

Magnitude of Type 2 Diabetes Mellitus, Dyslipidemia and Hypertension Among Young Adults in Urban Settings: A Cross Sectional Survey in Mwanza, Tanzania

EVANGELISTA KENAN MALINDISA (✉ maryvianey12@gmail.com)

Catholic University of Health and Allied Sciences <https://orcid.org/0000-0002-0560-954X>

Emmanuel Balandya

Muhimbili University of Health and Allied Sciences

Marina Alois Njelekela

Deloitte Consulting Limited

Fredirick Mashiri

Muhimbili University of Health and Allied Sciences

Research article

Keywords: Diabetes, Hypertension, Obesity, Dyslipidemia, Young Adults

Posted Date: August 20th, 2019

DOI: <https://doi.org/10.21203/rs.2.13177/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background Non-communicable diseases (NCDs), accounting for nearly one third of global deaths were diseases of public concern in developed countries. Due to economic transition, now NCDs are becoming more prevalent in middle and low-income countries (LMICs). However, little has been done about NCDs among young adults in LMICs, Tanzania in particular. Traditionally, health systems thought that this subpopulation has an active life style and therefore not at risk of NCDs hence left without intervention. But current research evidences indicated a gradual increase of NCDs among young adults especially to those living in urban. Therefore, a study was conducted to determine the magnitude of diabetes mellitus, obesity, dyslipidemia and hypertension among young adults from Mwanza urban areas. Methods A community based cross-sectional was conducted between May and August 2018 from an urban settings in Mwanza, Northern Tanzania. Case report forms (CRFs) were used to collect participants' demographic information, clinical assessment and laboratory measurements. Descriptive statistics were summarized using frequencies and percentages. The association between dependent and independent variables were analyzed using Chi-square test. All statistical analysis was performed using STATA version 13 and type 1 error for significance was 0.05. Results Overall 259 young adults were recruited. The median age [interquartile range (IQR)] was 21 (IQR: 19 -27), the prevalence of diabetes mellitus (DM) and impaired glucose tolerance (IGT) were 8% (259) and 16% (259) respectively. Overweight, obesity and dyslipidemia were present in 17%, 8.1% and 44.4% of the studied population (259) respectively. The prevalence of hypertension was 35.1%, more prevalent in males than females (52.4% vs. 32.7%; $p = 0.002$). Physical inactivity was significantly associated with isolated systolic hypertension ($p = 0.009$) and elevated mean arterial pressure (MAP) ($p = 0.004$). High Body Mass Index (BMI) was significantly associated with elevated mean arterial pressure (MAP) ($p = 0.03$) and dyslipidemia ($p = 0.018$). Conclusion Alarmingly high prevalence of diabetes, impaired glucose tolerance, hypertension, overweight, obesity and dyslipidemia was observed among young adults in Mwanza. This study highlights the need for concerted efforts targeting young adults in combating NCDs in Tanzania. Key Words: Diabetes, Hypertension, Obesity, Dyslipidemia, Young Adults

Background

In 2015, non-communicable diseases (NCDs) accounted for an estimated 17.7 million deaths (nearly one-third of all global deaths), with more than two-thirds of NCD-related deaths occurring in low and middle income countries (LMICs) [1, 2]. NCDs are projected to be the leading cause of death and disability globally, accounting for more than 24 million deaths by 2030 [3]. In Tanzania, NCDs have been observed to be on the rise, and there is a general call for urgent intervention [4]. The increasing burden of NCDs in LMICs is fueled mainly by four modifiable risk factors; smoking, excessive alcohol drinking, sedentary life style accompanied by physical inactivity and unhealthy dietary habits characterized by consumption of high energy dense foods [5].

Globally, the magnitude of hypertension is on the rise, with current data showing up to 36.9% of young adults in developed and middle income countries being hypertensive [6, 7]. The prevalence of diabetes in

young adults in US has been reported to be 5%, and that of pre-diabetes to be 28.2% [8, 9], while in LMICs, the prevalence of diabetes has been reported to be as high as 11.6% [10]. High prevalence of obesity has recently been reported across the globe with levels as high as 65.5% being observed among African immigrants in US [11]. In Tanzania, the prevalence of obesity has ranged from 6.7% to 28.7% in young adult populations [12]. Data on the prevalence of dyslipidemia in healthy young adults in low income countries are scarce, but few have reported up to 36% prevalence of dyslipidemia in young adults [13], and much higher prevalence in older ages [14].

Obesity is a key factor in development of dyslipidemia and later insulin resistance, hyperinsulinemia and Type 2 Diabetes Mellitus (T2D) through one of the four mechanisms, namely insulin receptor down regulation, free fatty acid interference of insulin action, intracellular lipid accumulation and the effect of adipokines interference of insulin action [15]. Insulin resistance is however more linked to intra-abdominal fat than to fat depots in other body organs [16].

Life style modifications that aim at reducing the energy intake and increasing energy expenditure such as physical exercise, even of modest degree, increase insulin sensitivity and often improve glucose control. In patients with diabetes, exercises have been shown to be effective in blocking the cascade of metabolic syndrome [17-19]. These modifications are however more effective before the onset of metabolic syndrome, and are generally less effective once the disease has already developed [20]. Prevention and early diagnosis therefore remain the best options to reduce disability and mortality contributed by NCDs.

The higher prevalence of NCDs in young populations poses a need for emergency interventions to rescue the future generation [21], especially in LMIC like Tanzania, where the costs of healthcare are high and out of reach by the majority of the population [22]. However, despite their increase, data on the magnitude of NCDs and associated risk factors in LMICs are limited. Particularly, few studies have evaluated the magnitude and risk factors for NCDs among the young adult populations, partly in belief that they are in low risk due to their seeming active lifestyle. Given their long natural history, it is likely that the true magnitude of NCDs and associated factors are hidden in young adults. For that reason, this study aimed to determine the magnitude of NCDs among young adults in an urban LMIC-setting, Tanzania in particular.

Methodology

Study design, area and population

This was a community based cross-sectional study conducted between May and August, 2018 in an urban setting in Mwanza, Northern Tanzania. Mwanza has seven administrative districts. 2 universities are in the urban areas and recruit a mixture of national and international students. Besides being university students, young adults in urban areas in Mwanza are involved in diverse economic activities, including small-scale agriculture and businesses. A minority of young adults is employed by formal sectors.

Sample size determination and sampling techniques

We used the Kish and Leslie formula (1965) to estimate the minimum required sample size. Given the global prevalence of 8.8 reported by IDF Diabetes Atlas as global estimates of diabetes in 2015 and 2040 [23], we targeted to enroll minimum of 192 participants. Inclusion criteria included male or female aged 18 – 35 years, not known to be diabetic or hypertensive currently and residence in Mwanza for a minimum of 12 months. A multi-stage random sampling technique was used to enroll participants into the study (from three of seven districts, two wards from each of the three districts, four streets from each of the two wards).

Clinical and anthropometric measurements

After providing written informed consent, all participants were interviewed using structured questionnaires where social-demographic data were obtained. Systolic and diastolic blood pressure was measured two times at a space of 5 minutes using calibrated digital sphygmomanometer (CH-432B, Citizen Systems Japan Co Ltd).

Mean Arterial Pressure (MAP) was calculated using the equation below;

Weight, height, hip and waist circumference were measured using a calibrated stadiometer and tape measure under World Health Organization (WHO) protocols. BMI was calculated using the formula $\text{Weight (kg)}/\text{Height}^2 (\text{m}^2)$. BMI cut off for overweight and obesity were defined according to WHO standards [24].

Biochemical assessment

Participants were instructed to appear at a designated study laboratory at Catholic University of Health and Allied Sciences (CUHAS) for biochemical tests the day that followed clinical and anthropometric measurements, having fasted overnight (at least 8 hours). A capillary fingertip blood sample was obtained from each participant for assessment of fasting blood glucose using an ONCALL-PLUS device (ACON Laboratories, Inc). Five milliliters (5mL) of venous blood was obtained from consenting participants, processed and analyzed for plasma lipids under standard operating procedure (SOP) for lipid profile tests using ERBA XL machine (Erba Lachema s.r.o). Assessment of glucose tolerance by Oral Glucose Tolerance Test (OGTT) was done after administering 75mg of oral glucose mixed with 200mls of water, taken in 5 minutes. Two-hour postprandial blood glucose was assessed on capillary blood sample using ONCALL-PLUS.

Definition of Biochemical, Clinical and Anthropometric Parameters

Dyslipidemia was defined as levels of total cholesterol of more than 5.2mmol/L, Low Density Lipoprotein of more than 3.3mmol/L, triglycerides of more than 1.7mmol/L and High Density Lipoprotein of less than 1.03mmol/L in males or less than 1.29mmol/L in females; Diabetes mellitus as OGTT capillary blood glucose levels of more than 11mmol/l; Impaired Glucose Tolerance (IGT) as OGTT capillary blood

glucose levels of 7.8mmol/l to 11mmol/l; isolated systolic hypertension as systolic blood pressure of more than 140mmHg with normal diastolic blood pressure, isolated diastolic hypertension as diastolic blood pressure of more than 90mmHg with normal systolic blood pressure, overweight as waist to hip ratio of above 0.9 in males and above 0.8 in females; or BMI of 25kg/m²-30kg/m² and Obesity as BMI> 30kg/m².

Statistical Analysis

Data was analyzed using STATA IC 13 (64-bit). Continuous variables (age, weight, height) were summarized in frequency, mean and standard deviation, median and inter-quartile range and categorical variables in frequency and prevalence, and are presented in Tables, Pie charts and Histograms. Association between dependent variables (dyslipidemia, dysglycemia, hypertension, overweight) and independent variables (age, sex, history of DM, physical activity, vegetable consumption) was done using Chi square. Two-side P-value of less than 0.05 was considered statistically significant.

Results

Socio-demographic characteristics of the study participants

We screened 281 individuals. Out of these, 15 did not meet the inclusion criteria and 7 did not provide consent. We therefore enrolled a total of 259 participants in this study (Figure 1). The median age of the study participants was 21 years (19-27 years). Females were more prevalent (60.2%). Majority of the participants were university students (66.8%; Table 1). Most participants reported being physically inactive and only 27.8% reported consuming vegetables on a daily basis. 17% of the participants were overweight and 8.1% were obese (Table 1).

Prevalence of T2D and its association with clinical parameters

Diabetes was prevalent in 8% while 16% had impaired glucose tolerance (Figure 2). There was a trend towards association between diabetes and IGT with physical inactivity, but this did not reach statistical significance (p=0.09). Sex and other clinical parameters did not correlate with OGTT values (Table 2).

Prevalence of hypertension and its association with clinical and biochemical parameters

More than one third of the study participants had systolic/diastolic hypertension. Isolated diastolic hypertension was more prevalent than isolated systolic hypertension (Figure 3). Hypertension was more pronounced among males than females (52.4% vs. 32.7%; p=0.002). Those with mean arterial pressure (MAP) greater than 110mmHg were 12.7% of the study population. Further, elevated MAP was significantly associated with high BMI and higher waist to hip ratio (Table 3). Isolated systolic hypertension and MAP were associated with physical inactivity (Table 3). Most participants who reported history of high blood pressure in the past were also found to have hypertension currently in contrast with

those who did not have a past history of hypertension (91.7% vs. 38%, $p < 0.001$). Other clinical parameters did not have statistically significant association with hypertension (Table 3).

Prevalence of Dyslipidemia and its Association with Clinical Parameters

44.4% of the study participants had dyslipidemia. High cholesterol levels and high triglyceride levels were more prevalent than other lipid profile derangements (Figure 4). There was a significant association between dyslipidemia and higher BMI, $p=0.018$. Trends for association between dyslipidemia and female sex as well as those with no habit of eating vegetables daily were observed, but these did not reach statistical significance (Table 4).

Discussion

Understanding the magnitude and factors associated with hypertension, DM and dyslipidemia among the at-risk but often forgotten young adult population is paramount. We found high levels of DM, hypertension, dyslipidemia, obesity and overweight among young adults with media age 21 years in an urban setting in Tanzania, with low level of physical activity being a major modifiable risk factor associated with the occurrence of these diseases. These findings indicate the need for strengthening of interventions against metabolic syndrome among young adults including increase awareness, early screening and promotion of physical activity.

Prevalence of diabetes and impaired glucose tolerance is higher in this group. More than a quarter of study participants had hyperglycemia and higher prevalence of undiagnosed overt diabetes in this age group. Recent studies have shown the higher prevalence of diabetes in young adults before age of 40 [25]. This prevalence is higher compared to recently reported prevalence of diabetes in urban Tanzania, for age group 20-34years. (3.22%-6.91%, IDF Atlas 2017). This value approaches the estimated prevalence of the year 2035 [26]. It has been reported that cardiovascular diseases develop rapidly in those with impaired glucose tolerance starting in early ages than those whom it starts late in life [25]. The future of Tanzanian young adults is foreseen to be in danger if this trend is not intervened. We see the burden is higher in less developed countries than the developed one. Being rich does not seem to be an important risk factor anymore. Life style of college students and especially the food which is rich of fats is not healthy and should be reviewed to combat this rise. With this observation, the number of young adults with undiagnosed pre diabetes and diabetes in young adults is presumed to be high. More studies should be done in other population, including rural areas to have enough data on the burden of diabetes in young adults, and also to probe potential risk factors and possible preventive measures.

Alarming prevalence of hypertension has been observed in this study. 35.1% of systolic/diastolic hypertension in young adults is alarming. Isolated diastolic hypertension is more prevalent in study subjects; this is keeping with other studies that describe diastolic hypertension to be common in younger ages [27]. This is associated with the onset of systolic hypertension and so development of systolic/diastolic hypertension and other cardiovascular complications. Prevalence of hypertension in this study is higher than the reported prevalence in developed countries [28]. However, from the studies of

school children and adolescents in Tanzania and other low income countries have reported significant higher prevalence of hypertension [29, 30]. Although there is trend of increased pressure with BMI, we see the possibility of other risk factors such as salt intake and excess free radical as other important risk factors in younger population. This cements the need to put more efforts in prevention of hypertension in younger ages.

Nearly half of the study participants (44.4%) had abnormality in at least one parameter of lipid profile. The prevalence of dyslipidemia in this study is higher than what is known from the available data [31], dyslipidemia prevalence in young has however been up to 36% in Indian young adults [13]. This is alarming, it's known that free fat acid and adipokines can impair insulin sensitivity and bring about the cascade of insulin resistance, hyperinsulinemia and T2D. We observed strong association between dyslipidemia and BMI, and therefore weight loss can reduce dyslipidemia and the unwanted outcomes among the young adults. We also observed the trend of dyslipidemia in those who were not eating vegetables on daily basis. Proper health education and eating the correct quantity and quality of vegetables is the cheaper way to reduce dyslipidemia and its complications in young adult for healthy future generation.

We observed higher prevalence of overweight and obesity in study participants. It is alarming to have BMI of up to 48.6% in people who are less than 20 years. Although there are much higher prevalence reported globally [32] and even in Tanzania [12], it is high time to employ intervention towards the rise. It's well-known that obesity accounts for more than 80% of the pathophysiology of metabolic syndrome [15], weight loss is therefore an important step in reducing the incidence of these disorders especially in younger population.

Despite all these findings, the population in this study was more of college students, than merely community population, more studies should be done in a community to have a representative population with different exposure.

Conclusions

Conclusively, we have observed a higher magnitude of T2D, dyslipidemia, hypertension and obesity among young adults population in low-income country which is greater than the prevalence of these disorders in developed countries. Few data are available and the risk of cardiovascular diseases and metabolic syndrome in this population has shown to be high. More research is needed to explore the hidden danger in this population. Extensive preventive measures should be employed in early ages to rescue future generation from these disorders and their outcomes such as cardiovascular diseases

Abbreviations

IQR: Interquartile Range

DM: Diabetes Type 2 Mellitus

NCDs: Non-Communicable Disease

IGT: Impaired Glucose Tolerance

BMI: Body Mass Index

Declarations

Ethical Approval and Consent to Participate

Ethical clearance was sought from research and publication committee of Muhimbili University of Health and Allied Sciences (MUHAS) with a Ref No DA_287/298/01.A/. Permission to conduct this study in Mwanza city was obtained from City Director through Regional Medical Officer. A verbal and written informed consent was request from each participant signed an informed consent before participation and after explaining the purpose of the study. Laboratory results were communicated to the patients and their attending physicians for further management. Furthermore to ensure confidentiality numbers and codes were during data analysis and interpretations.

Authors' Contributions

EM participated in conception, research design, data collection, data analysis and interpretation and drafting of the manuscript. EB, MN and FM contributed in research design, data analysis and interpretation, and revising the manuscripts. All authors read and approved the final version of this manuscript.

Conflict of Interest

Authors declare that there is no competing interest

Consent to Publish

Not Applicable

Availability of data

Data generated and used in analysis are available from the corresponding author on reasonable request.

Funding

This is study was funded by Catholic university of Health and Allied Sciences- Bugando. The funder did not influence the designing, data collection and analysis.

Acknowledgements

We thank the Mwanza city management for granting permission to conduct this study. More importantly, we thank the all participants who participated in this study.

References

1. Naghavi M, Wang H, Lozano R, Davis A, Liang X, Zhou M, et al. Global, regional, and national age–sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014;385(9963):117–71.
2. World Health Organization. Global status report on noncommunicable diseases 2010. *World Heal Organ*. 2011;176.
3. Fuster V, Kelly BB, Vedanthan R. Promoting global cardiovascular health: Moving forward. *Circulation*. 2011 Apr;123(15):1671–8.
4. Mayige M, Kagaruki G, Ramaiya K, Swai A. Non communicable diseases in Tanzania : a call for urgent action. 2012;14(2):1–12.
5. Abdesslam, Boutayeb Saber B. The burden of non communicable diseases in developing countries. *Int J Equity Health*. 2005;4(2).
6. Hien HA, Tam NM, Tam V, Derese A, Devroey D. Prevalence , Awareness , Treatment , and Control of Hypertension and Its Risk Factors in (Central) Vietnam. 2018;2018.
7. Zhang Y, Moran AE. Trends in the prevalence, awareness, treatment, and control of hypertension among young adults in the United States, 1999 to 2014. *Hypertension*. 2017;70(4):736–42.
8. Investigation O. Prevalence of and Trends in Diabetes Among Adults in the United States, 1988-2012. 2015;20910(10):1021–9.
9. Lascar N, Brown J, Pattison H, Barnett AH, Bailey CJ, Bellary S. Type 2 diabetes in adolescents and young adults. *LANCET Diabetes Endocrinol* [Internet]. 2018;6(1):69–80. Available from: [http://dx.doi.org/10.1016/S2213-8587\(17\)30186-9](http://dx.doi.org/10.1016/S2213-8587(17)30186-9)
10. Chiwanga FS, Njelekela MA, Diamond MB, Bajunirwe F, Guwatudde D, Nankya-Mutyoba J, et al. Urban and rural prevalence of diabetes and pre-diabetes and risk factors associated with diabetes in Tanzania and Uganda. *Glob Health Action*. 2016;9(May):31440.
11. Commodore-Mensah Y, Selvin E, Aboagye J, Turkson-Ocran R-A, Li X, Himmelfarb CD, et al. Hypertension, overweight/obesity, and diabetes among immigrants in the United States: an analysis of the 2010-2016 National Health Interview Survey. *BMC Public Health* [Internet]. 2018;18(1):773.
12. Shayo GA, Mugusi FM. Prevalence of obesity and associated risk factors among adults in Kinondoni municipal district , Dar es Salaam Tanzania. *BMC Public Health*. 2011;11(365):1471–2458.
13. Sawant A, Shetty D, Mankeswar R, Ashavaid T. Prevalence of dyslipidemia in young adult Indian Prevalence of Dyslipidemia in Young Adult Indian Population. *Japi*. 2008;56(February):99–102.
14. Darroudi S, Saberi-Karimian M, Tayefi M, Arekhi S, Motamedzadeh Torghabeh A, Seyedzadeh Sani SMR, et al. Prevalence of combined and noncombined dyslipidemia in an Iranian population. *J Clin Lab Anal*. 2018;(March):e22579.

15. JAMESON JL, WEETMAN AP. Harrison's Principles of Internal Medicine. Harrison's Principles of Internal Medicine, 18th Edition. LONGO DL, FAUCI AS, KASPER DL et al. 2012. 645-988 p.
16. Pereira MA, Jacobs DR, Horn L Van, Slattery ML, Kartashov AI, Ludwig DS. Dairy Consumption, Obesity, and the Insulin Resistance Syndrome in Young Adults The CARDIA Study. 2002;287(16):2081-9.
17. Steyn N, Mann J, Bennett P, Temple N, Zimmet P, Tuomilehto J, et al. Diet, nutrition and the prevention of type 2 diabetes. Public Health Nutr [Internet]. 2004;7(1a):147-65.
18. Coronary T, Risk A, Adults Y. Risk Factors for the Metabolic Syndrome. 2004;27(11).
19. Dalal S, Beunza JJ, Volmink J, Adebamowo C, Bajunirwe F, Njelekela M, et al. Non-communicable diseases in sub-Saharan Africa: What we know now. Int J Epidemiol. 2011;40(4):885-901.
20. Growth TA, Study HL. Development of Fatness, Fitness, and Lifestyle From Adolescence to the Age of 36 Years. 2005;165.
21. Bergman M, Buysschaert M, Schwarz PE, Albright A, Narayan KV, Yach D. Diabetes prevention: global health policy and perspectives from the ground. Diabetes Manag [Internet]. 2012;2(4):309-21.
22. Levitt NS. Diabetes in Africa: Epidemiology, management and healthcare challenges. Heart. 2008;94(11):1376-82.
23. Ogurtsova K, da Rocha Fernandes JD, Huang Y, Linnenkamp U, Guariguata L, Cho NH, et al. IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. Diabetes Res Clin Pract [Internet]. 2017;128:40-50.
24. Body mass index table. Consultant. 2000;40(3):581.
25. Lascar N, Brown J, Pattison H, Barnett AH, Bailey CJ, Bellary S. Type 2 diabetes in adolescents and young adults. LANCET Diabetes Endocrinol. 2018;6(1):69-80.
26. Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Res Clin Pract [Internet]. 2014;103(2):137-49.
27. Franklin SS, Pio JR, Wong ND, Larson MG, Leip EP, Vasan RS, et al. Predictors of new-onset diastolic and systolic hypertension: The framingham heart study. Circulation. 2005;111(9):1121-7.
28. Kavishe B, Biraro S, Baisley K, Vanobberghen F, Kapiga S, Munderi P, et al. High prevalence of hypertension and of risk factors for non-communicable diseases (NCDs): A population based cross-sectional survey of NCDS and HIV infection in Northwestern Tanzania and Southern Uganda. BMC Med. 2015;13(1):1-21.
29. Commodore-Mensah Y, Selvin E, Aboagye J, Turkson-Ocran R-A, Li X, Himmelfarb CD, et al. Elevated blood pressure among primary school children in Dar es salaam, Tanzania: prevalence and risk factors. BMC Pediatr. 2017;18(1):54.
30. Narang R, Saxena A, Desai A, Ramakrishnan S, Thangjam RS, Kulkarni S, et al. Prevalence and determinants of hypertension in apparently healthy schoolchildren in India: A multi-center study. Eur J Prev Cardiol. 2018;2047487318790056.

31. Frontini MG, Srinivasan SR, Elkasabany A, Berenson GS. Awareness of hypertension and dyslipidemia in a semirural population of young adults: The Bogalusa Heart Study. *Prev Med (Baltim)*. 2003;36(4):398–402.
32. Commodore-Mensah Y, Selvin E, Aboagye J, Turkson-Ocran R-A, Li X, Himmelfarb CD, et al. Hypertension, overweight/obesity, and diabetes among immigrants in the United States: an analysis of the 2010-2016 National Health Interview Survey. *BMC Public Health*. 2018;18(1):773.

Tables

Table 1: Socio-demographic and clinical Characteristics of the Study Participants

Characteristics	Median(IQR) /n (%) /frequency/mean(percent/Range)/N
Age in years, Median [Interquartile range (IQR)]	21(19 -27)
Sex, n (%)	
Female	156(60.2)
Male	103(39.8)
Education level, n (%)	
None	1(0.4)
Primary	33(12.7)
Secondary	29(11.2)
College and higher	196(75.7)
BMI categories, n (%)	
Lower than 17.99kg/m	24 (9.3)
18-24.99kg/m	170 (65.6)
25-30kg/m	44 (17)
Higher than 30kg/m	21 (8.1)
Waist hip ratio, n (%)	
Normal	215 (83)
Overweight	44 (17)
Physically active? N (%)	
Yes	65 (25.1)
No	194 (74.9)
Eating vegetables daily, n (%)	
Yes	72 (27.8)
No	187 (72.2)
Personal history of hypertension, n (%)	
Yes	12 (4.6)
No	247 (95.4)
Personal history of hyperglycemia, n (%)	
Yes	10 (3.9)
No	249 (96.1)
Family history of diabetes, n (%)	
No	188 (72.5)
Yes, first degree relative	22 (8.6)
Yes, second degree relative	49 (18.9)
Systolic blood pressure, mean (range)	129.14 (97-200)
Diastolic blood pressure, mean(range)	86 (53-133)

Table 2. Association of Glycemic State by OGTT with Age, BMI, WHR, Physical Inactivity, Vegetables Consumption and Family History of Diabetes

N=249					
Parameter		Glycemic state			P-value
		Normal	IGT	T2D	
Sex	Male	71(74.0)	15(15.6)	10(10.4)	0.567
	Female	118(77.1)	25(16.3)	10(6.6)	
BMI (kg/m ²)	<17.9	17(73.9)	4(17.4)	2(8.7)	0.55
	18-24.9	126(76.8)	27(16.5)	11(6.7)	
	25-30	29(67.4)	8(18.6)	6((14.0)	
	>30	17(89.4)	1(5.3)	1(5.3)	
Waist hip ratio	Normal	160(77.7)	29(14.1)	17(8.3)	0.186
	Overweight	29(67.4)	11(25.6)	3(7.0)	
Physical inactivity	No	39(69.1)	12(20.3)	8(13.6)	0.091
	Yes	150(79.4)	28(14.3)	12(6.3)	
Eating vegetables daily	Yes	51(76.1)	14(20.9)	2(3.0)	0.106
	No	138(75.8)	26(14.2)	18(10.0)	
Hyperglycemia history	Yes	9(90.0)	1(10.0)	0(0)	1
	No	180(75.3)	39(16.3)	20(8.4)	
Family history of diabetes	No	141(78.3)	27(15.0)	12(6.7)	0.315
	Yes, Second degree relative	31(66.0)	9(19.1)	7(14.9)	
	Yes, first degree relative	17(77.3)	4(18.2)	1(4.5)	

**P Value Computed Using Pearson X², and Fisher Exact Tests*

Table 3; Association of Blood Pressure with Social Demographic and Biochemical Characteristics of the Study Participants

N=259									
Variable	N	Hypertension		Systolic hypertension		Diastolic hypertension		Elevated MAP	
		N (%)	P value	N (%)	P value	N (%)	P value	N (%)	P value
Sex									
Male	103	54(52.4)	0.002	33(32.0)	0.001	42(40.8)	0.04	19(18.5)	0.025
Female	156	51(32.7)		21(13.5)		45(28.9)		14(9)	
BMI									
<18	24	9(37.5)	0.896	3(12.5)	0.072	9(37.5)	0.667	2(8.3)	0.03
18-24.9	170	69(40.6)		35(20.6)		53(31.2)		17(10)	
25-30	44	17(38.6)		7(15.9)		16(36.4)		7(15.9)	
>30	21	10(47.6)		9(42.9)		9(42.9)		7(33.3)	
WHR									
Normal	215	86(40)	0.737	45(20.9)	1	19(43.2)	0.13	23(10.7)	0.029
Overweight	44	19(43.2)		9(20.9)		68(31.6)		10(22.7)	
Daily vegetables consumption									
Yes	72	31(43.1)	0.672	18(25)	0.31	24(33.3)	1	10(13.9)	0.7
No	187	74(39.6)		36(19.4)		63(33.7)		23(12.3)	
Physical inactivity									
Yes	65	32(49.4)	0.079	21(32.3)	0.009	27(41.6)	0.117	15(23.1)	0.004
No	194	73(37.3)		33(16.6)		60(30.6)		18(9.3)	
Hypertension history									
Yes	10	11(91.7)	<0.001	47(19.0)	0.004	10(83.3)	<0.001	7(58.3)	<0.001
No	249	94(38.0)		7(58.3)		77(31.2)		26(10.5)	
*P Value Computed using Pearson X^2, and Fisher Exact Tests									

Table 4: Association between Lipid Profile and Sex, BMI, WHR, Vegetable Consumption and Physical Inactivity.

N=250				
Parameter		DYSLIPIDEMIA		P value
		Yes	NO	
<i>Sex</i>	Male	36(36.7)	62(63.3)	0.069
	Female	74(48.7)	78(51.3)	
<i>BMI</i>	<18	11(52.4)	10(47.6)	0.018
	18-24.9	62(37.1)	105(62.9)	
	25-30	26(60.5)	17(39.5)	
	>30	11(57.9)	8(42.1)	
<i>WHR</i>	Normal	87(42.0)	120(58.0)	0.18
	Overweight	23(53.5)	20(46.5)	
<i>Physical activity</i>	Yes	26(43.3)	34(56.7)	1
	No	84(43.9)	106(56.1)	
<i>Eating vegetables daily</i>	No	36(55.6)	31(44.4)	0.064
	Yes	74(40.6)	109(59.4)	

**P Value Computed Using Pearson X^2 , and Fisher Exact Tests*

Figures

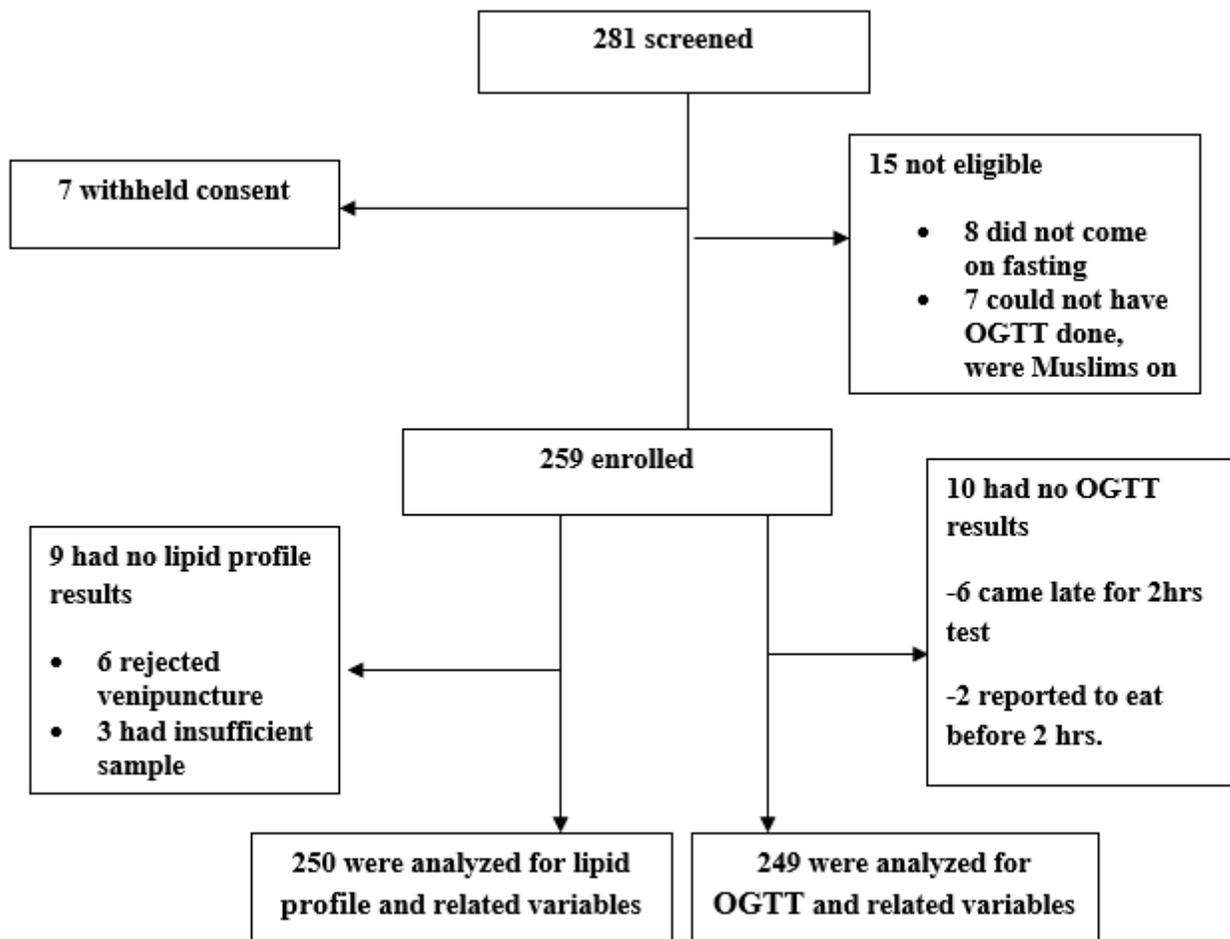


Figure 1

Schematic of Study Enrolment

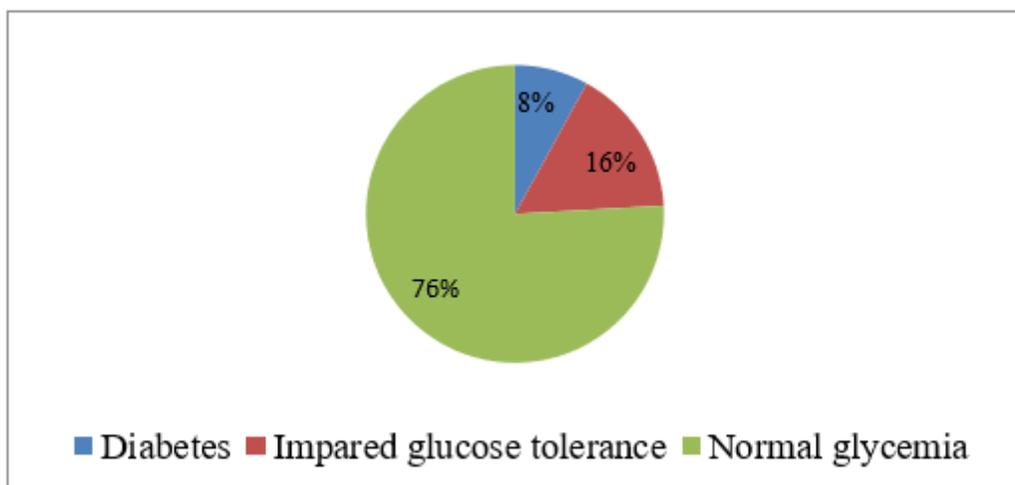


Figure 2

Percentage Distribution of OGTT Categories among study participants

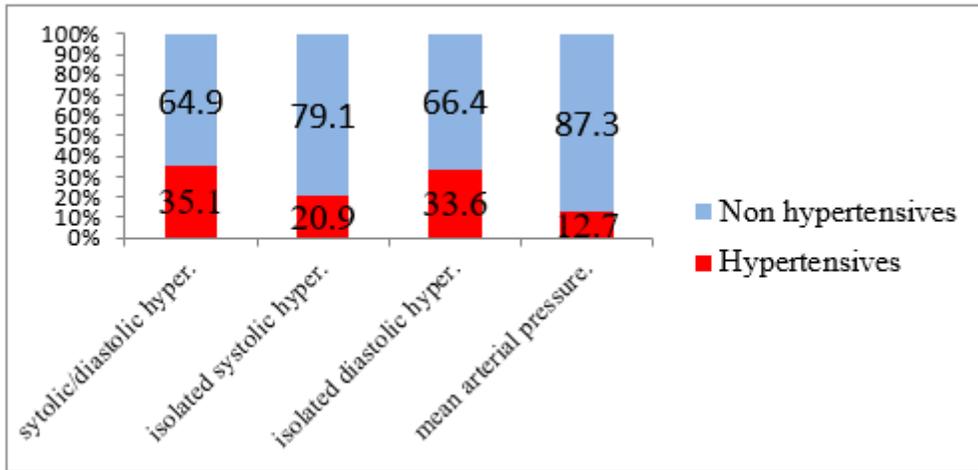


Figure 3

Proportion of hypertension among study participants

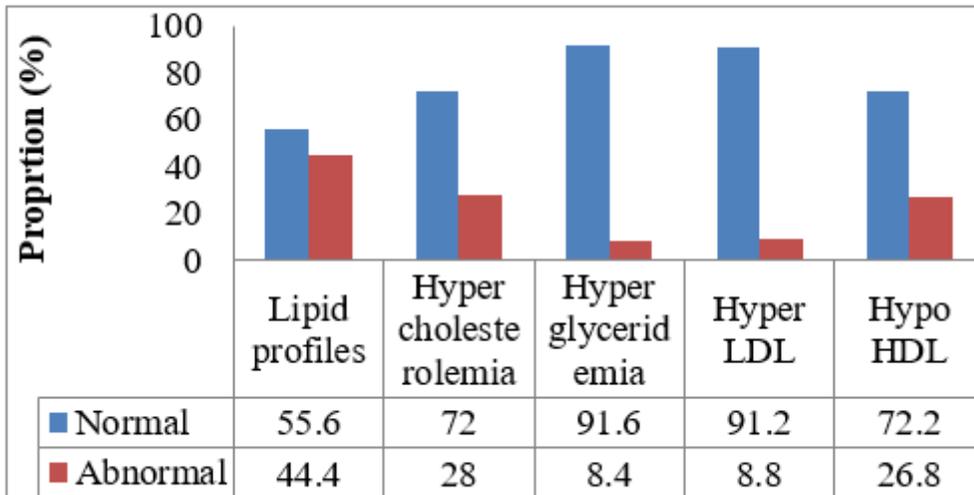


Figure 4

Proportions of Dyslipidemia among participants