PREVALENCE OF HYPETENSION, ITS CONTROL AND OTHER CARDIOVASCULAR RISK FACTORS AMONG DIABETIC PATIENTS AT MUHIMBILI NATIONAL HOSPITAL, DAR ES SALAAM

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PREVALENCE OF HYPETENSION, ITS CONTROL AND OTHER CARDIOVASCULAR RISK FACTORS AMONG DIABETIC PATIENTS AT MUHIMBILI NATIONAL HOSPITAL, DAR ES SALAAM

By

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Cardiology of the Muhimbili University of Health and Allied Sciences

October 2010

CERTIFICATION

The undersigned certify that they have read and hereby recommend for the examination of a dissertation entitled **"Prevalence of Hypertension, its control and other cardiovascular risk factors among diabetic patients at Muhimbili National Hospital, Dar es salaam"** in fulfilment of the requirements for the degree of Master of Science in Cardiology of the Muhimbili University of Health and Allied Sciences

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DECLARATION AND COPYRIGHT

I, **Julius Chacha Mwita,** 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.

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DEDICATION

To my mother,

My wife, Nelly,

And our son, Chacha Jr

ABSTRACT

Background: Hypertension is a common co morbidity of diabetes that has twice the risk of cardiovascular disease as compared to non-diabetic. This risk is reduced by hypertension treatment to a target blood pressure (BP) level of <130/80 mmHg. However, reaching target BP in hypertensive patients is often difficult and it has only been reached in 9 to 58% of diabetics studied. Generally, hypertension in type 2 diabetic patients clusters with other cardiovascular risk factors such as obesity, hyperglycemia, and dyslipidemia. Little information is available about the magnitude of hypertension, its control and other associated cardiovascular risk factors among diabetics in our setting.

Objectives: To determine the prevalence of hypertension, its control and the prevalence of other cardiovascular risk factors among diabetic patients at Muhimbili Diabetic clinic, Dar es Salaam

Methods: This was 6 months prospective cross-sectional and descriptive study that consecutively enrolled 150 diabetics patients attending MNH clinic aging 18 years and above. Data on weight and height, blood pressure, random capillary blood glucose, lipid profile and serum creatinine were ascertained. Hypertension and diabetes therapy were also documented.

Results: Fifty four percent of all patients were hypertensive. Of these, 67 (81.7%) patients were on anti- hypertensive medications with only 34% of them achieving a controlled target of BP < 130/80 mmHg. Hypertensive patients were older, more overweight/obese, had a longer duration of diabetes and elevated serum creatinine. Majority of the patients were on glucose-lowering agents but only 23.3% achieved glycemic control (pre-prandial glucose < 7.2 mmol/l). Dyslipidemia was highly frequent (88%) with elevated LDL cholesterol being the commonest form. Hypertriglyceridemia was significantly associated with poor glycemic control. Overweight and obesity were found in 48.7% and 18.7% respectively. Active cigarette smoking was uncommon (1.3%).

Conclusion: Hypertension, hyperglycaemia, dyslipidaemia and obesity are prevalent among our diabetic patients. Of all patients who were on antihypertensive drugs only a third reached a control target level of 130/80 mmHg. Similarly most patients had poor glycemic control. It is recommended that a more aggressive and multifactorial approach to address cardiovascular risk factors be used in this high-risk group to prevent cardiovascular events.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACE-I	Angiotensin converting enzyme inhibitors
ACCORD BP	The Action to Control Cardiovascular Risk in Diabetes blood pressure trial
ADA	American Diabetes Association
ARB	Angiotensin Receptor Blockers
BMI	Body mass Index
BP	Blood pressure
CAD	Coronary artery disease
CAPP	Captopril Prevention Project
CHARM	Candesartan in Heart failure: Assessment of Reduction in Mortality and morbidity
CHD	Cardiovascular Heart Disease
DBP	Diastolic Blood pressure
HDLC	High density lipoprotein cholesterol
HOPE	Heart Outcomes Prevention Evaluation trial
INVEST	International Verapamil SR-Trandolapril trial
JNC7/VII	Seventh Joint National Committee on Prevention, Detection, Evaluation and Treatment of high blood pressure
LDLC	Low density lipoprotein cholesterol
LIFE	Losartan Intervention For Endpoint reduction in hypertension
MI	Myocardial infarction
MNH	Muhimbili National Hospital
NCEP	National Cholesterol Education Program
NDCCB	non-dihydropyridine Calcium Channel Blockers
PRA	plasma renin activity
RAAS	Renin Angiotensin Aldosterone system
SBP	Systolic Blood pressure
TC	Total Cholesterol
UKPDS	UK Prospective Diabetes Study Group
VALUE	Valsartan Antihypertensive Long-term Use Evaluation

1. INTRODUCTION

Hypertension is a common co morbidity of diabetes, affecting 20–60% of diabetic patients. The prevalence of hypertension in the diabetic population is 1.5 to 3 times higher than that of non-diabetic age-matched groups [1]. Observational studies show that people with both diabetes and hypertension have approximately twice the risk of cardiovascular disease as non-diabetic people with hypertension. The greatest reduction in cardiovascular mortality occurs at achieving a diastolic blood pressure of <80 mmHg [2]. Epidemiological evidence indicates that there is a benefit to reducing systolic blood pressure to <130 mmHg [3]. Diagnosis and treatment of hypertension is important in preventing cardiovascular disease in people with diabetes. However, reaching target blood pressures in hypertensive patients is often difficult. In a study done in the United Kingdom, only 43% of men and 58% of women with hypertension were found to be well controlled [4]. In other studies control was as low as 9% among diabetic hypertensive patients [5]. Based on clinical trials and epidemiologic studies, the target blood pressure goal of <130/80 mmHg is recommended for diabetic patients with hypertension [6]. This should be part of an overall risk factor control, also addressing smoking, dyslipidaemia, obesity and hyperglycaemia. In patients with type 2 diabetes, hyperglycemia, hypertension and dyslipidemia, have been associated with poor disease outcomes [7].

2. LITERATURE REVIEW

Although diabetes mellitus is associated with a considerably increased cardiovascular risk [8], the presence of hypertension in the diabetic individual markedly increases morbidity and mortality [9]. Subjects with diabetes are at approximately 60% increased risk of early mortality [10]. The age-adjusted relative risk of death due to cardiovascular events in persons with type-2 diabetes is three-fold higher than in the general population. Approximately 35-75% of diabetic complications are attributed to hypertension [11]. Indeed, the absence of hypertension is the usual finding in long-term survivors of diabetes [12]. Thus, the presence of hypertension in diabetic patients substantially increases the risks of coronary heart disease, stroke, nephropathy and retinopathy [13]. Generally, hypertension in type 2 diabetic patients is associated with other cardiovascular risk factors such as microalbuminuria, central obesity, insulin resistance, dyslipidaemia,

hypercoagulation, increased inflammation, and left ventricular hypertrophy [14].This clustering risk factor in diabetic patients ultimately results in the development of cardiovascular disease, which is the major cause of premature mortality in patients with type 2 diabetes. The presence of hypertension in patients with diabetes markedly enhances their development of macrovascular and microvascular diseases such as strokes, transient ischemic attacks, peripheral vascular diseases, atherosclerotic and ischemic heart diseases and acceleration of diabetic retinopathy and nephropathy [15, 16, 17]. Both the onset of microalbuminuria and the progression of renal disease after the onset of proteinuria are accelerated by hypertension [17, 18]. The onset and presentation of hypertension differs between type 1 and type 2 diabetes. In type 1 diabetes, hypertension develops after several years of the disease and usually reflects the development of diabetic nephropathy. It ultimately affects 30% of individuals with type 1 diabetes [15, 19]. In type 2 diabetes, hypertension may be present at the time of diagnosis or even before the development of hyperglycemia [20].

2.1.Prevalence and Epidemiology of hypertension among Diabetic patients

Arterial hypertension is common in both type 1 and 2 diabetes mellitus. Several confounding factors are present in type 2 diabetes that makes the assessment of the prevalence of hypertension attributable to diabetes difficult. These include age and obesity which are common among diabetic than non-diabetic patients. Thus, elevated blood pressure in these individuals may represent the aging or obesity of the population [21]. However, after adjusting for age and weight, the prevalence of hypertension is still 1.5 times higher in diabetic groups [20].Other confounding factors include type of diabetes, weight, metabolic control, and heredity. Race, age, and sex, body mass index, a longer duration of diabetes, and the presence of persistent proteinuria are major determinants of elevated blood pressure, especially systolic pressure, in the diabetic population. Hypertension in diabetic patients is more frequent in men than in women before the fifth decade and more frequent in women thereafter. It is also higher in blacks compared with whites [16].Both systolic and diastolic blood pressures have been observed to be greater in adolescent type 1 diabetics than in their non-diabetic siblings [15]. The prevalence of hypertension among diabetics is variable in different populations. In Africa, for example, a

study done in Cameroon found an overall prevalence of hypertension of 66.7% [22]. With type 2 diabetic patients being more hypertensive (70.1%) than type 1(33.6 %). In Tanzania hypertension was found in 5% of type 1 diabetes mellitus and 29.2% of type 2 patients at presentation with diabetes [23].

2.2. Hypertension in type 1 and type 2 Diabetes mellitus

2.2.1. Type 1 Diabetes mellitus

Patients with type 1 usually remain normotensive before the development of persistent proteinuria (albumin excretion rate greater than 300-500 mg/day, clinically detectable by dipstick) [12]. At the time of recognition of microalbuminuria (albumin excretion rate of more than 30-70 mg/day, but less than 300 mg/day), the blood pressure is increased and tends to increase in parallel with the extent of microalbuminuria [24, 25]. Once persistent proteinuria develops, systolic blood pressure begins to rise at an average of about 1 mm Hg per month for both type 1 and 2 diabetic patients [26, 27]. With the onset of established diabetic nephropathy, clear-cut hypertension is common in type 1 diabetes [9, 28]. Without treatment, mean blood pressure increases at a yearly rate of about 5-8% in overt diabetic nephropathy [26].

2.2.2. Type 2 Diabetes mellitus

Whereas patients with type 1 are usually normotensive until overt renal disease develops, about 28% of type 2 patients are already hypertensive at the time of diagnosis of diabetes. [9].This is probably representing essential hypertension and relating in part to obesity [9]. The prevalence of hypertension increases markedly in the proteinuric state [9, 27].

2.3. Pathophysiology

Hypertension in diabetic patients has characteristics similar to that of the elderly [29]. It can also occur in a background of diabetic nephropathy, or as an essential hypertension at any age [30]. The hallmark of the hypertensive state in both instances is increased vascular resistance [16, 29]. Premature atherosclerosis in diabetic individuals with hypertension probably contributes to premature aging changes of the vasculature [16].The premature aging in diabetics may be the cause of the relatively high prevalence of isolated systolic

hypertension and decreased baroreceptor sensitivity in young diabetic patients [31]. Decreased baroreceptor reflex sensitivity as well as altered cardiac innervations may partially explain the marked variability of blood pressure and the propensity toward orthostatic hypotension observed in diabetics with hypertension [16,31].These latter characteristics, also seen in elderly hypertensive patients, suggest premature aging of the cardiovascular system in diabetic individuals with coexistent hypertension[29]. In diabetes mellitus, abnormalities in the systems that regulate blood pressure have been described, e.g. in the renin-angiotensin system, the sympathetic nervous system, the sodium/volume control systems, and vascular reactivity [32].

2.3.1. Renin-Angiotensin-Aldosterone System

Measurements of plasma renin activity (PRA) as an indicator of the renin-angiotensin system have shown normal, high, and low levels in diabetes, depending on such factors as metabolic control, age, and renal function [33]. Plasma renin activity is low in diabetics with autonomic neuropathy and renal disease [34]. In general, when corrected for sodium intake, age, and other variables, PRA is lower in both type 1 and type 2 compared to nondiabetic subjects [35]. Inactive renin is found in greater quantity in diabetics with microvascular complications [36]. However, changes in plasma renin activity in diabetes are probably secondary to increased extracellular volume, renal damage, and low sympathetic activity, and probably do not contribute in a major way to hypertension in diabetes mellitus.

2.3.2.Sodium and Volume

Diabetic hypertension is related both to an increase in total peripheral vascular resistance and to increased exchangeable sodium [16, 37]. On the average, exchangeable sodium is increased by about 10%, even in normotensive diabetics. The increase in exchangeable sodium correlates with age and systolic blood pressure. Diabetics have impaired sodium excretion in response to a high salt diet [38]. Plasma volume may be higher than normal, even in the absence of hyperglycemia [39]. Mechanisms for renal sodium retention in diabetes have not been established. One concept is that increased tubular reabsorption of glucose simply results in the co transport of greater amounts of sodium [39]. In the early

stages of diabetes mellitus, proximal tubular sodium reabsorption is increased by 20-40% [40]. It has also been postulated that sodium retention in diabetics might be related to a decreased ability to release natriuretic factors (including dopamine, prostaglandins, and kallikrein) and to the tubular effects of insulin [16, 41].

2.3.3. Vascular Reactivity

Blood pressure response to pressor agents such as norepinephrine and angiotensin II is consistently exaggerated in diabetic subjects [37]. Increased peripheral vascular resistance and enhanced vascular smooth muscle contractility responses to agonists such as norepinephrine and angiotensin II appear to be the hallmark of hypertension in both type 1 and type 2 diabetic individuals [42]. Vessels from both insulinopenic and insulin-resistant rats also display exaggerated vasoconstrictive responses to various agonists [42, 43]. The precise reason for the enhanced vascular contractility in the diabetic state is unclear. Increased vascular reactivity is seen in both type 1 and type 2 and in normotensive as well as hypertensive individuals, which suggests an early abnormality in the vasculature in diabetes. Factors related to alterations in vascular smooth muscle cation transport may play a key role in this enhanced vascular resistance [16]. These alterations in cation transport could result in an increase in vascular smooth muscle cytoplasmic free calcium (Ca2+), which is a major determinant of vascular smooth muscle contractility [44]. Some of the evidence indicating that decreased insulin action, due to either insulin deficiency or resistance, could account for this increased vascular resistance. Insulin appears to play an important role in regulation of two important membrane pumps, the Ca2+- ATPase and the Na+/K+-ATPase pump [45, 46]. Accordingly, insulin deficiency or insulin resistance could result in decreased activity of these pumps. Decreased activity of either the Ca –ATPase pump or the Na+/K+-ATPase pump could result in increases in Ca2+concentration[46,47]. Thus, abnormalities in vascular smooth muscle cation metabolism and in states of decreased cellular insulin action may play an important role in the increased peripheral vascular resistance that characterizes hypertension in diabetic patients. Another cell membrane pump that is affected by insulin is the Na+-H+ exchanger, which is stimulated by physiological levels of insulin [48, 49]. The Na+-H+ anti-porter is a ubiquitous transport system that is involved in regulation of intracellular pH, cell volume, and cell

growth and is linked to Ca2+ exchange [50]. It has been postulated that enhanced Na+-H+ antiport activity may account for increased cell [Ca2+] in essential hypertensive subpopulations [50]. An increase in [Ca2+], as a result of enhanced Na+-H+, may be the cause of vascular hypertension associated with insulin resistance and associated hyperinsulinemia[37,43]. Increased Na+-H+ exchange activity would also lead to intracellular alkalinization, which is a known stimulator of protein synthesis and cell proliferation which could promote vascular remodeling, hypertrophy, and accelerated atherosclerosis [50]. Further, Na+-H+ exchange may represent a transmembrane signal for various growth factors known to be stimulated by insulin [51, 52]. Thus, hyperinsulinemia accompanying insulin resistance and exogenous administration of insulin may contribute to enhanced cellular Na+-H+ exchange, abnormal vascular smooth muscle [Ca2+], metabolism, enhanced vascular reactivity, and accelerated atherosclerosis, all of which occur in states of hypertension associated with diabetes mellitus[50,51,52]..

2.3.4.Body Fat

Obesity appears to be an important factor linking hypertension to impaired carbohydrate metabolism [53]. The fact that blood pressure rises in concert with body weight and increased adiposity, even at an early age suggests that obesity is an important factor in the development of hypertension. Fat distribution appears to be important because central or android obesity is much more strongly linked to insulin resistance and type 2 diabetes, hypertension, and dyslipidemia than is peripheral or gynecoid obesity [54]. Obese subjects also display adaptive changes in sodium metabolism and vascular hemodynamic comparable to those in diabetes. Diets low in sodium but with normal calorie counts can decrease blood pressure in obese hypertensives and sodium-sensitive blood pressure responses are found in obese adolescents [55, 56]. Salt-sensitive blood pressure in obesity may be secondary to increased cardiac output and plasma volume, and the degree to which blood pressure responds to salt is directly correlated with insulin levels [56]. However, studies examining the mechanisms the hypotensive effect of weight loss show that blood pressure can fall substantially, independent of sodium intake and excretion [57, 58]. Thus sodium may play different roles during weight maintenance and weight loss.

2.3.5.Insulin and Insulin Resistance

Circulating insulin levels are high in obesity, secondary to resistance to insulin-mediated glucose uptake. Insulin may be a factor in obesity-associated hypertension [59]. Insulin resistance and increased circulating insulin responses to oral glucose are also found in essential hypertension [60]. Post glucose insulin levels are reported to be higher in hypertensive than in normotensive individuals, even after controlling for body weight. *Insulin resistance is also common in both obese and nonobese essential hypertensive subjects [61]. Thus, hypertension per se appears* to be associated with hypcrinsulinemia.

2.3.6.Role of Hyperglycemia in the Pathogenesis of Hypertension

Chronic hyperglycemia likely contributes to the genesis of hypertension in diabetic individuals through several mechanisms. One such hypertensive effect caused by hyperglycemia is that of sodium retention and the increase in exchangeable body sodium that has been observed in diabetic hypertensive individuals [62]. Hyperglycemia results in glomerular hyperfiltration of glucose and stimulation of the proximal tubular glucose-Na+ co transporter [63]. Thus, sodium retention occurs in association with mild-to moderate hyperglycemia and likely contributes to increased total exchangeable Na+ and blood pressure elevations in diabetic hypertensive patients [64]. Chronic hyperglycemia may also contribute to increased vascular rigidity by promoting vascular structural changes [65]. At high concentrations, glucose appears to have a direct toxic effect on endothelial cells, which may result in decreased endothelial-mediated vascular relaxation, increased constriction, promotion of vascular smooth muscle cell hyperplasia, and vascular remodeling [65]. High glucose levels mimicking the diabetic hyperglycemic state have also been shown to induce fibronectin and collagen IV overexpression in cultured human vascular endothelial cells [66]. Enhanced expression of fibronectin and collagen IV may further contribute to endothelial dysfunction. Fibronectin is a glycoprotein that has a complex role in cell matrix interactions, and its increased expression has been associated with thickened glomerular basement membranes and mesangium [66]. Thus, hyperglycemia-induced local synthesis of fibronectin by endothelial cells may contribute directly to endothelial dysfunction as well as indirectly to increases in basement membrane production. There is considerable evidence that hyperglycemia accelerates formation of

nonenzymatic advanced glycosylation products, which accumulate in vessel wall proteins [67].The rate of this accumulation is proportional to the time-integrated blood glucose level over long periods of time. A highly significant correlation has been noted between accumulation of increased levels of advanced glycosylation end products and vascular complications [68]. The binding of proteins with advanced glycosylation end products to macrophage receptors induces the synthesis and secretion of tumor necrosis factors and interleukin-1 [69]. These cytokines, in turn, stimulate other cells to increase protein synthesis and to proliferate. Interleukin-1 causes vascular smooth muscle cells, mesangial cells, and endothelial cells to proliferate and increases glomerular Type 1V collagen synthesis [70]. The growth-promoting effects of tumor necrosis factors and insulin are synergistic [70]. Tumor necrosis factors appear to stimulate platelet derived growth factor-like mitogens from both aggregating platelets and endothelial cells by causing thrombosis-promoting alterations in the endothelial cell surface [67, 70]. As extensively reviewed, these alterations include induction of a tissue factor-like procoagulant, suppression of the anticoagulant protein C pathway, and synthesis of an inhibitor of plasminogen activator. The thrombotic changes may then induce release of platelet-derived growth factor from aggregating platelets and from endothelial cells through receptor- mediated thrombin stimulation [70]. Thus, prolonged hyperglycemia could lead to excessive production of extracellular matrix and proliferation of vascular smooth muscle cells as a result of an increase in the number of highly cross-linked proteins with advanced glycosylated end products, with resulting hypertrophy and vascular remodeling. This could, in turn, contribute to the enhanced vascular constriction and accelerated atherosclerosis characteristic of diabetic vasculature. The observation that chronic hyperglycemia is associated with decreased elasticity of connective tissues in arterial walls may also be related, in part, to increased advanced glycosylation [71].

2.3.7.Diabetic Nephropathy and Its Relation to Hypertension

Approximately 20-30% of patients with type 2, and 30-40% of those with type 1 diabetes develop diabetic nephropathy; the incidence in the latter peaks after 16-20 years [72]. In the United States, diabetic nephropathy accounts for approximately 30% of new patients placed on dialysis [73]. As diabeticnephropathy progresses, the prevalence of hypertension

increases in both type 1 and 2 diabetic patients [74]. Established proteinuria heralds an increasing likelihood of hypertension[75].

2.4.Treatment of Hypertension in Diabetic patients

Once hypertension is detected both pharmacological and non-pharmacological interventions should be implemented. Instituting lifestyle modifications is paramount, along with medical therapy at the earliest detection of the pre-hypertensive patient.

2.4.1.Life style changes

The first objective in any hypertensive diabetic should be to initiate lifestyle changes. These changes should include an improved diet, regular physical activity, weight management and cessation of smoking. Weight loss has been shown to be an effective therapy in hypertension management. Modest weight loss can lower or even eliminate the need for antihypertensive and anti-diabetic medications [76]. Patients should be advised to adopt the Dietary Approach to Stop Hypertension (DASH) eating plan, consisting of a low sodium, high potassium, low calorie (800–1,500kcal/day) and high fiber diet, as it is shown to be effective in lowering BP [77]. Coupled with diet, increased physical activity, such as walking for 30–45 minutes three to five days a week, has been shown to improve lipid profiles, BP and insulin resistance [77].

2.4.1.1.Pharmacotherapy

The JNC 7 and the American Diabetes Association (ADA) recommend that BP in diabetics be controlled to levels of 130/80mmHg or lower [6, 78]. To achieve goal BP in diabetics, two or more drugs are usually required [80, 81].There is convincing evidence regarding a certain class of drugs that seems to offer certain beneficial effects than others in hypertensive diabetics

Angiotensin converting enzyme inhibitors (ACE-I)

By virtue of their ability to obviate the effects of angiotensin II primarily at the level of the efferent arteriole, ACE inhibitors can normalize the glomerular capillary hydraulic

pressure without reducing the glomerular filtration rate in rats with diabetes mellitus [82]. Consequently, maintenance of normal glomerular capillary hydraulic pressure is associated with markedly reduced development of proteinuria and glomerular structural lesions. Therefore, therapy directed at reducing the glomerular capillary pressure effectively retards the progressive loss of renal function in rats with diabetes mellitus. ACE-I have demonstrated the ability to slow progression of nephropathy in microalbuminuric, normotensive type 2 diabetes mellitus compared with other antihypertensives [83]. They are also known to improve insulin sensitivity, retard the progression of diabetes, cardio-protective and even prevent the development of diabetes in hypertensive patients by inhibiting the rennin- Angiotensin aldosterone system (RAAS) [78, 84]. Data from several large studies, such as the Captopril Prevention Project (CAPPP) and the Micro-HOPE, a sub-study of the Heart Outcomes Prevention Evaluation (HOPE) trial, have demonstrated the cardiovascular benefits of ACE-I [84].

Angiotensin Receptor Blockers (ARBs)

Other medications receiving considerable attention in recent years are the ARBs. The antihypertensive action of ARBs is roughly equivalent to ACE-I, but does have an improved side effect profile when compared with ACE-I. Similar to ACE-I, ARBs have beneficial effects in reducing the progression of diabetes and carry other cardiovascular and renal benefits noticed in ACE-I, by virtue of its RAAS blockade [84]. Several clinical trials demonstrate that ARBs also have beneficial effects on glucose metabolism that are likely independent of bradykinin-mediated mechanisms [85]. In the Losartan Intervention For Endpoint reduction in hypertension (LIFE) study, losartan reduced the relative risk of developing type 2 diabetes by 25% when compared with the beta-blocker atenolol [86]. Similarly, reduction in the relative risk of developing diabetes was noted in the Candesartan in Heart failure: Assessment of Reduction in Mortality and morbidity (CHARM) studies [85, 87]. The Valsartan Antihypertensive Long-term Use Evaluation (VALUE) trial demonstrated the advantage of an ARB, valsartan, over a calcium channel blocker, amlodipine, in reducing the relative risk of new onset diabetes by 23% in patients with hypertension aged 50 years or older [88].

Beta-blockers

Beta-blockers can be effective antihypertensive agents in the diabetic population as part of a multi-drug regimen. They are also useful in diabetes patients with concomitant evidence of coronary artery disease (CAD) such as angina symptoms or post-myocardial infarction (MI). The effectiveness was demonstrated in the UK Prospective Diabetes Study Group (UKPDS), where atenolol was comparable with captopril in reduction of cardiovascular outcomes [89]. Although these agents have been associated with adverse effects on glucose and lipid profiles and implicated in new onset diabetes in obese patients, they are not absolute contraindication for use in diabetic patients. In fact, carvedilol, which has both α- and β-receptor blocking properties, has been shown to induce vasodilatation and improve insulin sensitivity [90, 91].

Thiazide Diuretics

Thiazides have been shown to cause electrolyte imbalances, metabolic changes and volume contraction. Nevertheless, in the Antihypertensive and Lipid-lowering Treatment to Prevent Heart Attack Trial (ALLHAT), which compared a thiazide (chlorthalidone) with a calcium channel blocker (CCB) (amlodipine) or an ACE-I (lisinopril), found that the thiazide was less expensive and superior to the ACE-I or CCB in lowering the incidence of cardiovascular in hypertensive populations[92].Therefore, ALLHAT suggests that thiazides could be considered as a first-line therapy for many diabetic patients with hypertension,[92] despite the fact that they may adversely affect insulin resistance and potassium balance in some individuals [78].Thiazide diuretics have consistently been shown to improve cardiovascular outcomes, even in those with diabetes[92,93]. Treating volume expansion with thiazide diuretics can increase the activity of the RAAS. Thus, combining a diuretic with an ACE-I or an ARB can be an effective BP lowering combination.

Calcium Chanel Blockers

It has been shown that non-dihydropyridine (ND) CCBs, such as verapamil and diltiazem, decrease proteinuria in diabetics [81]. Not to the degree of ACE-I alone, but in combination therapy, NDCCBs and ACE-I have been shown to have additive effects in reducing albuminuria [81]. The Syst-Eur trial with netrendipine demonstrated that intensive antihypertensive therapy for older patients with type 2 diabetes and isolated systolic hypertension eliminated the additional risk for cardiovascular events and stroke associated with diabetes [94]. In the Hypertension Optimal Treatment (HOT) trial, there was a reduction in major cardiovascular events with diastolic BP control in patients with diabetes when felodipine was used as first-line therapy [95]. The recent International Verapamil-Trandolapril Study (INVEST) also showed an adequate hypertension control among diabetic patients with verapamil alone or in combination with trandopril[96].Thus, CCBs are not harmful or contraindicated in hypertensive patients with diabetes and the combination of an ACE-I and a calcium antagonist is effective for the management of hypertension in diabetic patients [97].

2.4.2.Blood pressure goals in diabetic patients

Randomized clinical trials have demonstrated the benefit (reduction of CHD events, stroke, and nephropathy) of lowering blood pressure to <140 mmHg systolic and <80 mmHg diastolic in individuals with diabetes [3, 80, 89, 95]. Epidemiologic analyses show that blood pressure >115/75 mmHg are associated with increased cardiovascular event rates and mortality in individuals with diabetes [7, 79, 97]. Therefore, a target blood pressure goal of <130/80 mmHg has been thought to be reasonable and is used in guidelines [6, 79]. However, a recent ACCORD trial done among patients with type 2 diabetes at high risk for cardiovascular events has shown that targeting a systolic blood pressure of less than 120 mm Hg, as compared with less than 140 mm Hg, did not reduce the rate of a composite outcome of fatal and nonfatal major cardiovascular events [98].. As a consequence the event rate observed in the standard-therapy group was almost 50% lower than the expected rate. Interpretation of the ACCORD BP results is complicated by the fact that patients with dyslipidemia were excluded and enrolled into the ACCORD lipid trial. They were also frequently using statins and hence likely to have lower risk of cardiovascular. It is however

postulated that lowering systolic blood pressure from the mid-130s to approximately 120 mm Hg does not further reduce most cardiovascular events or the rate of death, and most of the benefit from lowering blood pressure is achieved by targeting a goal of less than 140 mm Hg. This is supported by in a new retrospective analysis of the International Verapamil SR-Trandolapril (INVEST) trial where intensive blood-pressure control in patients with diabetes and cardiovascular disease was associated with a higher mortality rate than usual control [96]. In this trial, patients whose systolic blood pressure was lowered to 130 to 140 mm Hg had a better outcome than those with systolic pressures over 140 mm Hg. But those whose systolic blood pressure was reduced to below 130 mm Hg did not appear to receive any additional benefit and had a higher mortality rate. Although the two trials had slightly different populations, they both showed the harm of aggressive hypertension treatment that aims to lower systolic pressure below 130 mm Hg. In INVEST all patients also had coronary heart disease, whereas in ACCORD only around 30% had heart disease [96, 98].

2.5. Dyslipidemia and diabetes Mellitus:

Dyslipidemias are disorders of lipoprotein metabolism, including lipoprotein overproduction and deficiency. They may manifest as one or more of the following; elevated total cholesterol, elevated triglyceride levels, elevated low-density lipoprotein cholesterol (LDL-C) or decreased high-density lipoprotein cholesterol (HDL-C) levels. Dyslipidemia is closely associated with atherosclerosis and is a major causal factor in the development of ischemic cardiovascular and cerebrovascular events which are the leading causes of morbidity and mortality. It occurs in about 70– 97% of individuals with diabetes [99]. In the Framingham and several other studies elevated triglyceride associated with low HDL-C concentration dominated the diabetic dyslipidemia pattern in most races [100, 101]. African- Americans on the other hands have distinct dyslipidemic patterns with elevation of LDL cholesterol, low HDL and low triglycerides [102, 103]. The usual reciprocal elevation in triglyceride concentration that accompanies low HDL cholesterol is not evident in this group as seen in other races. Diabetic African-Americans do not demonstrate impairment of post hepatic–lipoprotein lipase activity commonly seen with insulin resistance in other ethnic groups. This impairment is inversely associated with

serum triglyceride concentration [104]. A low frequency of impairment of post hepatic–lipoprotein lipase in African Americans would help explain why triglyceride levels remain low, even when there is a decrease in HDL cholesterol levels. Thus, elevated triglyceride concentration is uncommon dyslipidemia among black patients. Various studies have demonstrated that lipid-lowering therapy in type 2 diabetes is effective in decreasing the number of cardiac events by 22- 65% [105, 106]. The risk of major coronary events in untreated diabetic patients is 1.5-1.7-fold greater than in untreated nondiabetic patients [106]. Statins are the current lipid-lowering drugs of choice because the change in LDL-cholesterol-to-HDL-cholesterol ratio is better than other antilipids [105, 106].

3. PROBLEM STATEMENT

Hypertension is an extremely common co morbidity of diabetes, affecting 20–60% of individuals with diabetes. It contributes to the leading causes of morbidity and mortality in the diabetic population: coronary heart disease, stroke, peripheral vascular disease and lower extremity amputations, nephropathy and end-stage renal disease [9]. Even though trials show that treating hypertension is beneficial in reducing hypertension associated morbidity and mortality reaching target blood pressures in hypertensive patients is often difficult. This is especially seen in diabetic population. Reaching a treatment target goal of 130/80mmHg among diabetics has been found to range between 9 and 58% in studies [4, 5]. As the coexistence of hyperglycemia, hypertension and dyslipidemia is common and has been associated with poor disease outcomes, an overall risk factor control, addressing hypertension, smoking, dyslipidaemia, obesity and hyperglycaemia has been recommended among diabetics in most guidelines. Hypertension management in the diabetic population should therefore include improved detection, evaluation, and treatment of hypertension as well as long-term follow up.

4. RATIONALE

All persons with diabetes are at high risk of developing hypertension during their lifetimes. Coexistence of diabetes mellitus with hypertension, obesity and dyslipidemia is also common and adds to the already increased risk of cardiovascular events in this group. As data on the prevalence and level of control of hypertension in our setting is scarce, this

study is therefore done to determine the prevalence and control of hypertension and other risk factors among diabetic patients in our clinic.

5. OBJECTIVES

5.1.Broad objective:

To determine the prevalence of hypertension, its control and the prevalence of other cardiovascular risk factors among Diabetic patients attending MNH Diabetic clinic, Dar es Salaam.

5.2. Specific objectives

5.2.1. To determine the prevalence of hypertension among Diabetic patients attending Muhimbili Diabetic clinic

5.2.2. To determine the proportion of hypertensive patients on antihypertensive with controlled blood pressures among Diabetic patients attending Muhimbili Diabetic clinic

5.2.3. To determine the prevalence of dyslipidemia among Diabetic patients attending Muhimbili Diabetic clinic

5.2.4. To determine the prevalence of obesity among Diabetic attending Muhimbili Diabetic clinic

5.2.5. To determine the prevalence of smoking among Diabetic patients attending Muhimbili Diabetic clinic

5.2.6. To determine the association of blood pressure control and other cardiovascular risk factors (dyslipidemia, BMI, smoking) among Diabetic patients attending Muhimbili Diabetic clinic

6. MATERIALS AND METHODS

6.1. Study design

It was a prospective cross-section descriptive study

6.2. Study setting

The study was conducted at Muhimbili National Hospital (MNH) Diabetic clinic. This is one of several diabetic clinics in the city. Other clinics are run in each of the three municipal hospitals as well as in some of the private hospitals. The MNH Diabetes clinic cares diabetic patients from Dar es Salaam, its suburb and other parts of the country. It runs

twice a week with Tuesday clinic being reserved for diabetic children (mainly type 1 diabetics) and the Thursday clinic for adult diabetics (both type 1 and 2 diabetics). This study was done on Thursdays as it involved adult diabetics. It has an average of 50 patients attending on each of these two days.

6.3.Sample Size and Sampling Procedure

The sample size was obtained using this formula

$$N = \frac{4p(1-p)}{e^2}$$

Where, p = the prevalence of hypertension among the Diabetics = 40%

E= margin of error= 8%

Therefore, one hundred and fifty diabetic patients attending at the MNH Diabetes clinic of were consecutively enrolled over a month period.

6.4.Inclusion criteria

Patients were included if they were aged 18 years or more, non-pregnant , those without diabetes that is secondary to a known medical condition and have been attending the clinic for at least twice

6.5.Exclusion criteria

The study excluded all patients who had been attending the clinic in less than 3 months because they were likely to have visited the clinic only once Clinic visits are scheduled at least 3 monthly.

This study involved diabetic patients who were attending the Muhimbili National Hospital Diabetic outpatient clinic between February and September 2009. Data collection was done by the researcher or by the assistant who was a specialist physician working at the clinic. At this clinic consultations are usually done in several consultation rooms one of which was used by the researcher or the assistant. Patients who consecutively entered the researcher's/assistant's room for consultation were informed of the study and asked if they would like to participate. Those who

accepted and provided informed consent were consecutively enrolled for the study and their age, gender, family history of diabetes or hypertension, smoking history, year of diagnosis of diabetes, history hypertension, antihypertensive use, type of diabetes and diabetes treatment were recorded on structured questionnaires. Other documented information were height, weight, lipid profile, renal profiles and blood pressure as explained below. Patients were classified as having type 1 or 2 diabetes mellitus based mainly on pharmacological treatment they have been using. A patient who had Insulin administration immediately at the diagnosis (while not pregnant) and continued to be maintained on insulin was counted as a type 1 Diabetes mellitus. Type 2 Diabetic patients were those with a prior history of use of oral agents to control hyperglycemia. The presence of obesity, lack of history of ketosis and a family history of diabetes favored type 2 Diabetes mellitus. When insulin was first administered years after the diagnosis, this information did not allow conclusions as to the type of diabetes, as the onset of type 1 diabetes Mellitus may be slow in young adults and Type 2 diabetics may require insulin during the natural course of the disease. These cases would be accounted as undefined if they had appeared.

6.5.1.Blood pressure measurement

Blood pressure was measured on the right arm using a standard mercury sphygmomanometer with an appropriate cuff size and the bladder within the cuff encircling at least 80 percent of the arm. Measurement began after at least 5 minutes of rest. The first appearance of Korotkoff sound (phase 1) was used to define Systolic blood pressure (SBP). The disappearance of Korotkoff sound (phase 5) was used to define Diastolic blood pressure (DBP). Two or more readings separated by 5 minutes were averaged. Blood pressure during the previous visit was also documented. Hypertension was defined according to criteria of the seventh Joint National Committee on Prevention, Detection, Evaluation and Treatment of high blood pressure (JNC VII) as a systolic blood pressure of 140 mm Hg or greater, diastolic blood pressure of 90 mm Hg or greater or taking antihypertensive medication [80]. Newly diagnosed hypertensives were those whose blood pressures were elevated in at least two visits. The two visits were either a visit prior to recruitment for the study or that followed recruitment. Prevalence of hypertension was

the number of subjects with hypertension divided by all studied subjects. The level of blood pressure control was assessed against the American Diabetes Association (ADA) and JNC 7 targets [6,80].Controlled hypertension was that of BP <130/80 mmHg in subjects taking antihypertensive medications.

6.5.2.Anthropometric and laboratory measurements

Weight and height were measured and body mass index (BMI) calculated as weight (kg) divided by height squared (m^2). Participants with a BMI 18.5- 24.9 kg/m^2, 25 -29.9 kg/m^2 and $\geq$30 kg/m^2 were defined as normal weight, overweight and obese respectively. For every patient, a rapid blood glucose test from a capillary (finger prick) was performed in at the clinic using glucose meter (Accu-Check® Active, Roche) and the results were documented in the reporting form. Patients were thereafter sent for venopuncture to the room in the Department of Medicine research laboratory that is situated about 300 meters away from the Diabetic clinic. From each patient, 10 mls of venous blood samples collected and sent to the central laboratory of the Muhimbili National Hospital for analysis of serum levels of glucose, LDL-cholesterol, HDL-cholesterol, total cholesterol, triglycerides and creatinine. Analysis for both the lipid profile and renal functions were done using the Abbott's ARCHITECT® automated chemistry Analyzer at the clinical chemistry unit of the MNH central pathology laboratory. Dyslipidemia was defined on the basis of The European guideline on cardiovascular disease prevention in clinical practice [97,99] and the National Cholesterol Education Program (NCEP) guidelines [107] using Total Cholesterol (TC) and Low density lipoprotein cholesterol (LDL-C), Triglycerides (TGs) and High Density Lipoproteins (HDLs). Dyslipidemia was applied to patients who had one or more of the following; total cholesterol levels of > 4.5mmol/l) and LDL cholesterol of 3.4mmol/l; low HDL-C: <1.04mmol/l; high TG: >1.7mmol/l [108]. Glycosylated hemoglobin could not be determined. Patient's random blood glucose during a previous visit was also documented. Glycemic control was defined by the level of capillary glucose the two consecutive visits. Patients had poor glycemic control when their random capillary glucose was > 7.2 mmol/l according to American Diabetic Association criteria [6].

7. DATA ENTRY, CLEANING AND ANALYSIS

All questionnaires were checked daily for completeness, coverage and consistencies. Then data were entered into computer using SPSS version 10 for further cleaning, categorizing of continuous variables and eventually analyses. Bivariate analyses including comparison of different categories were done by the use of χ^2 and t- tests especially when comparing different proportions. The cut-off point for rejecting the null hypotheses is when p-values are less than 5%. Logistic regression was also used for factors with significant association on bivariate analysis.

8. ETHICAL CONSIDERATION

All participants were asked to provide informed consent to participate in the study and the ethical approval for the study was obtained from the ethical committees of both MUHAS and MNH. Hypertensive patients were informed of their hypertensive status, started on antihypertensives aiming at a treatment goal of 130/80 mmHg. The targeted goal was clearly explained to the patients and the importance of attaining the target BP level. Other cardiovascular risk factors were also managed. For those whom further investigations would be required, referral to appropriate sections/clinics for investigation and care were done.

9. RESULTS

9.1.General characteristics of studied patients

Between February and September 2009 a total of 196 consecutive eligible patients informally consented to participate in the study. Their baseline information was therefore documented. For unknown reasons, 46 patients absconded before they were venopunctured. They therefore had incomplete documentation and were excluded from the study. Patients who were excluded had similar social and demographic characteristics to those studied except for a significantly higher mean systolic blood pressure among excluded group. (Table 1)

Table 1: Baseline characteristics of study patients at MNH diabetic clinic between February and September 2009 ((*n* =196)

Characteristic	Enrolled(*n* =150)	Excluded(*n* =46)	P-value
Females, *n* (%)	93(62)	28(60.9)	1.00
Age , mean (SD) years	51.6(11.2)	48(12.8)	0.16
Diabetes			
diabetes duration, mean (SD), years	7.2 (5.4)	6.8(5.9)	0.70
Type 2, n (%)	125 (83.3)	36(78.3)	0.68
Type 1, *n* (%)	25(16.7)	10(21.7)	0.70
Blood Pressure, mean (SD), mmHg			
Systolic	135.0(23.5)	126.8(23.3)	0.04
Diastolic	83.6(11.0)	79.9(12.4)	0.06
Previous hypertension diagnosis *n* (%)	67(44.7)	17(37.0)	0.20
BM I, mean(SD), kg/m2	26.7(4.5)	27.0(5.5)	0.73
Random capillary glucose, mean(SD), mmol/l	11.3(5.0)	10.58(5.1)	0.41
Current Smoking *n* (%)	2 (1.3)	0	0.08

Clinical and biochemical characteristics of participants are summarized in Table 2. The study included 25(16.7%) type 1 and 125(83.3%) type 2 diabetics whose mean (±SD) duration of diabetes was 7.2 ± 5.4 years. The mean age of all participating patients was 51.6 ± 11.2 years, with 62% (n = 93) being females. Their mean(± SD) blood pressure were 135 ± 23.5 mmHg and 83.6 ± 11 mmHg for systolic and diastolic BP, respectively

Table 2 Clinical and laboratory characteristics of study patients at MNH diabetic clinic February to September 2009(n = 150)

Characteristic	All n=150	Females, n=93	Males, n=57	P-value
Age , mean (SD) years	51.6(11.2)	51.4(11.8)	51.8(10)	0.87
Diabetes				
diabetes duration, mean (SD), years	7.2 (5.4)	7.3(4.9)	7.1(6.2)	0.83
Type 2, n (%)	125 (83.3)	45(78.9)	80(86.0)	0.27
Type 1, *n* (%)	25(16.7)	12(21.1)	13(14.0)	0.19
Blood Pressure, mean (SD), mmHg				
Systolic	135.0(23.5)	135.1(25)	134.8(21)	0.92
Diastolic	83.6(11.0)	83.2(11.1)	84.2(11)	0.61
Previous hypertension diagnosis *n* (%)	67(44.7)	24(42.1)	67(46.2)	0.62
Lipids, mean(SD), mmol/l				
Total serum cholesterol	5.6(1.1)	5.8(1.0)	5.4(1.2)	**0.03**
High density lipoprotein	1.2(0.3)	1.3(0.4)	1.2(0.2)	0.06
Low density lipoprotein	4.1(1.0)	4.2(0.9)	3.9(1.1)	**0.04**
Triglycerides	1.8(0.8)	1.8(0.8)	1.8(0.8)	0.88
Dyslipidemia	131(87.3)	86(92.5)	45(78.9)	**0.02**
Serum creatinine, mean (SD), mmol/l	95.4(46.9)	95.4(56.6)	95.3(24)	0.06
Weight, mean (SD), kg	68.9(12.5)	68.2(12.1)	70(13.3)	0.38
BM I, mean(SD), kg/m2	26.7(4.5)	27.2(4.6)	25.8(4.1)	0.8
Random capillary glucose, mean(SD), mmol/l	11.3(5.0)	11.3(4.8)	11.2(5.2)	0.89
Current Smoking *n* (%)	2 (1.3)	2(3.5)	0	0.08

The mean total and low density lipoprotein (LDL) cholesterol was significantly higher in females. Oral hypoglycemics, insulin and diet alone were used in 78%, 16.7% and 5.3% respectively. However, most 115(76.7%) patients had a higher random capillary glucose ($\geq$ 7.2 mmol/L) with an overall mean ($\pm$SD) random capillary glucose of 11.3 $\pm$ 5.0 mmol/l.

Only 49(32.7%) of patients had normal body mass indices. Overweight and obesity were found in 48.7% and 18.7% respectively. Hypertensive patients were more likely to be overweight or obese as compared to normal weighted diabetics (p=0.02). There was no significant gender difference in body mass indices. Smoking was not common among participants

9.2.Prevalence and control of hypertension and other risk factors

Table 3: Characteristics of patients by hypertension status at MNH diabetic clinic between February and September 2009 (n = 150).

Characteristic	Normotensive *n*= 68	Hypertensive n= 82	P-value
Sex			
Female's *n* (%)	41(60.3)	52(63.4)	0.4
Male's *n* (%)	27(39.7)	30(36.6)	0.4
Age , mean(SD) years	49.3(12.4)	53.5(11.8)	**0.02**
Diabetes			
Disease duration, mean (SD) years	6.0(3.7)	8.2(6.3)	**0.02**
Type 1, *n* (%)	17(25.0)	8(9.8)	**0.02**
Type 2, *n* (%)	51(75.0)	74(90.2)	**0.02**
Serum Lipids *n* (%)			
Elevated total serum cholesterol	58(85.3)	73(89)	0.6
Reduced high density lipoprotein	13(19.1)	15(18.3)	1.0
Elevated low density lipoprotein	52(76.5)	68(82.9)	0.4
Elevated Triglycerides	27(39.7)	40(48.8)	0.3
Serum creatinine, mean (SD) mmol/l	87.6(29.0)	101(9.0)	0.06
BMI, kg/m^2			
Mean (SD)	25.3(4.3)	27.9(4.3)	**0.00**
<25	29(42.6)	20(24.4)	**0.02**
25 – 29.9	34(50)	39(47.6)	0.87
≥30	5(7.4)	23(28)	**0.001**
Random capillary glucose, mean(SD) mmo/l	12(5.5)	10.7(4.4)	0.11

About half (54.7%) of all the patients studied were hypertensive. Of these, 67 (81.7%) patients were aware of their hypertension and all were on blood pressure lowering medications. However, only 23 (34%) of those who were on blood pressure lowering drugs

had controlled hypertension with BP measurement < 130/80 mmHg. Fifteen (10%) were newly diagnosed to have hypertension during the study period. Among type 2 diabetic patients 74/125 (59.2%) were hypertensive whereas only 8/25(25%) were hypertensive among type 1 diabetic patients ($p<0.001$). Compared to patients without hypertension, hypertensive patients were significantly older, were obese, had type 2 diabetes mellitus and a long duration of diabetes. There was no difference in their lipid profiles and diabetes control. To measure the independent association of these variables and hypertension, a multiple logistic regression was performed with hypertension as the dependent variable. Increasing duration of diabetes (OR=1.2, 95% 1.08 – 1.32); increasing BMI (OR=1.4, 95% 1.03 – 1.90); and increasing serum creatinine (OR=1.02, 95% 1.01 – 1.04); were significantly associated with hypertension, whereas age was not.

Table 4: Characteristics of hypertensive patients at MNH diabetic clinic who were using antihypertensives by hypertension control status between February and December 2009 (n=67).

Characteristic	Controlled hypertension, *n* = 23	Uncontrolled hypertension, *n* = 44	P-value
Sex			
Female *n* (%)	16(69.6)	27(61.4)	0.6
Male *n* (%)	7(30.4)	17(38.6)	0.6
Age, mean(SD) years	51.6(9.6)	53.9(9.1)	0.95
Diabetes			
Disease duration, mean (SD) years	7.2(5.8)	9.7(6.9)	0.14
Type 1, n (%)	2(8.7)	4(9.1)	0.9
Type 2, n (%)	21(91.3)	40(90.9)	1.0
Serum Lipids (mmol/l)			
High total serum cholesterol *n* (%)	20(87.0)	41(93.2)	0.41
Low high density lipoprotein *n* (%)	3(13.0)	8(18.2)	0.74
High low density lipoprotein *n* (%)	19(82.6)	38(86.4)	0.73
High Triglycerides *n* (%)	8(34.8)	24(54.5)	0.2
Serum creatinine Mean (SD)mmol/l	93(25.6)	103.4(60.8)	0.34
BMI, kg/m^2			
Mean, (SD)	27.9(3.5)	27.8(4.5)	0.95
<25, n (%)	5(21.7)	13(29.5)	0.57
25 – 29.9, n (%)	13(56.5)	18(40.9)	0.37
≥30, n (%)	5(21.7)	13(29.5)	0.57
Random capillary glucose, mean (SD)	9.7(4.5)	11.1(4.6)	0.23

The mean systolic and diastolic blood pressures were significantly lower in the controlled group as compared to uncontrolled one. Duration of diabetes, body mass index,

hyperlipidemia and hyperglycemia were insignificantly more deranged in the uncontrolled than controlled group (Table 4).

Dyslipidemia was common (88%) among the participating patients. Elevated total cholesterol and low density lipoprotein cholesterol was found in 131(87.7%) and 120 (80%) patients respectively. Triglyceridemia and low high density lipoprotein (HDL) cholesterol were found in 67(44.7%) and 28(18.7%) of all patients respectively. Compared to males, females had a significantly higher prevalence of dyslipidemia (78.9% vs. 92.5%, p= 0.02). Although, there were no significant differences between normotensive and hypertensive patients with regards to their lipid profiles, a combination of hypertension and dyslipidemia was found in 73(48.6%) patients (Table 3). Hypertriglyceridemia was significantly associated poor glycemic control - 17.6% vs. 58.0% in well and poor glycemic control respectively (p=0.005).

10. DISCUSSION

This study was designed mainly to evaluate the prevalence and control of hypertension in diabetic patients in our clinic. In this study the prevalence of hypertension was found to be 54.7 %. This was higher than the previously documented 29.2% and 5% prevalence rates in type 2 and type 1 diabetes mellitus respectively in Tanzania. However the prevalence rates were consistently higher in type 2 diabetes in both studies [23]. This prevalence is similar to that found in Kenya where 50% of diabetics were found to have hypertension [110] .It is however lower than the 66.7% prevalence rate in Cameroun [22]. Differences in diagnostic cut off values for hypertension in different studies may be among the reasons behind this variation in prevalence rates. With changing from a previous diagnostic blood pressure cut-off level of ≥160/95 mmHg to a current one BP ≥140/90 mmHg, there has been an increase in prevalence rates of hypertension among diabetic patients [111]. For example in a study done in Greece using diagnostic criteria of ≥130/85 hypertension a relatively higher prevalence (87.7%) was found [112].

In this study, hypertension was independently associated with increasing duration of diabetes, body mass indices and serum creatinine; a finding similar to a study by Otieno et al [109] in Kenya. Although these factors may predict hypertension in diabetic patients, they may as well be a consequence of hypertension itself.

In this study only 34% of those who were on blood pressure lowering medications had their hypertension controlled to blood pressure levels of less than 130/80 mmHg. Similar low blood pressure control rates among diabetic have been reported in different studies with control rates ranging from as low as 9% to 58 % [4, 5, 112]. For instance, Skliros et al using blood pressure of ≤130/80 and ≤ 140/90 mmHg found control rates of 8.6 % and 48.4% respectively [112]. In Nigeria a study using a blood pressure level of <140/90 mmHg as target for control, found a control rate of 11% among treated patients with diabetes that is even lower than findings in this study[113].There has been a use of different control targets to define controlled hypertension across these studies. This variation in hypertension control cut off levels may account for the wide variation in control rates from these studies. The current criterion recommends use of blood pressure less ≤ 130/80mmHg as cut off level for control as used in this study [80]. To achieve this goal, aggressive treatment with two or more drugs is usually required [80, 81]. In this study poor hypertension control was not associated with age, BMI, gender, serum lipids,

creatinine or glucose levels of the patients. As seen in the above cited studies and this study, reaching recommended target blood pressure is difficult and may need increased treatment aggressiveness. It is however dangerous to be too aggressive in treating these patients as lower levels of systolic blood pressure to levels below 130 mmHg did not appear to give any additional benefit and had a higher mortality rate in the recent trials [96, 98].

More than three quarters (87.7%) of our patients had dyslipidemia. Although comparison of results from different studies is difficult due to differences in study populations, race, age-distributions and definitions used for dyslipidemia, similar higher prevalence rates have also been reported in studies in Tanzania, Kenya and German where 95%, 75% and 76% of patients studied had dyslipidemia [110,114,115]. The Centers for Disease Control and Prevention also reported a dyslipidemia prevalence of 70–97% of individuals with diabetes [103]. In our patients higher LDL was the commonest dyslipidemia found. Females had significantly elevated LDL cholesterol as compared to men. A similar pattern is reported a study done in a large population of African-Americans with type 2 diabetes in whom lower Triglycerides and higher HDL cholesterol concentrations than Caucasians was found. Women with diabetes had higher LDL and HDL cholesterol concentrations than their male counterparts [99]. A study done by Chattanda and Mgonda surprisingly found that hypertriglycemia was the commonest dyslipidemia among patients in specialized Diabetic clinics in Dar es Salaam [115]. Inclusion of Indians in their study population may likely explain the pattern they found. In the Framingham and several other studies elevated triglyceride associated with low HDL-C concentration dominated the diabetic dyslipidemia pattern in most races including Indians [100, 101]. In our patients, although hypertriglyceridemia was not the commonest dyslipidemia, it was the only lipid abnormality that was significantly associated with poor glycemic control. As for the Kenyan study, females had higher rates of dyslipidemia in this study [110]. It was also alarming to find that about half (48.6%) of our patients had hypertension and dyslipidemia compounding the already present risky diabetes mellitus on cardiovascular events. This calls for aggressive screening and treatment of cardiovascular risk factors among diabetic patients. It is also evident that a substantial percentage (80%) of diabetic patients in this study population requires intervention and ongoing monitoring to ensure that the recommended LDL cholesterol goal is reached and maintained.

Most patients in this study were on glucose lowering medication although glycemic control (random glucose $\leq$ 7.2mmol/l) was only reached in 23.3% of patients. A lower control rate is not only found in our patients as rates of 30% and 37% have also been reported in studies in Kenya and northern Tanzania [110, 116]. The later study used casual blood glucose (<7.8mmol/l) while the former used glycosylated hemoglobin (HbA_{1c} < 7 %) to assess the glycemic control. These methodological differences may be the reason for relatively different control rates as compared to our study. Similar to our study, the above studies were done in referral and specialized centers. It is surprising however that glycemic control is alarmingly poor in these centers as well. Self-monitoring of blood glucose is not practical and affordable among our patients. Blood glucose profiles are usually determined during their hospital visits that are usually scheduled at least three monthly because of the patients load. Unlike HbA_{1c} measurements, these hospital rapid capillary blood tests are episodic and they only measure glucose at one point in time. In between visits patients' glycemic status are unknown. The use of two or more point measurements of random capillary glucose in our patients grossly gave an estimate of their glycemic control over the period between visits that may be reproduced by HbA_{1c} measurement. HbA_{1c} measures glycemic control during the preceding 2 to 3 months. The high rate of poor glycemic control in this study calls for more attention to the control goals but carefully not to induce hypoglycemia because of infrequent monitoring particularly to those on insulin therapy.

Contrary to the smoking habits reported in other studies, smoking was an infrequent finding in our study as only 1.3% of patients reported to be actively smoking [110]. Although it is an encouraging finding it is difficult to be relied as patients may tend to hide some information that exposes their risky behaviors.

About 67.3% of the patients were at least overweight or obese. This was more likely among hypertensive patients as compared to those with normal blood pressure with no significant differences between males and females. Obesity appears to be an important factor linking hypertension to impaired carbohydrate metabolism [53]. As weight loss has been associated with a substantial hypotensive effect among obese hypertensives [57], a greater importance should be given to nutrition education and weight reduction in our patients.

11. CONCLUSION AND RECOMMENDATIONS

About half (54.7%) of our diabetic patients were hypertensive. Of those who were on antihypertensives only a third achieved JNC 7/ADA control targets. Similarly, only a fifth of these patients achieved glycemic control. About two third of these patients were either overweight or obese with majority (88%) being dyslipidemic as well. Coexistence of these cardiovascular risk factors was a common finding in this study. As the coexistence of hyperglycemia, hypertension and dyslipidemia has been associated with poor disease outcomes, an overall risk factor control, addressing hypertension, smoking, dyslipidaemia, obesity and hyperglycaemia is recommended among our patients. This multifactorial approach will enhance the proportion of well treated patients to target goals which have been shown to be beneficial.

12. STUDY LIMITATIONS

The small sample size and the hospital based nature of this study could be a limitation to the generalization of our results. However, the results reflect what is seen in clinical practice and hence they provide useful information that can be used to improve our care to patients. This study was also limited by the failure of using glycosylated hemoglobin that is more specific in characterization of a longstanding glycemic control among diabetics. The use of two random levels of capillary glucose from two consecutive visits at least three months apart could reliably provide information on the glycemic status over this span of time.

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