quarters were the age of 45 years and over, and almost two-thirds were males, in both groups. Most of the Asian ethnic populous was seen to be residing in the Ilala district, while the African ethnic participants were almost equally divided over the three districts of the city, with a minority in both groups residing outside Dar-es-Salaam. Three-quarters of the participants in both groups were either married or cohabiting. Just over half of the African and almost three-quarters of the Asian participants had secondary or further education, and just over half in both groups had some form of employment.

Almost one-third of both groups had been diagnosed with T2DM for a duration of over 10 years, but only about one-fifth in each group had had their HbA1c% checked in the last 12 months, during the time the data was being collected. Almost three-quarters in both groups were aware of their HTN, and only one-tenth of these reported a poorly controlled HTN status. Contrastingly, just a little over half in both groups were aware of their dyslipidemia status, of which almost all of the Asians were on lipid-lowering therapy, but only just above half of the Africans were on similar therapy.

Factors associated with PAD in type 2 diabetics of Asian and African ethnicities

Age and PAD

The mean age of patients from both ethnicities in this study was 54.4 years (with the mean ages of Africans and Asians in this study were 58.8 years and 54.0 years, respectively), which is similar compared to the mean of >50 years reported in studies around the world[30-35,38-40,44,45,46], however the ACC/AHA guidelines[12-15] recommend that diabetics >40 years with at least one other risk for atherosclerosis are at risk of PAD, as also seen in this study where a majority of the patients with PAD in both ethnic groups were age 45 years and older; and similar findings were also shown in other studies[30,31,33,34,40].

Sex and PAD

As reported, almost two-thirds were males in both groups in our study, though no significant statistical difference was seen in the prevalence of PAD in both sexes of both ethnicities, with the findings for the Asian ethnicity being similar to both the Agarwal[31] study and the Akram[32] (Pakistan) study, however the Bembi[34] study (India) showed a stronger male predominance of PAD, whereas a female predominance for the disease was seen in the Eschol[44] study. For the African ethnicity however, the Oyelade[40] study and the Okello[43] study showed a stronger female predominance for PAD, whereas the Mwebaze[39], the Ogbera[45] and the Soyoye[46] studies showed a higher male predominance for PAD. Differences can be credited to a smaller sample size being recruited to the Bembi[34] study and a larger proportion of females being recruited in the Oyelade[40] and the Okello[43] studies, however there was still a higher incidence of PAD in men in the Ogbera[45] even though they only formed about one third of the total population included for that study.

Duration of T2DM, Glycemic control and PAD

Duration of diabetes was seen to be a strong predictor of PAD development in our study, where by one third of all the recruited subjects (almost one third of both Asians and Africans) were found to have been diagnosed with T2DM for a duration of more than 10 years, of whom about half had been diagnosed with PAD during the course of this study (quarter of Asians and almost one third of Africans), which overall is also reflected in the Agarwal[31], Bembi[34], Mwebaze[39], Okello[43] and Ogbera[45] studies, though the Mwebaze[39] and Okello[43] studies had a much lower cut-off for the duration (at 4 and 5 years, respectively). Suboptimal and poor glycemic control (HbA1c level >7.0%) was observed in almost two thirds of both ethnicities, which was again seen as a strong predictor of PAD, which was also seen in the Agarwal[31], Soyoye[46] and Ogbera[45] (where the same HbA1c level was used as a cut-off in both studies) and Mwebaze[39] and Eschol[44] studies (though a cut-off of HbA1c level of more than 7.6% was used as an indicator of poor glycemic control in these studies).

These can concurrently be explained by the higher age of the patients and the overall control of T2DM in patients who have had the disease for more than 10 years, along with other existing risk factors of PAD such as hypertension and dyslipidemia.

Smoking and PAD

Smoking, which is reported by the ACC/AHA guidelines[12-15], to also be a significant contributor to the development of PAD, was not observed in our study for either ethnicity, with similar observations in other studies such as the Akram[32],Mwebaze[39], Okello[43] and Soyoye[46] studies, however all these studies, our study included, had a very low proportion of smokers. However, the Agarwal[31] study reported a strong association between smoking and PAD.

Obesity and PAD

Obesity was not seen as a risk factor of development of PAD in type 2 diabetics in our study, despite the fact that more than half of the participants with PAD in both ethnic groups, though small in number, were either overweight or obese. Similar findings were similarly reported in the Agarwal[31], Okello[43] and Ogbera[45] studies. However, the number of overweight/obese patients in our study were much fewer as compared to the Akram[32], Mwebaze[39] and Soyoye[46] (which emphasized the importance of abdominal obesity and high BMI,) studies, which reported obesity to be a significant risk factor for PAD.

Co-morbidities among type 2 diabetics of Asian and African ethnicity with PAD

Hypertension, Dyslipidemia and PAD

It was observed in this study that almost all patients with PAD in both ethnicities had a very high prevalence of comorbidities, those being hypertension and dyslipidemia (high levels of total cholesterol/LDL/triglycerides or low levels of HDL (with raised total cholesterol in particular being a strong determinant of PAD in the African ethnic population) which as suggested by the ACC/AHA guidelines[12-15], are major contributors to the development of PAD.

However, hypertension was not seen as a determinant of PAD in our study for either ethnicity, a finding which is consistent with the observations made in the Ogbera[45] study, where it was reported that though hypertension was highly prevalent in the recruited population, it's association with PAD could not be ascertained. These findings are in contrast with the observations made in other studies[31,39,43,44,46], which report hypertension as a strong predictor of PAD. This disparity could be caused by the fact that more than three-quarters of the participants in this study had reported awareness and good control of their hypertension.

As seen for lipids, only raised level of total cholesterol in the African ethnic group, in this study, which was also seen in the Soyoye[46] study (which also reported high levels of LDL and triglycerides as predictors), though any observed variability reported by various studies is a result of variability in the cut-off end points for dyslipidemia.

Proportion of type 2 diabetics of Asian and African ethnicity with symptomatic PAD

Though leg pain in diabetics can be attributed to many reasons; in this study, of the one third overall who had reported a history of leg pain, whether physically active or inactive, two thirds of these patients with PAD had presented with a positive history of leg pain, rendering the rest as asymptomatic. Of those who were symptomatic, more than half were Africans. Classic claudication, which is considered to be the hallmark sign of PAD, was present in almost half of the PAD patients in this study, with two thirds of them being Africans, which was similarly observed in the Bembi[34] and the Mwebaze[39] studies, but contrastingly different from the Oyelade[40] study, which reported to have a significantly larger proportion of asymptomatic patients (attributable to the fact that only older patients between the ages of 50-89 were considered, who may have less exertional activity above a certain age to present with symptoms) and also in the Okello[43],Ogbera[45] and Soyoye[46] studies where asymptomatic PAD was more prevalently observed, which poses the question of how prevalent the possible presence peripheral neuropathy is in type 2 diabetics with PAD affects the symptomatology.

Signs associated with PAD among type 2 diabetics of Asian and African in DSM

The Mwebaze[39] study showed the prevalence of signs of PAD in their recruited type 2 diabetic participants, though it did not discuss how many of the 39% detected with PAD had actually presented with the signs. Our study, being the first to explore the signs exhibited exclusively by PAD-detected patients, showed a significantly higher prevalence of signs, namely erythema of the lower limbs, nail dystrophy and lower limb ulcers, in the African ethnicity as compared to the Asian ethnicity. Almost half of all African patients detected with PAD had lower limb erythema and nail dystrophy, and one fifth of them also had foot ulcers (which is almost similar or the observation in the Chiwanga[46] study (Dar-es-Salaam), however the number of patients in our study with foot ulcers were considerably less. Our study is also the first to explore these signs in the PAD of Asian ethnicity, and it was observed that almost half of these patients also had nail dystrophy, but a much smaller proportion had erythema (one-third) and ulcers (less than one-fifth).

6.1 Strengths

The strength of this study lies in the fact that no candidate was excluded.

6.2 Limitations

There were no limitations observed in this study.

6.3 Conclusion

This study explicitly reveals that there is a higher prevalence of PAD in type 2 diabetics of African ethnicity (two-fifths of the ethnicity) as compared those of the Asian ethnicity (one quarter of the ethnicity); also highlighting that the overall increasing burden of the disease in the city (almost one-third of the total population) in line with the increasing burden of T2DM and related comorbidities.

The study also showed that older age, duration of T2DM, poor glycemic control and history of leg pain are significant factors associated with PAD in both these groups, with Africans

having an increased burden of high total cholesterol levels as an additional factor as compared to Asians.

Africans also bear the burden of more prevalent comorbities along with T2DM(HTN and dyslipidemia) as compared to the Asians, which can be explained by the Asians having an early incidental diagnosis of the disease and comorbities and early control which possibly decelerates the progression of PAD in this ethnic group.

Prevalence of symptomatic PAD in both these groups was similar, though the PAD patients of the African ethnicity had more a higher prevalence of the signs of the disease as compared to the Asians.

6.4 Recommendations

1) About one-third of the type 2 diabetics in Dar-es-Salaam have PAD, with a higher burden seen in the African ethnicity (about two-fifths) than in the Asian ethnicity (about one-quarter). This study should prompt care-givers to screen any diabetic patient with an older age, or duration of DM for more than 10 years, or with poor glycemic control or a history of any form leg pain for PAD.

2) Data from this study provides guidance for identification of patients who are more at risk and will allow timely and appropriate measures to be taken to reduce the health and economic burden of PAD complications.

3) Larger studies can be done to look at other possible causative factors for PAD in T2DM patients, such as genetic or environmental factors, other comorbidities or dietary composition.

REFERENCES

1. Alberti K, Zimmet Pf. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabetic medicine. 1998(15):539-53.

2. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 2003 Jan;26Suppl 1:S5-20.

3. Organization WH. WHO Expert Committee on diabetes Mellitus: second report. Geneva, Switzerland: World Health Organization, 1980. WHO Technical Report Series. (646).

4. Atlas D. International Diabetes Federation. Halladoen :http://wwwidf org/diabetesatlas/5e/es/prologo. 2000.

5. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. Diabetes care. 1998;21(9):1414-31.

6. Wild SH, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030 response to Rathman and Giani. Diabetes care. 2004;27(10):2569-.

7. Guijarro C, Mostaza JM, Hernández-Mijares A. [Lower limb arterial disease and renal artery stenosis]. *ClinInvestigArterioscler*2013; **25**: 218 223

8. Hirsch AT, Criqui MH, Treat-Jacobson D, et al. Peripheral arterial disease detection, awareness, and treatment in primary care. JAMA 2001; 286:1317.

9. Selvin E, Erlinger TP. Prevalence of and risk factors for peripheral arterial disease in the United States: results from the National Health and Nutrition Examination Survey, 1999-2000. Circulation 2004; 110:738.

10. Smith SC Jr, Milani RV, Arnett DK, et al. Atherosclerotic Vascular Disease Conference: Writing Group II: risk factors. Circulation 2004; 109:2613.

11. Murabito JM, D'Agostino RB, Silbershatz H, Wilson WF.Intermittentclaudication. A risk profile from The Framingham Heart Study. Circulation 1997; 96:44.

12. Hirsch AT, Haskal ZJ, Hertzer NR, et al. ACC/AHA 2005 guidelines for the management of patients with peripheral arterial disease; TransAtlantic Inter-Society Consensus; and Vascular Disease Foundation. J Am CollCardiol 2006; 47:1239.

13. 2011 writing group members, 2005 writing committee members, ACCF/AHA TaskForcemembers. 2011 ACCF/AHA Circulation 2011; 124:2020.

14. Hirsch AT, Haskal ZJ, Hertzer NR, et al. ACC/AHA 2005 Practice Guidelines for the management of patients with peripheral arterial disease TransAtlantic Inter-Society Consensus; and Vascular Disease Foundation. Circulation 2006; 113:e463.

15. Jude EB, Oyibo SO, Chalmers N, Boulton AJ. Peripheral arterial disease in diabetic and nondiabetic patients: a comparison of severity and outcome. Diabetes Care 2001; 24:1433.

16. Bundó M, Muñoz L, Pérez C, et al. Asymptomatic peripheral arterial disease in type 2 diabetes patients: a 10-year follow-up study of the utility of the ankle brachial index as a prognostic marker of cardiovascular disease. Ann VascSurg 2010; 24:985.

17. Selvin E, Erlinger TP. Prevalence of and risk factors for peripheral arterial disease in the United States: results from the National Health and Nutrition Examination Survey, 1999-2000. Circulation 2004; 110:738.

18. Leibson CL, Ransom JE, Olson W, et al. Peripheral arterial disease, diabetes, and mortality. Diabetes Care 2004; 27:2843.

19. Selvin E, Marinopoulos S, Berkenblit G, et al. Meta-analysis: glycosylated hemoglobin and cardiovascular disease in diabetes mellitus. Ann Intern Med 2004; 141:421.

20. Weiss JS, SumpioBE. Review of prevalence and outcome of vascular disease in patients with diabetes mellitus. Eur J VascEndovascSurg 2006; 31:143.

21. Komai H, Obitsu Y, Shigematsu H. Diabetes and old age could affect long-term patency of paramalleolar distal bypass for peripheral arterial disease in Japanese patients. Circ J 2011; 75:2460.

22. Dosluoglu HH, Lall P, Nader ND, et al. Insulin use is associated with poor limb salvage and survival in diabetic patients with chronic limb ischemia. J VascSurg 2010; 51:1178.

23. Mellière D, Berrahal D, Desgranges P, et al. Influence of diabetes on revascularisation procedures of the aorta and lower limb arteries: early results. Eur J VascEndovascSurg 1999; 17:438.

24. Lester FT. The clinical pattern of diabetes mellitus in Ethiopians. Diabetes Care. 1984 Jan-Feb;7(1):6-11.

25. Greenwood B, Taylor J. The complications of diabetes in Nigerians. Tropical and geographical medicine. 1968;20(1):1.

26. Chukwuemeka AC, Fulton WF, M'Ngola E N. Ischaemic heart disease among African diabetics in Nairobi. East Afr Med J. 1972 Nov;49(11):854-9.

27. Osuntokun BO, Akinkugbe FM, Francis TI, Reddy S, Osuntokun O, Taylor GO. Diabetes mellitus in Nigerians: a study of 832 patients. West Afr Med J Niger Pract. 1971 Oct;20(5):295-312

28. Criqui MH. Peripheral arterial disease--epidemiological aspects. *Vasc Med* 2001; **6**: 3-7

29. Puras-Mallagray E, Gutiérrez-Baz M, Cáncer-Pérez S, Alfayate-García JM, de Benito-Fernández L, Perera-Sabio M, Criado-Galán F, Hernández-Mijares A. Estudio de prevalencia de la enfermedad arterial periférica y diabetes enEspa-a. *Angiologia* 2008; 60: 317-326

30. Li, JueLuo, YingyiXu, Yawei Yang, JingangZheng, LiqiangHasimu, Buaijiaer Yu, Jinming Hu, Day; Risk factors of peripheral arterial disease and relationship between low ankle - brachial index and mortality from all-cause and cardiovascular disease in Chinese patients with type 2 diabetes. 2006; 60: 7-9.

31. Agarwal a K, Singh M, Arya V, Garg U, Singh VP, Jain V. Prevalence of peripheral arterial disease in type 2 diabetes mellitus and its correlation with coronary artery disease and its risk factors. *J Assoc Physicians India*. 2012;60(july):28-32.

32. Akram J, Aamir A, Basit A, et al. Prevalence of peripheral arterial disease in type 2 diabetics in Pakistan. *J Pak Med Assoc*. 2011;61(7):644-648.

33. Bianchi C, Penno G, Pancani F, et al. Non-traditional cardiovascular risk factors contribute to peripheral arterial disease in patients with type 2 diabetes. *Diabetes Res Clin Pract*. 2007;78(2):246-253.

34. Bembi V, Singh S, Singh P, Aneja GK, Arya TVS, Arora R. Prevalence of peripheral arterial disease in a cohort of diabetic patients. *South Med J*. 2006;99(6):564-569.

35. Faglia E, Caravaggi C, Marchetti R, et al. Screening for peripheral arterial disease by means of the ankle-brachial index in newly diagnosed Type 2 diabetic patients. *Diabet Med*. 2005;22(10):1310-1314. doi:10.1111/j.1464-5491.2005.01612.x.

36. Al-Delaimy WK, Merchant AT, Rimm EB, Willett WC, Stampfer MJ, Hu FB. Effect of type 2 diabetes and its duration on the risk of peripheral arterial disease among men. *Am J Med*. 2004;116(4):236-240. doi:10.1016/j.amjmed.2003.09.038

37. Criqui MH, Vargas V, Denenberg JO, Ho E, Allison M, Langer RD, et al. Ethnicity and peripheral arterial disease: The San Diego population study. Circulation. 2005;112(17):2703– 7.

38. Lee AJ, MacGregor AS, Hau CM, Price JF, Rumley A, Lowe GD FF.Role Haematol factors Diabet Peripher Arter Dis Edinburgh artery study.1999; 105(3):648.

39. Mwebaze RM Mbayo, Kibirige D. Peripheral arterial disease among adult diabetic patients attending a large outpatient diabetic clinic at a national referral hospital in Uganda: a descriptive cross sectional study. PLoS One. 2014;9(8):e105211.

40. Oyelade BO, OlaOlorun AD, Odeigah LO, Amole IO, Adediran OS. The prevalence of peripheral arterial disease in diabetic subjects in south-west Nigeria. African J Prim Heal Care Fam Med [Internet]. 2012;4(1):6 pages.

41. Abbas Z, Archibald L. The diabetic foot in sub-Saharan Africa: a new management paradigm. *Diab Foot J* 2007; 10: 128–36

42. Tesfaye S, Gill G. Chronic diabetic complications in Africa. African J diabetes Med. 2011;19(May 2011):36–40.

43. Okello, S., Millard, A., Owori, R., Asiimwe, S., Siedner, M., Rwebembera, J., . . . Annex, B. Prevalence of lower extremity Peripheral artery disease among adult diabetes patients in Southwestern Uganda. BMC Cardiovascular Disorders.2014; 14(1), 75.

44. Eshcol, J., Jebarani, S., Anjana, R., Mohan, V., & Pradeepa, R. Prevalence, incidence and progression of peripheral arterial disease in Asian Indian type 2 diabetic patients. Journal of Diabetes and Its Complications. 2017, 4 26; 28(5), 627-631.

45. Ogbera, A., Adeleye, O., Solagberu, B., & Azenabor, A. Screening for peripheral neuropathy and peripheral arterial disease in persons with diabetes mellitus in a Nigerian University Teaching Hospital. BMC Research Notes.2015; 8, 533.

46. D. O. Soyoye, R. T. Ikem, B. A. Kolawole, K. S. Oluwadiya, R. A. Bolarinwa, and O. J. Adebayo, “Prevalence and Correlates of Peripheral Arterial Disease in Nigerians with Type 2 Diabetes,” Advances in Medicine, vol. 2016, Article ID 3529419, 6 pages, 2016. doi:10.1155/2016/3529419

47. Fowkes, F., Murray, G., Butcher, I., Folsom, A., Hirsch, A., Couper, D., Sutton-Tyrrell, K. Development and validation of an ankle brachial index risk model for the prediction of cardiovascular events. 2014; Eur J Prev Cardiol, 21.

48. National Institute for Medical Research (Tanzania), World Health Organization (WHO). Tanzania STEPS Noncommunicable Disease Risk Factors Survey 2012.

49. Zargar AH, Khan AK, Masoodi SR, Laway BA, Wani AI, Bashir MI, Dar FA Diabetes Res ClinPract. 2000 Feb; 47(2):135-46.

50. Ramachandran A, Snehalatha C, Kapur A, Vijay V, Mohan V, Das AK, Rao PV, Yajnik CS, Prasanna Kumar KM, Nair JD, Diabetes Epidemiology Study Group in India (DESI) Diabetologia. 2001 Sep; 44(9):1094-101.

51. Chiwanga F., Mugusi F. Diabetic Foot: Prevalence, risk factors,knowledge and practices of foot care among diabetic patients attending public diabetic clinics in DSM 2008; 48-52.

APPENDICES

Appendix I: Informed Consent Form – English Version

INFORMED CONSENT FORM FOR PARTICIPATION

Introduction

Greetings,

I am Dr. Amar Swali from Muhimbili National hospital. I am doing a research on the prevalence of peripheral arterial disease in Dar-es-Salaam, a comparative study between type 2 diabetics of Asian and African ethnicity. I will now tell you all about the details of this research and will then request your consent for participation. If you have any questions I will be very happy to answer them.

Research aim

You are being asked to participate in a study which aims at evaluating the magnitude of peripheral arterial disease in people suffering from Type 2 Diabetes Mellitus. At the end of the study a percentage of those patients whose ABI are abnormal will be identified. We will also identify some factors associated with these abnormalities in these patients.

What is to be done?

Those who accept to participate in this research will be asked to respond to a number of questions. Anthropometric measurements and physical examination will be done. Then, their ABI will be measured by the use of an 'ABI Doppler'. In this procedure, you will be asked to lie down on the examination bed and allow the principal investigator to measure the blood pressure in your extremities with a blood pressure cuff and the ABI Doppler. Blood samples will also be taken to check certain parameters that are relevant to this study (HbA1c and Lipid profile). The test requires a high degree of your cooperation. The entire exercise should not take more than 15 minutes of your time.

Those found to have abnormal ABI will be given prescription for medications and/or urged to seek medical advice from a cardiovascular surgeon at Muhimbili National Hospital. This will depend on the severity of the condition.

Confidentiality

All the information taken is strictly confidential and will be used only for the purpose of this research, whose results can be used in health programs.

Advantages and disadvantages

You shall be provided with the results of your ABI and thus you will know whether or not your lower limb circulation is impaired.. Also, you can get an advice from the principle investigator at any time you need it by communicating with him. There is no financial compensation for participation.

It is our hope that the findings of this research will create awareness about PAD among sufferers of T2DM to individual participants and the nation as a whole. This will help sensitize health care providers about this condition so that appropriate care may be instituted for such patients.

There is no harm in participating in this research. You may feel a little uncomfortable during the maneuver but it is a safe exercise and requires a high degree of your cooperation.

The right to terminate participation

You are not forced to participate in this research and thus you are free to quit it at any time. Your decision to quit will not ruin the good rapport you have established so far with the investigators up to this moment nor will it affect you access to care at this or any other hospital.

In case of injuries due to participation

We do not expect any injury in your participation but if any occurs then we will treat it accordingly, in Tanzanian standards.

For further information contact:-

Dr. Amar Swali, (principle investigator), or Prof. Said Aboud (Director of Research and Publications),

Muhimbili University of Health and Allied Sciences (MUHAS),
Department of Internal Medicine,
P.O.Box 65001, Dar es Salaam.
Phone: +255-686-561336

OR

Dr. Kaushik Ramaiya, (Co Supervisor)
Muhimbili University of Health and Allied Sciences
P.O.Box 65001, Dar es Salaam.
Phone: +255-713-618495

I……., have understood the above information concerning this research and thus have agreed to participate.

Participant's signature _____

Research Assistant's signature _____

Signature of witness _____

Date: __/__/_____

Appendix II: Informed Consent Form – Swahili Version

Fomu ya ridhaa Kwa Ushiriki

Utangulizi

Salamu,

Mimi ni Dr Amar Swali kutoka hospitali ya Taifa ya Muhimbili, nafanya utafiti juu ya ugonjwa wa mzunguko wa damu kwenye mishipa ya miguu jijini Dar-es-Salaam, utafiti linganishi kati ya ugonjwa wa kisukari aina ya pili(T2DM) miongoni mwa watu wa asili ya Asia na Afrika.Nakupatia maelezo kuhusu maelezo ya utafiti huu na kisha naomba idhini yako kwa ajili yakushiriki. Kama una maswali yoyote mimi nitakuwa na furaha sana kujibu.

Utafiti

Utafiti huu una lengo la kutathmini ukubwa wa ugonjwa mishipa ya pembeni kati ya watu wanaosumbuliwa na ugonwa wa kisukari aina 2.

Kitakachofanyika

Ukiridhia kushiriki, utatakiwa kujibu maswali kadhaa. Vipimo vya urefu na uzito vitafanyika. Kisha, utafanyiwa kipimo cha ABI kwa kutumia kifaa cha 'ABI Doppler'. Sampuli za damu zitachukuliwa pia kuangalia vigezo fulani ambayo ni muhimu kwa utafiti huu (HbA1c na Lipid profile). Ninaomba ushirikiano wako kufanikisha zoezi hili.

Endapo utakutwa na kipimo cha ABI kisichoridhisha, unaweza kupewa dawa au kushauriwa kuona daktari bingwa wa upasuaji wa moyo na mishipa katika Hospitali ya Taifa Muhimbili.

Usiri

Siri za mgonjwa zitalindwa na mtafiti.

Faida na hasara

Unaweza kupata ushauri kutoka kwa mtafiti mkuu wakati. Hakuna fidia ya kifedha kwa ajili ya kushiriki.

Ni matumaini yetu kwamba utafiti huu utaboresha huduma za magonjwa ya mishipa ya damu kwa wagonjwa wa T2DM.

Hakuna madhara katika kushiriki katika utafiti huu.
Haki ya kusitisha ushiriki
Mshiriki anayo ridhaa yakujitoa katika utafiti wakati wowte hata bila kutoa sababu.

Kwa taarifa zaidi wasiliana na: -
Dk Amar Swali au Prof. Said Aboud (Mkurungenzi wa Utafiti na Machapisho) Chuo Kikuu cha Tibana Sayansi Muhimbili (MUHAS),

Idara ya Tiba ya Ndani, P.O.Box 65001, Dar es Salaam. Simu: + 255-686-561336

AU
Dk Kaushik Ramaiya, (Co Msimamizi) Chuo Kikuu cha Tibana Sayansi Muhimbili P.O.Box 65001, Dar es Salaam.
Simu: + 255-713-618495
Mimi ....., nimeelewa maelekezo yaliyotolewa hapo juu na nimeridhia/sijaridhia kushiriki katika utafiti huu.
Sahihi ya Mshiriki _____

Sahihi yaMsaidiziwa Utafiti _____

Sahihi ya Shahidi _____

Tarehe: __/__/_____

Appendix III: Questionnaire

PAD AMONGST PATIENTS WITH T2DM

Date of Interview:	
Research Asst:	

PART A: DEMOGRAPHIC DETAILS

S/NO	Participant Identifier No.		
1.	a)Name :		
	b)Ethnicity	1. Asian 2. African	
2.	Age:		
3.	Sex	1.Male 2.Female	
4.	Telephone/mobile Contact:		
5.	Residence	a)Region	
		b)District	
		c) Ward	
		d) Street	
6.	Next of kin:		
7.	Telephone/Mobile(Next of kin):		

PART B: MARITAL STATUS, EDUCATION AND OCCUPATION

8.	**Marital Status**			
	1.Single	2.Married		
	3.Divorced	4.Cohabiting		
	5.Widowed			
9.	**Highest level of education attained**			
	1.No formal education	2.Primary Education		
	3.Secondary Education	4.Post-Secondary		
	5.Other			
10.	**Occupation**			
	1.Farmer	2.Employed	3.Self-employed/Business	
	4.Home-maker	5.Student	6. Retired 7. Others(specify)	

PART C: HISTORY AND PHYSICAL EXAMINATION

11.	History of leg pain 1.Yes 2. No	
12.	No pain noted 1.Yes 2.No	
13.	Unilateral or Bilateral limb pain? 1.Unilateral 2.Bilateral ***(If Bilateral, skip to 15)***	
14.	If unilateral, which limb is involved? 1.Right(R) 2.Left(L)	
15.	If bilateral, then; 1.R=L 2.R>L 3.L>R	
16	No exertional leg pain, physically active 1.Yes 2.No	

17.	No exertional leg pain, physically inactive 1.Yes 2.No	
18.	Leg pain on both exertion and rest 1.Yes 2.No	
19.	Atypical exertional leg pain type II – Pain similar to that of classic claudication, but does not involve the calves or does not resolve within 10 minutes of rest 1.Yes 2.No	
20.	Atypical exertional leg pain types I – Pain similar to that of classic claudication, but does not cause the patient to stop walking 1.Yes 2. No	
21.	Classic claudication – Exertional calf pain that does not begin at rest, causes the patient to stop walking, and resolves within 10 minutes of rest 1. Yes 2. No	
22.	Pain at rest: 1.Yes 2.No	
23.	Is pain relieved by compressing calf muscles? (Suggestive of restless legs syndrome) 1.Yes 2.No	

24.	**Location of pain in symptomatic patients**	
	a)Buttock and Hip 1.Yes 2.No	
	b)Thigh 1.Yes 2.No	
	c)Upper two-thirds of calf 1.Yes 2.No	
	d)Lower one-third of calf 1.Yes 2.No	
	e)Foot 1.Yes 2.No	

GENERAL HISTORY

25.	PMHx:	Hypertension 1.Well Controlled 2.Poorly Controlled 3. No HTN			
26.		Hyperlipidemia 1.Naïve,Not on Rx 2.Aware ,On Rx 3.Aware,Not on Rx			
27.	Pregnant: 1.Yes 2.No 3.N/A (***if is male***)				
28.	LNMP				
29.	Menopausal 1.Yes 2.No 3.N/A				
30.	Past or recent surgery 1.Yes 2.No				
31.	Smoking	1.Never	2.Former	3.Active ***(If Never, skip to 35)***	
32.	a) If active smoker, do you smoke daily? 1.Yes 2.No				
	b) If former smoker, were you smoking daily? 1.Yes 2.No				
33.	If active smoker; duration since started smoking(years)				
34.	If former smoker; duration since stopped smoking				

HISTORY OF T2DM

35.	When was T2DM diagnosed?				
36.	How was it diagnosed?: 1.Symptomatic 2.Incidental				
37.	On treatment?	1.No,None	2.No,Only Life-style	3.Yes (***if not on treatment,***	

			control	***skip to 40***)	
38.	If Yes; specify	1.Oral	2.Insulin	3.Both	
39.	Compliance:	1.Good	2.Poor		
40.	Control:	1.Good	2.Poor		
41a.	Have you checked for HbA_1c for the last 12 months? 1. Yes 2.No (***if no, skip to 42***).				
41b.	Last recorded HbA_1c value:				

PHYSICAL EXAM

42.Weight kg	43.Height cm	
44.Blood Pressure(mmHg) & PR(b/min): a)1st Reading SBP DBP PR b)2nd Reading SBP DBP PR c)3rd Reading SBP DBP PR		
FOOT EXAMINATION		
45.Integumentary	a)Erythema 1.Yes 2.No	
	b)Ulcer(s) 1.Yes 2.No	
	c)Callus(es) 1.Yes 2.No	
	d)Nail dystrophy 1.Yes 2.No	
	e)Paronychia 1.Yes 2.No	
46.MS(Deformity)	a)None 1.Yes 2.No	
	b)Claw/Hammer Toe 1.Yes 2.No	
	c)Bunion/Overlapping 1.Yes 2.No	
	d)Rocker-bottom 1.Yes 2.No	

PART D: ABI DETERMINATION BY ABI DOPPLER

Parameter	**Observed reading (mmHg)**
47.Right arm systolic pressure	
48.Right leg systolic pressure	
49.Left arm systolic pressure	
50.Left leg systolic pressure	

INTERPRETATION

51.Left ABI	
52.Right ABI	

HbA1C and LIPID PROFILE

Parameter(Units)	**i)Patient Value**	**ii) Reference Range**
53. HbA_1C(%)		**4.4-6.6%**
54.S.Triglycerides		**<1.7 mmol/l**
55.LDL		**<4.2 mmol/l**
56.HDL		**0.9-1.8 mmol/l**
57.Total Cholesterol		**<5.2 mmol/l**

58. Conclusion……..

Appendix IV: Doppler Information

dopplex® ABPI

Ankle Brachial Pressure Index Kit

The ABPI Kit contains all the items required to undertake a full ABPI assessment on regular or oedematous limbs and includes two Doppler probes and cuffs. The Easy8 probe helps to locate vessels and also maintain vessel contact during inflation and deflation procedures, and the VP5 is ideal for oedematous limbs. Pack includes:

- Dopplex® MD2 bi-directional Doppler
- High sensitivity widebeam EZ8 8MHz probe
- High sensitivity VP5HS 5MHz probe
- Large arm/ankle cuff
- Standard arm/ankle cuff
- Sphygmomanometer (quick release)
- ABPI Guide
- Educational CD
- Large carry bag