Risk Factors Associated with Elevated Blood Glucose Among Adults in Mwanza City, Tanzania

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Abstract

Type 2 diabetes mellitus (T2DM) prevalence is increasing at alarming rates posing significant health problem in Tanzania. Urbanization with economic advancement has led to lifestyle behaviors such as high intake of dense caloric foods, sedentary lifestyle, smoking, and limited intake of fruits and vegetables. All these have been associated with higher prevalence of cardiovascular diseases, hypertension and T2DM. This cross-sectional study was conducted to assess the risk factors and lifestyles characteristics associated with type 2 diabetes mellitus among adults in Mwanza city, Tanzania. A multistage random sampling technique was used to obtain 640 male and females respondents aged 30 and above years. Data were collected through face to face interview by using a structured questionnaire which was constructed to solicit information about risk factors and lifestyle characteristics of the respondents. Anthropometric measurements such as height, weight, waist and hip circumferences and total fat and fat free mass were also taken. Random blood glucose and blood pressure levels were measured. Prevalence of overweight in the studied population was 10.5% in males and 18.1% in females. Most females (60.8%; n=79) had waist hip ratio of ≥ 0.85. BMI and body fat were significantly ($p<0.05$) related to elevated blood glucose. It was further noted that, relationship between diabetic respondents with their first degree relatives with diabetes was significant ($p<0.05$). The relative risk for developing type 2 diabetes mellitus by having first class relative with the disease was RR 2.11, (95% CI: 1.4-3.1). There was a strong ($p<0.05$) association between smoking and elevated blood glucose. It can be concluded that it is of utmost importance to intervene, and modify lifestyle behaviours of adults so as to reduce the risks of developing T2DM.

Keywords: Lifestyles, Risk factors, T2DM, adults, Mwanza city, Tanzania

Introduction

Type 2 Diabetes Mellitus (T2DM) is a type of diabetes which affects about 90% of the diabetic population globally (WHO, 2013). It is estimated that about 387 million people had diabetes in the year 2014 (IDF, 2014). The trend shows that by the year 2035 this will rise to 592 million people. The number of people with type 2 diabetes is increasing in every country. About 77% of people with diabetes live in low-and middle-income countries (IDF, 2013). The greater number of people with diabetes is between 40 and 59 years of age (IDF, 2014). It is estimated that 179 million people with diabetes are undiagnosed (IDF, 2014). Study has shown that Diabetes treatment caused at least expenditure of USD 612 billion dollars in 2014 worldwide (IDF, 2014). In Tanzania, T2DM is the 14th cause of death which accounts for 1.9% of all causes of death (WHO, 2013). About 5% of the health budget was estimated to be spent in the management of the disease in Tanzania in the year 2010 (Zhang, 2010).

Tanzania and other countries in Sub Saharan Africa are experiencing the most rapid

epidemiological transitions. Urbanization with economic advancement has led to lifestyle behaviors such as high intake of dense caloric foods, sedentary lifestyle, smoking, and limited intake of fruits and vegetables. All these have been associated with the higher prevalence of cardiovascular diseases, hypertension and T2DM (Hamada, 2010). Sedentary lifestyle, poor diet and excessive alcohol intake may lead to overweight, obesity, excessive body fat and large waist hip ratios. These are important risk factors for the development of T2DM (Brown, 2012)

Studies have shown that lifestyle modification, by maintaining a healthy diet with wholegrain starchy foods, fruits and vegetables, participating in regular physical activities, achieving and maintaining a healthy body weight, limiting alcohol intake, and quitting smoking can be effective in controlling many of the adverse risk factors for the development of T2DM (Schulze, 2004; Manumbu, 2011). This study was therefore conducted to assess major risk factors and lifestyles characteristics among adults in relation to the development of T2DM disease in Mwanza city, Tanzania. The results will therefore help health professionals to plan for interventions to modify lifestyles and reduce risk factors for the development of T2DM.

Methodology

Description of the Study Area

The study was conducted in Ilemela and Nyamagana districts of Mwanza city, Tanzania. Mwanza is located in the northern part of Tanzania, between latitude 1° 30' and 3° 0' and longitudes 31° 45' and 34° 10' 1 (URT, 2012). The population of Mwanza city was 924,221 with growth rate of 3.2%. The average per capita income of Mwanza was US$ 21 per month (URT, 2012). Mwanza City had six hospitals, 12 health centers, and 52 dispensaries (Mwanza Socio-economic Profile, 2010). Majority of Mwanza people were self-employed involved in petty trading, agriculture, and micro fishing activities and those employed were working in the public sector (Mwanza Socio-economic Profile, 2010).

Study design

Cross-sectional study design was employed to identify those at risk of T2DM. Thereafter, a fasting blood glucose test was conducted for those with elevated blood sugar (200 mg/dl) to confirm the cases. The study population comprised of adults (males and female) of 30 years old and above who had been residing in Mwanza city for at least 3 months prior to the study. Mentally ill people and pregnant women were excluded from the study.

Sampling techniques and sample size

A multistage random sampling technique was used to obtain representative wards as described by Kothari (2006). Six wards from Ilemela and Nyamagana districts were randomly selected. From each ward, four streets were randomly selected and from each street, 27 households were randomly selected. At the household, respondents were stratified by sex. From the age group of 30 years and above, a representative sample was randomly selected. Sample size was calculated using the formula by Daniel (1999) for prevalence studies,

$$n = \frac{Z^2 P(1-P)}{d^2}$$

where n = sample size, Z = Z statistic for a level of confidence, P = expected prevalence or proportion (in proportion of one; if 20%, P = 0.2), and d = precision (in proportion of one; if 5%, d = 0.05). Z statistic (Z): For the level of confidence of 95%, which is conventional, Z value is 1.96. with 95% confidence intervals (CI). Because the prevalence for diabetes mellitus used was 2.6% in Tanzania (Sobngwi, 2001) and the prevalence was smaller than 10% thus, half of P was used (Naing, 2006). Therefore, the sample size was 1.962(0.026) (1-0.026)/ (0.026)2/2 with 24% attrition rate to cover for the dropouts, 640 respondents.

Data collection

A questionnaire was designed to solicit information about risk factors for T2DM and lifestyle behaviors from the respondents and was pretested prior to the study. Anthropometrics such as height, weight, waist

and hip circumferences and total fat and fat free mass were also measured. Current smoking was self-reported and classified as yes/no. Alcohol consumption was determined by inquiring about the number of alcoholic drinks consumed per day and categorized as abstainers 0 units/ day, moderate drinkers 1-4 drinks /day, or heavy drinkers ≥ 4 drinks/per day (IDG, 2010). Blood related relatives were self-reported and classified as yes/no.

Overall, fruits intake was assessed by asking how much fruits were eaten per day so as to determine if people were adhering to recommendations for fruits intake. Dietary guidelines require that people should take five servings of fruits of about 400 g per day in order to have good health (WHO, 2005). Therefore, information about fruits and vegetable intake was assessed by using HHNES food frequency questionnaire (Hall, 2014) that was changed to suit the study environment and by 24 hour dietary recall. Bowls which showed amounts of food were used to establish the grams that were eaten per day. Also preparation methods of all the food items were recorded. Physical activities were assessed by adopting international physical activity questionnaire which was changed to suit the study environment. The questionnaire was translated into Kiswahili and included frequency and duration of participation in different physical activities and exercises that were used to calculate hours per week at each intensity level. Participants were classified according to guidelines for data processing and analysis of the international physical activities questionnaire (Ipaq and Booth, 2000). Classification levels were as follows; people were classified as doing heavy activities if they were doing heavy activities for ≥2.5 hours/ week of moderate or ≥1 hour/week of vigorous physical activity; sedentary if they were doing sedentary type of activities for ≤1 hour/week of moderate and ≤1 hour/week of vigorous physical activities, or moderately active if they did not do any physical activity or were inactive.

Anthropometric measurements

Height and weight were measured using standard procedures (WHO, 2005). Body mass index was calculated and categorized in four groups (underweight, BMI >18.5; normal BMI 18.5-24.9; overweight BMI, 25-29.9; obese BMI, ≥30) on the basis of (WHO, 2004), classification. These values were used because no other values to represents African population. Waist and hip circumferences were measured using standard procedures according to (WHO, 2008). Waist circumference was measured by using a non–stretchable tape and the readings were taken at the mid–point between the costal margin and iliac crest, with the subject standing erect in a relaxed position and feet placed 25-30 cm apart. Hip circumference was measured at the level of the greater trochanters (widest portion of the hip) using a non-stretchable tape while the subject was standing with arms on side and feet together. The hip circumferences were thereafter recorded to the nearest 0.1cm. Waist and hip circumferences were used to determine waist hip ratio. Where normal waist hip ratio for women was <0.8, overweight was 0.80-0.84 and obesity ≥ 0.85. While in men < 0.9 was normal weight, 0.9-0.99 was overweight and ≥ 1 was obese. Information on demographic characteristics and lifestyle behaviors were collected by trained interviewers (WHO, 2008).

Total body fat composition was determined by using Bi-electric impedance (BIA) method (BF 905, Maltron, UK). A subject was requested to stand on the electrodes without shoes on and with minimum clothing. Body-fat-percent categories for this analysis were as follows: 10% for under-body-fat, 10% to 20% for normal-fat, 20% to 25% for over-fat while >25% was for higher-body-fat (Yamasita *et al.,* 2012).

Biochemical measurement

Random blood glucose (RBG) of the respondents was measured at the time of the interview by using a standardized Gluco Plus machine (Glucometer Type 25 KB JPG). Respondents with RBG ≥ 200 mg/dl were requested to do a follow up fasting plasma glucose (FPG) on the following day. A subject was confirmed to be diabetic when fasting plasma glucose was ≥126/ mg/dl.

Blood pressure measurements

Blood pressure was measured by using standard procedures (Alexander *et al.,* 2016). Respondents were made comfortable in the sitting position. The subject's arm was resting on the desk so that the antecubital fosa were at the level of the heart and the palm was facing up. Three serial measurements of blood pressure were taken one minute apart, using a digital blood pressure monitor sphygmomanometer (make-CH-432B, Citizen Systems Japan Co Ltd) The blood pressure was measured after the subject has rested for at least 5 minutes. The classification of blood pressure was systolic pressure of >120/mmHg to diastolic of >80 was normal pressure. Systolic pressure of 120-139/ mmHg to 80-89/mmHg diastolic pressure was pre hypertension. Lastly sytolic pressure of >140 mmHg to >90 mmHg diastolic pressure was hypertension (AHA, 2014).

Ethical consideration

Ethical clearance to conduct this study was obtained from Ethical Clearance Commettee of the National Institute for Medical Research (NIMR) with reference number NIMR/HQ/R.8a/ Vol.IX/1322. After the objectives and benefits of the study were explained to the respondents, they were requested to sign an informed consent form to affirm their willingness to participate in the study. Confidentiality of the collected data was assured. Permission to conduct the study was obtained from Mwanza region and from Ilemela and Nyamagana district health authorities. If respondents were identified to have the disease they were given a referred to Bugando Referral hospital for further checkup and management.

Statistical analysis

Data were analyzed by using SPSS (Statistical Packages for Social Sciences) software version 16. Descriptive statistics such as frequency, percentage and cross tabulations (where odds/ risk ratio) were computed between variables. Inferential statistics such as the chi square were computed with 95% confidence interval to find the relationship among lifestyle risk factors and T2DM. A difference was considered to be significant at $p<0.05$. Relative risk for different groups in the study were also analyzed to identify the risk of developing T2DM after exposures to overweight, obesity, first degree relative with a disease etc.

Results

Socio-economic and demographic characteristics of the respondents

A total of 640 participants were involved in this study of whom 352 (55%) were females. Most of respondents had 30-40 years (46.4%) while few (11%) had more than 60 years. About 57% of the respondents had primary level of education while only 9.8% had college level of education. Males had a significantly higher education level than females ($p<0.05$). Findings showed that 28.8% of the respondents were dealing with petty businesses while 18.8% were employed in formal sectors. It was further depicted that 68.7% of the respondents were married, while 17.8% were singles, 5.4% divorced and 7.9% widowed. Most of the respondents (47.7%) earned less or equal to 33.33 US $ per month while only 1.1% earned higher or equal to 476.19 US $ per month. Males earned significantly higher incomes than female counterparts ($p<0.05$).

Distribution of different risk components with blood glucose levels

Findings showed that about 38.8% (n=248) of the screened normal respondents had normal blood glucose levels while 5.3% (n=34) of overweight and 2.3% (n=15) of the obese respondents had elevated blood glucose levels. Respondents with high BMI had strong association with elevated blood glucose ($\chi2=22.45$, $p=0.008$) (Table 2). It was observed in the study that about 20.1% (n=43) of females with elevated blood glucose had w:h ratio ≥ 0.85 while 23.5% (n=4) of males with elevated blood glucose had w:h ratio ≥1.0. Result revealed further that about 21.4% of respondents with elevated blood glucose had body fat above 25% while 17.2% of the respondents with elevated blood sugar were in over fat category with fat mass of 20-25%. There was a significant relationship between fat mass of respondents and the blood glucose levels ($\chi2=20.52$, $p=0.05$) (Table 2).

Table1: Socio-economic and demographic characteristics of the respondents

Characteristic	Value/response	Total (n=640) (%)	No. females (n=352) (%)	No. males (n=288) (%)
Education level	Informal	64(10.00)	46(13.12)	18 (6.22) *
	Primary	413(57.22)	248(70.51)	165 (57.39)
	Secondary	100(62.53)	31(8.82)	69 (24.00)
	College	63(9.81)	27(7.71)	36 (12.51)
Marital status	Single	114(17.82)	46(13.11)	68 (23.63) *
	Married	440(68.70)	236(67.00)	204 (70.83)
	Divorced	35(5.43)	25(7.13)	10 (3.52)
	Widow/widower	51(7.92)	45(12.84	6 (2.12)
Agegroup (years)	30-40	297(46.40)	154(43.84)	143 (49.72)
	41-50	174(27.13)	100(28.46)	74 (25.71)
	51-60	98(15.34)	62(17.67)	36 (12.51)
	>60	71(11.09)	36(12.51)	35 (12.22)
Income per month Tsh	< 33.33	305(47.60)	190(54.00)	115 (39.91*
	33.33- 47.6	183(28.52)	102(29.2)	81 (28.12)
	47.6-237.61	131(20.44)	54(15.32)	77 (26.71)
	238.09-475.71	14(2.13)	2(0.65)	12 (4.22)
	>476.19	7(1.12)	4(1.17)	3 (1.00)
Occupation	Formal employment	74(11.56)	52(14.75	126(40.46)
	Self employed	202(31.56)	61(17.32)	141 (22.00)
	Farmer	6(1.95)	72(20.58	78 (12.23)
	Not working	220(34.44)	137(38.93)	83(28.85)*
	Petty businesses	19(6.35)	5(1.44)	14 (4.91)
	Students	119 (18.59)	14(4.91)	5(1.44)

** Significant at p<0.05*

Distribution of risk factors and selected lifestyle characteristics in males and females with random blood glucose levels

The prevalence of overweight in the studied sample was 10.5% (males) and 18.1% (females) (Table 3). The relative risk of developing type 2 diabetes mellitus for obese or overweight respondents was 0.621, 95% (CI: 0.080-1.881). The majority of female respondents had higher fat mass compared to their male counterparts. More than 7.1% (n=46) of respondents who had high percentage body fat mass were females, while only 1.2% (n=8) of the respondents with high percentage body fat mass were males. Most of respondents classified as under fat mass percent were males 64.2% (n=158). There was a significant relationship between body fat mass and sex of the respondents ($\chi 2=85.5$, p=0.00) with females having more fat mass percent than their male counterparts (Table 3).

Findings showed that 10.1% (n= 65) of males were smoking and only 0.46% (n=3) of the females had the habit of smoking. There was a significant (P=0.00) association between smoking and elevated blood glucose. The relative risk of developing T2DM if one smokes observed to be 16.23, 95% CI: 9.98-26.39. Prevalence of hypertension was high in 41-50 age group (10.2%, n=65) while the overall prevalence of hypertension was 34.1%. The

Table 2: Distribution of different risk components with random blood glucose levels (mg/dl)

	Under normal (≤70)	Normal (71-139)	Impaired Glucose (140-199)	Diabetic (≥200)	χ2	P value
BMI Kg/m2	**N (%)**	**N (%)**	**N (%)**	**N (%)**		
<18.5	4(0.6)	32(5)	1(0.2)	0(0)	22.45	0.01*
18.5-24.9	25(3.9)	248(38.8)	22(3.4)	27(4.2)		
25-29.9	10(1.6)	126(19.7)	13(2)	34(5.3)		
>30	3(0.5)	72(11.3)	8(1.3)	15(2.3)		
W:H						
< 0.9 men	8(5.3%)	126(83.4%)	5(3.3%)	12(7.9%)	0.081	11.23
0.9-0.99 men	7(5.8%)	86 (71.7%)	13(10.8%)	14(11.7%)		
>1,0 men	1(5.9%)	11(64.7%)	1(5.9%)	4(23.5%)		
< 0.8 in women	5(11.6%)	27(62.8%)	7(16.3%)	4(9.3%)	0.609	4.50
0.8-0.84 women	11(11.6%)	60(63.2%)	8(8.4%)	16(16.8%)		
0.85>0.85 women	22(10.3%	125(58.4%)	24(11.2%)	43(20.1%)		
% Body fat						
< 1.0	24 (9.9)	182(76)	15(6.2)	19(7.9)	20.52	0.02*
10-20	10(4.8)	162(77.9)	14(6.7	22(10.6)		
20-25	6(4.5)	96(71.6)	9(6.7)	23(17.2)		
>25	2(3.6)	36(64.3)	6(10.7)	12(21.4)		

Figures in parenthesis indicates percentage
**Shows significance at (p≤0.05)*

prevalence of hypertension was 16.7% and17.3% in females and males, respectively (Table 3). The relative risk of developing elevated blood glucose if one has hypertension was 4.052, 95% (CI: 2.553-6.433) p=0.06. Findings from this study show that 24.37% of respondents had their first degree relatives with type 2 diabetes mellitus. The relationship between diabetic respondents with their first degree relative with diabetes was significant (P=0.00). The relative risk for developing type 2 diabetes mellitus by having first class relative with the disease was 2.11, 95% (CI: 1.4-3.1) p=0.003.

Fruits and vegetable intake

Findings showed that 31.2% (n=200) of the respondents ate fruits and vegetables once per day while only 27.5% (n=98) ate fruits and vegetables twice per day (Figure 1). More than 10% (n=64) of the respondents did not consume

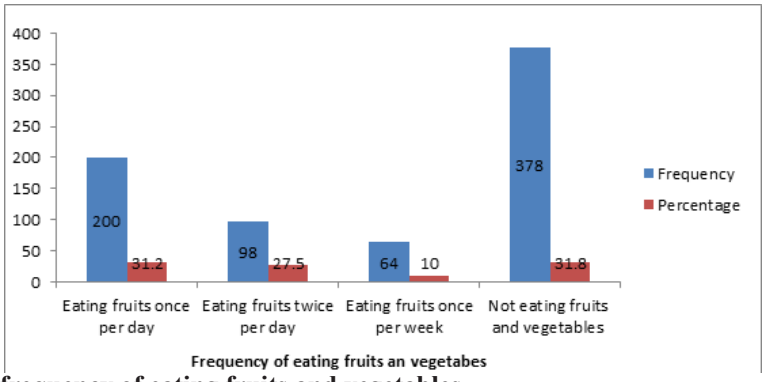

Fig 1: Daily frequency of eating fruits and vegetables

Table 3: Distribution of risk factors and selected lifestyle characteristics in males and females with random blood glucose levels (N=640)

Category	Sex (%)		χ2	P- value
	Male	Female		
BMI				
Underweight	24 (3.8)	13 (2.0)		
Normal	178 (27.8)	144 (22.5)	50.03	<0.001*
Overweight	67(10.5)	116 (18.1)		
Obese	19(3)	79(12.3)		
Fat mass (%)				
Underbody fat <10	158 (24. 6)	88(13. 7)	85.54	<0.001*
Healthy 10- 20	94 (14. 6)	116(18. 1)		
Over fat 20-25	28 (4. 3)	102(15. 9)		
High body fat >25	8(1. 2)	46(7. 1)		
Smokers				
Smokers	65(10. 1)	3 (0. 46)	45. 06	<0.001*
Non Smokers	223(34)	349 (54. 5)		
Hypertension				
Hypertension	114 (17.3)	118 (16.7)	12.426	0. 060
Normal	174 (27.7)	234 (38.3)		
First relative with T2DM				
Relative T2DM	60 (9.3)	86 (13. 4)	13.245	0.003*
Relative without T2DM	12.426	266 (41.5)		

**Shows significant at p ≤0.001 and p≤0.05*

vegetables and fruits in a week. The relative risk of developing diabetes mellitus if one doesn't consume fruits and vegetable was 0.90, 95% (CI: 0.575-1.446) p=0.68.

Physical activities and exercises

This study revealed that 65.7% (n=421) of the respondents usually walk to, and from their usual activities, 3.6% (n=23) use bicycles as their mode of transport, 25.31% (n=162) used public buses while 5.3% (n=34) use personal cars for transportation. It was also observed that 76.7% (n=491) of the respondents were engaged in sedentary activities. Furthermore, the results indicated that only 4.5% (n=29) of the respondents actively participated in exercises for ≥ 2.5 hours/week of moderate or ≥1 hour/week of vigorous physical exercise. The relative risk of developing T2DM if one does not exercise was RR 1.65, 95% (CI: 0.696-1.630,) P=0.80.

Alcohol consumption

Results from this study showed that, 27% (174) of the respondents were used to take alcohol. There was a significant association (P=0.01) between alcohol intake and development of T2DM in the study population. The amount of intake showed that 7.5% (n=48) of the respondents were drinking more than 5 units (equivalent to 5 bear/5 litre) of alcohol per day while 16.40% (n=105) drank moderate amount per day. The relative risk for developing T2DM due to alcohol intake was 1.562, 95% (CI: 1.148 - 2.125) P=0.01.

Discussion

These findings indicated that, most of the respondents studied had low education levels and hence limited knowledge of the disease. Moreover, most of the respondents earned their livelihoods through small businesses which reflected their low income of about 70000Tsh

per month. Generally, this study revealed that most of respondents in the high body fat category and those who were over fat were diabetic though the relationship was not significant. It was observed further that, females were having higher fat contents compared to their male counterparts. Studies have shown that, fat mass exceeding 32% increased the risk of developing chronic diseases for women (Eyre, 2004). These findings also were consistent with other research done elsewhere which indicated that, those who suffer excessive body weight and body fat had increased prevalence of diabetes (Despres, 2006) (Perry, 2013). Increased BMI had shown to be a risk factor for elevated fasting blood glucose level though there was no significant difference in this study. Findings also revealed that women were more overweight and obese as compared to males, and therefore, they had increased risk for developing T2DM. A study by Mokdad (2003), revealed that, prevalence of diabetes increased with increasing BMI. Moreover, overweight and obesity were among the most factors that have shown to increase the global diabetes epidemic (Narayan, 2007, Kelly, 2005). They have shown to affect most adults in developed and developing countries.

Generally, the findings in this study indicated that visceral obesity which was determined by waist circumference (WC) or waist-hip ratio (WHR) was typically seen in overweight and obese males and females. Respondents with elevated blood glucose also tended to have elevated waist-hip ratios. Females had large waist hip ratios therefore more likely to develop high blood glucose levels eventually T2DM as compared to males though the relationship was not significant. A study by Shah (2009) reported waist –hip ratio to be the best predictor of the risk for developing T2DM among populations. Also, Wang (2005) suggested that WC and WHR (measures of central obesity) were more positively and significantly associated with T2DM than BMI. Epidemiologic studies have demonstrated that, waist circumference, waist-hip ratio and obesity were strong and consistent predictors for T2DM (Bray, 2008, Miljkovic, 2008).

The prevalence of hypertension was significantly related with increasing blood glucose levels in this study. The findings showed that, prevalence of hypertension was in line with previous findings in the country (Mayige, 2012). Therefore, there was increased risk for the prevalence of T2DM as it was attributed to high blood pressure. According to the study by Feldstein (2002), an estimated 35% to 75% of diabetic complications were triggered by hypertension. Hypertension and T2DM occured together so frequently that they are considered to be comorbidities likely to be present in the same patient (Weber, 2009). Studies have shown that, obesity was the major precipitating factor for both hypertension and T2DM because of the obesity-induced insulin resistance (Landsber, 2013). Furthermore, insulin resistance ay contribute to hypertension in diabetic individuals through effects on sodium retention, activation of sympathetic nervous system and direct effects on blood vessels (Paton, 2013).

This study found that prevalence rate of alcohol users was 27%. These findings were in agreement with prevalence reported by Mayige, (2012) which were in the range 23 to 37% in males and 13 to 23% in females. Moreover, relative risk of developing type two diabetes mellitus was doubled for alcohol users compared to non-alcohol users as shown in this study. This study also revealed a significant relationship between alcohol intake and elevated blood glucose. It was suggested that, heavy alcohol intake has multiple deleterious metabolic effects, including excess caloric intake and obesity, increased triglyceride levels, pancreatitis, disturbance of carbohydrate glucose metabolism, and impairment of liver function (Manumbu, 2011). Prevalence of smoking in males was significantly related to elevated blood glucose levels. These findings revealed that respondents who were diabetic were smoking or were formerly smokers. According to available statistics, prevalence of smoking was 11.0% for males and 0.4% for females in Tanzania (Frank, 2011) which was also reflected in this study. It was observed that smokers had 16 times more chances of developing diabetes mellitus compared to non-smokers in this study. Results from other

studies indicated that, active smokers had a 44% increased risk of developing type 2 diabetes compared with non-smokers (Culliton, 2008).

The frequency and amount of intake of fruits and vegetable was minimum among the respondents compared to the recommended intakes. Recommended intake of fruits and vegetables per day was 400/g or 5 servings or more (WHO, 2005). Most of the respondents reported that the cost of fruits was high and therefore they could not afford to buy them often. According to a study by Schulze (2004), people who eat fewer fruits and vegetables had increased risk of developing chronic diseases. A study by Culliton (2008) also revealed that higher blood levels of vitamin C were associated with a substantially lower risk of developing diabetes. Eating even a small quantity of fruits and vegetables may be beneficial and the protection against diabetes increases progressively with the quantity of fruit and vegetables consumed (Schulze, 2004). In this study, most of the respondents were engaged in sedentary type of lifestyle while very few were engaged in vigorous physical exercises. Numerous epidemiologic studies have shown that increased physical activities reduced the risk of diabetes, while sedentary lifestyles increased the risk for chronic diseases including T2DM.

Conclusion

This study highlights the risks and lifestyles characteristics that were associated with the development of T2DM among adults in Mwanza city. Lifestyles and other related risk factors were observed to be significantly related to T2DM. Prevalence of hypertension was significantly related with elevated blood glucose levels in this study. Prevalence of smoking in males was significantly linked to elevated blood glucose levels. Moreover most of the respondents were engaged in sedentary lifestyle while only very few were engaged in vigorous physical exercises. Therefore, it was important to intervene, and modify lifestyle of adults so as to reduce the risks of developing T2DM. A good approach for professions was to create awareness about the risk factors for the development of the disease and frequent screening of the population to identify those at risk at the very early stages of the disease development.

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