TYPE 2 DIABETES MELLITUS RISK AND PREVALENCE: A DESCRIPTIVE STUDY IN COMMUNITIES OF THE ZAMBOANGA PENINSULA, PHILIPPINES

TYPE 2 DIABETES MELLITUS RISK AND PREVALENCE: A DESCRIPTIVE STUDY IN COMMUNITIES OF THE ZAMBOANGA PENINSULA, PHILIPPINES

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Maryam Shirinzadeh

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AUTHOR:

Maryam Shirinzadeh

DEGREE:

Master of science

SUPERVISOR:

Professor Dr. Gina Agarwal

THESIS COMMITTEE MEMBERS:

Professor Dr. Lisa Dolovich

Professor Dr. Lydia Kapiriri

EXTERNAL COMMITTEE MEMBER

Professor Dr. Floro Dave B. Arnuco

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Abbreviations

T2DM: Type 2 diabetes mellitus
CVD: Cardiovascular disease
ADA: American Diabetes Association
BMI: Body Mass Index
WC: Waist Circumference
FINDRISC: The Finish Diabetes Risk Score
RCT: Randomized Clinical Trial
LMICs: Low- and middle-income countries
WHO: World Health Organization
GDM: Gestational diabetes mellitus
IFG: impaired fasting glucose
IGT: impaired glucose tolerance
PSEM: Philippine Society of Endocrinology and Metabolism
FPG: Fasting Plasma Glucose
2HPG: 2-hour plasma glucose concentration
OGTT: Oral glucose tolerance test
A1c/ HbA1c: Haemoglobin A1c;
DCCT: Diabetes Control and Complications Trial
NGSP: The National Glycohemoglobin Standardization Program
CDA: Canadian Diabetes Association
IDF: International Diabetes Federation
UKPDS: UK Prospective Diabetes Study
DPP: The Diabetes Prevention Program
CANRISK: Canadian Diabetes Risk Score
IDRS: Indian Diabetes Risk Score
AUSDRISK: Australian Type 2 Diabetes Risk Assessment Tool
HICs: High-income countries
BHW: barangay health workers
CHAP-P: The Community Health Assessment Program for the Philippines
IPAQ: Physical Activity Questionnaire
EQ-5D-5 L: Descriptive system of health-related quality of life states consisting of five dimensions
SD: Standard Deviation
PH: Parkinson’s disease

Abstract

Background: Diabetes is an important cause of morbidity, mortality, and health-system costs worldwide. The growing burden of T2DM particularly in developing countries has directed more attention to primary prevention. This cross-sectional study assessed the prevalence of T2DM and its risk factors among general and diabetic populations of the Zamboanga Peninsula, Philippines.

Methods: This was a multi-center community-based cross-sectional study. 2624 individuals 40 years old or older residents (100 persons per Barangay of total 26 barangays) of the Zamboanga Peninsula province have been chosen via door-to-door systematic random sampling procedure. Personal demographic, anthropometric and lifestyle information was collected using a structured questionnaire. Weight, height, WC, BMI, and HbA1c test was were obtained through participant measurements.

Results: Valid data of 2572 (98.01%) individuals analyzed, mean ±SD of age was 57.39 ± 10.41 and 1843 (71.7%) of participants were women. Based on ADA 2018 guideline, the prevalence of T2DM and prediabetes were 18.3% and 26.7%, respectively. The frequency of having T2DM and prediabetes was higher in older people ($p< 0.05$). Urban areas had a significantly higher prevalence of diabetes, prediabetes compared with rural areas ($p< 0.01$). 54.4 % of the population had a normal body mass index while 45.6% of the population were overweight (32.1 %) or obese (13.5%), and 65% had high or elevated WC. There was a significant association between BMI /central obesity and glucose abnormalities ($P<0.01$). The prevalence of overweight, obesity and abdominal obesity was significantly higher in women and the older age groups had significantly lower BMIs/ abdominal obesity than younger age groups. 40.4% of the participants had HTN and the prevalence of HTN was significantly higher in the older age groups and female participants. The prevalence of HTN and family history of diabetes were higher in T2DM patients and individuals with prediabetes ($P<0.01$). Based on the FINDRISC score, the risk of developing diabetes was high or very high in 17.6% and moderate in 20.0% of the population.

Conclusion: The prevalence of T2DM and prediabetes was higher in this study compared to previous surveys in the country. This finding highlights the need for public health efforts to improve T2DM risk factors such as obesity and hypertension in this population.

Keywords: T2DM, Type 2 diabetes, prediabetes, IGT, community-based, survey, prevalence, risk factor, obesity, Philippines, LMICs

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1. Introduction

Diabetes is an important cause of morbidity, mortality, and health-system costs worldwide (1, 2). Diabetes prevalence continues to increase at an unprecedented rate, exceeding projected estimates, globally (3, 4). Aging, genetics, urbanization, and lifestyle change favoring the adoption of western lifestyle, decreased physical activity and obesity are major determinants of the growing prevalence of diabetes in the developing countries (5-7). Type 2 diabetes mellitus (T2DM) is a devastating disease because it increases the risk of cardiovascular diseases (CVD) such as stroke and ischaemic heart disease that can lead to microvascular complications (retinopathy, neuropathy, nephropathy, foot ulcers, and limb amputation). Individuals with diabetes have a higher mortality rate and their life-expectancy can be reduced from 5 to 15 years, with up to 75 percent dying of cardiovascular diseases (8-10).

Risk factors for T2DM, prediabetes and impaired glucose tolerance can be detected early before the clinical onset of T2DM (11). Prediabetes, i.e. impaired fasting blood glucose or impaired glucose tolerance, often occurs at least five years before the development of T2DM (12). People with prediabetes have 5% to 15% percent greater risk of the progression of T2DM (13). The slow progression from the earliest detectable glucose disorder to clinical diabetes offers the opportunity to prevent T2DM. The growing burden of T2DM particularly in developing countries has directed more attention to primary prevention. Observational studies have identified risk factors of T2DM including modifiable risk factors such as obesity and physical activity (14). Public health practitioners and decision-makers would benefit from awareness about the prevalence of T2DM, risk factors and health behaviors in each population or ethnicity in order to design and apply prevention programs and interventions aimed at modifiable risk factors in the primary and secondary health care services(7). This cross-sectional study assessed the prevalence of T2DM and its risk factors among general and diabetic populations of the Zamboanga Peninsula, Philippines.

1.1 Study objectives

1. To determine T2DM and prediabetes prevalence among the Zamboanga Peninsula, Philippines.
2. To describe T2DM modifiable risk factors among the Zamboanga Peninsula, Philippines.

1.2 Study questions

I. What is the prevalence of T2DM and prediabetes in communities of the Zamboanga Peninsula, Philippines based on the American Diabetes Association (ADA) 2018 guidelines' diagnostic criteria?

   a. What is the prevalence of T2DM and prediabetes in communities of the Zamboanga Peninsula, Philippines according to gender and age groups?

   b. What is the prevalence of T2DM and prediabetes in communities of the Zamboanga Peninsula, Philippines according to rural / urban distribution?

II. What are the modifiable risk factors and what is the risk of T2DM among communities of the Zamboanga Peninsula, Philippines?

a. What are anthropometric indices -Body Mass Index (BMI) and waist circumference (WC)- of individuals with T2DM or prediabetes according to ADA diagnostic criteria among communities of the Zamboanga Peninsula, Philippines?

b. What is the physical activity status of individuals with T2DM or prediabetes according to ADA diagnostic criteria among communities of the Zamboanga Peninsula, Philippines?

c. What are health behaviors (diet, alcohol consumption and smoking) of individuals with T2DM or prediabetes according to ADA diagnostic criteria among communities of the Zamboanga Peninsula, Philippines?

d. What is the overall risk of T2DM in the communities of the Zamboanga Peninsula, Philippines based on the Finish diabetes risk score (FINDRISC)?

1.3 The rationale of the study

Several randomized clinical trials (RCTs) in low- and middle-income countries (LMICs) such as China and India have demonstrated that T2DM is preventable in the high-risk populations by behavioral interventions or lifestyle change. These findings have revealed that lifestyle interventions are very effective to decrease T2DM incidence by up to 58% in high-risk populations

(14-19). The opportunity to prevent T2DM is based on the early detection of individuals at high risk of T2DM that should be followed by appropriate lifestyle interventions to modify lifestyle resulting in risk reduction and prevention of diabetes. A major challenge in LMICs is to identify these at-risk individuals, and to implement the knowledge translation of the evidence in primary health care. Therefore, the success of implementing diabetes prevention programs has been thwarted with these barriers (20). This evidence provides a strong rationale for assessing the risk factors and prevalence of glucose abnormalities in the population in order to identify at-risk individuals who may benefit from early primary prevention programs. Those residing in LMICs of certain ethnicities such as the Philippines population have a higher risk of developing T2DM (6) and are therefore the type of individuals who would benefit from T2DM prevention programs.

2. Literature Review

2.1 Diabetes as a disease

2.1.1 Definition and classification of diabetes, and prediabetes

Diabetes mellitus refers to a group of heterogeneous disorders whose common finding is the increase in blood glucose concentration. It is a complex of diseases of abnormal metabolism, most notable hyperglycaemia resulting from defects in insulin secretion, insulin action, or both (15). The chronic hyperglycaemia of diabetes results in disruptions of carbohydrate, protein, and fat metabolism and is associated with long-term dysfunction, damage, and failure of various organs, such as the kidneys, heart, eyes, and blood vessels (16).

The World Health Organization (WHO) has classified diabetes into four categories that are defined as type 1 diabetes, T2DM, gestational diabetes (GDM) and other forms of diabetes (17). T2DM is the most common form of diabetes affecting about 90 percent of individuals with diabetes. Clinically, T2DM is at one end of a continuous glucose spectrum with normal glucose value at one other end (18). In between, there is some type of abnormal blood glucose called prediabetes including impaired fasting glucose (IFG), or impaired glucose tolerance (IGT) or both (19). IFG and IGT represent intermediate states of abnormal glucose regulation that exist between normal glucose homeostasis and diabetes (20).

T2DM is often preceded by prediabetes, a preventable condition in which the level of blood glucose in the body is higher than the normal level, but not high enough to be considered as a complete disease (21). Prediabetes tends to remain undiagnosed for many years until it turns into a full-blown diabetes mellitus. Individuals with prediabetes are at high risk of developing the disease within 5 to 10 years unless they maintain a healthy lifestyle, including more physical activity, weight loss and healthy diet (21).

Identification and classification of abnormal glucose regulation are based on the measurement of blood glucose concentrations. Diagnostic criteria for diabetes and prediabetes have changed over time and currently vary depending on the institution. In Table 1.1 and Table 2, diagnostic criteria for T2DM and prediabetes in the American Diabetes Association (ADA) (15), the Canadian Diabetes Association (CDA) (22) and, the Philippine Society of Endocrinology and Metabolism (PSEM) (23) has been shown. For the stage of prediabetes; IFG is defined by an elevated fasting plasma glucose (FPG) level (≥100 and <126 mg/dl) (24). IGT is defined by an elevated 2-hour plasma glucose concentration (2HPG) (≥140 and <200 mg/dl) after a 75-g glucose drink on the oral glucose tolerance test (OGTT) in the presence of an FPG concentration <126 mg/dl (24, 25).

Table 1-1: Criteria for the diagnosis of diabetes, based on ADA 2018, CDA 2018 and PSEM 2014

FPG ≥126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 h up to a maximum of 14 hours. *
OR
2HPG ≥200 mg/dL (11.1 mmol/L) during OGTT. The test should be performed as described by the WHO, using a glucose load containing the equivalent of 75-g anhydrous glucose dissolved in water. *
OR
In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥200 mg/dL (11.1 mmol/L).
OR
ADA 2018 and CDA 2018: glycated hemoglobin (HbA1c) ≥6.5% (48 mmol/mol). The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay. * PSEM 2014: Philippine Society of Endocrinology and Metabolism cannot recommend the routine use of HbA1c test for the diagnosis of diabetes

* In the absence of unequivocal hyperglycemia, results should be confirmed by repeat testing. Diabetes Control and Complications Trial (DCCT). The National Glycohemoglobin Standardization Program (NGSP).

Table 1-2: Diagnostic criteria for prediabetes (21)

Authority, year	**Venous plasma**
WHO 1999 & 2006 (most recent)	IGT Fasting: <7.0mmol/L and 2HPG: ≥7.8mmol/L and <11.1mmol/L IFG Fasting: ≥6.1 and <7.0mmol/L and 2HPG: <7.8mmol/L (if measured) (2HPG measurement recommended to exclude diabetes or IGT)
ADA 2003	IGT FPG of <7.0mmol/L and 2HPG: 7.8 – 11.0mmol/L (if measured) IFG FPG of 5.6 – 6.9mmol/L (measurement of 2HPG not recommended)
ADA 2018 (15)	IFG FPG of 100 mg/dL (5.6 mmol/L) to 125 mg/dL (6.9 mmol/L) IGT 2HPG in in the 75-g OGTT 140 mg/dL (7.8 mmol/L) to 199 mg/dL (11.0 mmol/L) Prediabetes HbA1c 5.7% – 6.4% (39−47 mmol/mol)
PSEM 2014 (23)	IFG FPG of 5.6 mmol/L (100 mg/dL) up to 125 mg/dL or 6.9 mmol/L IGT Random/casual blood glucose of 7.7 up to 11.0 mmol/L (140-199 mg/dL) OR 2HPG in the 75-gm OGTT equal to 7.7 (140 mg/dL) up to 11.0 mmol/L (199 mg/dL)
CDA 2018 (22)	IFG FPG 6.1–6.9(mmol/L) IGT 2HPG in the 75g OGTT 7.8–11.0(mmol/L) Prediabetes HbA1c 6.0–6.4 (%)

Type 1 diabetes mainly occurs in young non-obese individuals (childhood or adolescence age). It is associated with complete depletion of insulin secretion due to autoimmune destruction of pancreatic beta cells. However, autoimmunity is a mechanism for the appearance of T1DM but may not be its primary cause. The disease presents in genetically susceptible individuals, likely as a result of an environmental trigger. The immune system attacks the β-cells of the pancreas, destroying or damaging them sufficiently to reduce and eventually eliminate insulin production (15). This type of diabetes essentially is managed by insulin injection to patients.

Gestational diabetes is the most common medical complication of pregnancy and affects up to 10 percent of all pregnant women and accounts for 90 percent of all cases of diabetes diagnosed during pregnancy (26-28) Incidence rates of gestational diabetes are increasing, possibly as a consequence of lifestyle factors (27).

The other types of diabetes include neonatal diabetes; Leprechaunism and Rabson-Mendenhall pediatric syndromes, maturity-onset diabetes of the young; Wolfram syndrome and less commonly the stiff-man syndrome (29). There are a few known aetiologies that may cause other forms of diabetes such as genetic defects of the beta cells, chromosomes or insulin action; pancreatic disease; endocrinopathies, such as Cushing's syndrome.

2.1.2 Complications of diabetes

The late complications of diabetes are of increasing concern in health care as they affect patients' quality of life and may result in considerably reduced life expectancy. In a joint report of the International Diabetes Federation (IDF) and WHO, diabetes was described as "a condition primarily defined by the level of hyperglycemia giving rise to the risk of microvascular damage (retinopathy, nephropathy, and neuropathy). It is associated with reduced life expectancy, significant morbidity due to specific diabetes related microvascular complications, increased risk of macrovascular complications (ischaemic heart disease, stroke and peripheral vascular disease), and diminished quality of life'' (30). Effective management of chronic hyperglycemia is associated with a risk reduction of diabetes complications. The UK Prospective Diabetes Study (UKPDS), reported that glycaemic control was associated with reductions of both microvascular and macrovascular outcomes in individuals newly diagnosed with T2DM (31). The study reported that a 1% reduction in mean HbA1c led to considerable risk reduction of microvascular, myocardial infarction, heart failure, peripheral vascular disease, stroke, and death (31).

China Da Qing Diabetes Prevention Study has shown that lifestyle intervention in people with IGT delayed the onset of T2DM and diminished the incidence of microvascular complications, cardiovascular events, all-cause and cardiovascular mortality rate, and boosted life expectancy. These findings proved the importance of diabetes prevention programs to curb T2DM prevalence and its consequences(32). The Diabetes Prevention Program (DPP; 1996-2001) is a landslide randomised trial that demonstrated prevention programs significantly decrease diabetes development over 15 years, and also the prevalence of microvascular complications in those who did not develop diabetes is significantly lower than diabetic patients (33).

2.2 Risk factors for T2DM

Risk factors for T2DM are common in all populations. The best- known non-modifiable risk factors are age, gender, ethnicity, and genetics. The most important modifiable risk factors are obesity/overweight, unhealthy dietary habits including low fiber diet (less consumption of fruit and vegetable), high glycemic load diet (high consumption of sugar), high intake of fat, sedentary lifestyle, smoking, metabolic syndrome, stress and depression (34-36). In T2DM management or prevention programs, clinicians and policymakers mostly focus on some modifiable risk factors that are clarified further below. The focus of this study was on the identification of modifiable risk factors of T2DM in the Zamboanga Peninsula, Philippines.

2.2.1 Modifiable risk factors for T2DM

Obesity and overweight: The most important predictor for type 2 diabetes is considered to be the elevated body-mass index (35). An observational study showed that increases in BMI over time and higher HbA1c even within the normal range were associated with the incidence of T2DM (37). Obesity and central (abdominal) obesity ,in particular, are indicated as the main reasons for insulin resistance (38) and have been associated with T2DM development in high-risk individuals (39, 40). Waist circumference has been reported to be an important predictor of T2DM in systematic reviews (41, 42). In the Philippines, obesity or overweight (BMI >25 kg/m2) prevalence rates were 35% to 49%; and 32% to 58% of the population had elevated WC in 2015 (43). Metabolic syndrome is the combination of medical abnormalities that occur in the same individual, making them at risk for CVD. The common feature of the syndrome is insulin resistance, and all other changes are likely to be secondary to this basic abnormality (44, 45). Only 20% of women in the Philippines were free of the metabolic syndrome criteria and the percentage of individuals with at least one component of metabolic syndrome is reported to be relatively high (43). The highest prevalence of high FPG was found among those with three risk factors - high BMI, high waist-to-hip ratio and high WC in the population (44).

Dietary pattern: Diet is an important environmental factor in the development of obesity and weight related non-communicable diseases such as T2DM (35). Previous studies have found that a reduced risk of type 2 diabetes is associated with a higher intake of fiber (46, 47) and that an increased risk is associated with a higher intake of fat (48) and a higher glycemic load which reflects the effect of diet on the blood glucose level (46, 47). The result of a systematic review and meta-analysis showed a non-linear relationship between fruits, vegetables, processed meat, whole grains, sugar-sweetened beverages, and T2DM risk. The study finding suggested that optimal intake of risk-decreasing foods was associated with a 42% reduction, and consumption of risk-increasing foods can result in up to three times increase in T2DM risk (49).

Physical activity: obesity and being overweight are also strongly associated with sedentary lifestyle and lack of physical activity (50). The lack of physical activity is reported to be associated with the increased risk of developing glucose intolerance and T2DM (50, 51). The evidence demonstrated a strong association between improved physical activity and enhanced insulin sensitivity and glucose tolerance (52, 53). Despite the recognized benefits of physical activity in diabetes prevention and management, many patients and high-risk individuals experience barriers like lack of self-control to adhere to exercise and diet guidelines (52, 54). Regular exercise has a beneficial effect on diabetes management; it considerably helps to lower high FPG and HA1C without additional insulin, as well as improving cardiovascular risk, and quality of life. Lower risk of non-communicable disease was reported with an average of at least one half-hour per day of vigorous or moderate activity, including brisk walking, according to the published guidelines and previous studies (35, 55, 56).

Health behaviors (smoking): A variety of epidemiological studies have revealed associations between cigarette smoking and the increased risk of developing T2DM (57-59). Several population-based studies indicated the association between cigarette smoking and an increased risk of T2DM and, clinical trials provided an insight into mechanisms through that smoking and nicotine exposure affect body composition, and insulin sensitivity (60). In the Philippines, smoking is highly prevalent. By the latest estimates, 48% of men and 9% of women in the adult population smoke, which translates to approximately 17 million adult Filipino smokers. Furthermore, 23% of young people (aged 13–15 years) smoke (61).

Health behaviors (alcohol consumption): Various studies linked heavy to moderate consumption of alcoholic beverages to the elevated risk of T2DM. Two observational studies indicated that T2DM risk increased near 2-fold for the consumption of more than 12 drinks weekly (62, 63). It has been reported that frequent alcohol consumption (≥ 5 drinks, ≥ 3 days/ week) substantially increased T2DM risk in young adulthood (64) and heavy drinkers (> 15 drinks/week) had an earlier onset of diabetes by about 5 years (65) A positive association between moderate alcohol consumption and glucose intolerance or elevated risk of T2DM incident is reported in different Asian populations (66, 67). Recent findings suggest that Light to moderate alcohol consumption might not increase the incidence of T2DM significantly, whereas heavy drinkers and binge drinkers were at increased risk for diabetes in the majority of the studies (68).

Overall, there is a long association between weight, physical activity, diet and health behaviors and the pathogenesis of T2DM. They are intricately linked to T2DM and has become increasingly important to identify and improve diabetes management and prevention programs. A recent study suggested that reduced risk of T2DM was strongly associated with healthy habits such as greater intake of fruit and vegetables, a lower intake of sugar-sweetened beverages and higher physical activity (69, 70). Recent systematic review and meta-analysis revealed that diet alone or physical activity alone compared to standard treatment had less or no influence on the risk of T2DM in people at high-risk of developing T2DM. However, diet plus physical activity decreases or delays the incidence of T2DM in high risk people or individuals with IGT (71).

2.3 The use of diabetes risk assessment tools to identify T2DM risk factors

The aim of developing diabetes risk scores was to have a practical, simple, and informative scoring method to characterize people according to their risk for developing T2DM. In the large population, these tools became popular to use for initial screening to identify at-risk subpopulations on which the blood glucose screening methods could be carried out more effectively (72). These scoring systems evaluate the risk of T2DM in individuals using predictors including anthropometric indices, dietary habits, and physical activity to predict the risk of developing T2DM (56). In other words, the presence of these risk factors predicts the future development of T2DM.

2.3.1 Development of diabetes risk scores

Risk assessment tools and scores first developed for cardiovascular disease risk assessment and they are frequently used in public and clinical health practice in recent years (73, 74). The idea of the development of a risk scoring system to identify individuals at high risk for T2DM originated in the 1990s (75). Many risk scores or models to predict and help to prevent T2DM have been already developed (76), such as the Canadian Diabetes Risk Score (CANRISK)(77), the Finnish Diabetes Risk Score (FINDRISC)(56), the Indian Diabetes Risk Score (IDRS), and the Australian Type 2 Diabetes Risk Assessment Tool (AUSDRISK) (22, 78). Although they are implemented in prevention programs in some Western countries (72), the use of these as part of formal health policy or guideline for practitioners is limited in many countries ,in particular, in LMICs(79).

These models vary in many ways, such as the time scope for prediction and nature and number of predictors. Some models are based on non-invasive risk scores (non-laboratory clinical variables); and some others have also incorporated biological invasive risk scores, although invasive risk scores are more successful (80). Thus, non-invasive risk scores are more likely to be used for large-scale screening invasive risk scores due to cost-effectiveness and feasibility. However, risk scores are not generalizable from one population to another, and the validity of each diabetes risk score should be confirmed in different settings and populations (81). It is very important to choose a proper assessment tool in a population since not every tool is appropriate for every setting. The sensitivity, specificity and potential screening efficacy of risk assessment tools can be increased through adaptation and validation in each population (82). The performance of FINDRISC (56) has been evaluated in community screening for undiagnosed T2DM in the Philippines (83, 84). This risk score calculator had its best performance in the cut-off point of ≥7 (diagnostic accuracy ~ 0.7) (83) and accepted to be the most reliable diabetes risk assessment tool among local residents in the Philippines compared to other tools (83, 84). The Finnish Diabetes Risk Score is currently the most widely used to predict the risk of T2DM in the populations. It is an excellent tool to be used in primary diabetes screening and prevention programs, it is simple to understand, does not require any laboratory or nutrient intake data, and can be applied on a population level.

2.3.2 Clinical use of diabetes risk scores in screening for the risk factors of T2DM

Diabetes prevention interventions addressing diet, physical activity, and health behaviors in high-risk individuals have shown some positive effects on the prevention or risk reduction of T2DM in LMICs (85) however, identifying the population at risk of T2DM has been always a key barrier for implementing diabetes prevention programs in these countries (86). People are mostly unaware of their risk of prediabetes or diabetes and barely undergo T2DM screening tests. Therefore, assessing the risk of diabetes among any population using non-invasive, sensitive, specific and low-cost tools is vital in order to detect the high-risk individuals (76, 87).

A diabetes risk assessment tool is an example of a prognostic model (88). These models should ideally be developed by executing a large and age defined cohort of a population without diabetes, measuring baseline risk factors, and following the cohort for an adequately long time to see who develops T2DM (79, 89). Since prospective longitudinal cohorts are expensive and time-consuming to implement, cross-sectional designs in which risk factors are measured in a population including people both with and without diabetes are more suitable for these research studies (79).

Overall, a diabetes risk score can be used as an initial screening step followed by a diagnostic test including an OGTT or HbA1c test (90, 91). Using a risk score with adequate sensitivity and specificity can considerably reduce the number of individuals who would otherwise need to undergo an OGTT or HbA1c test (92).

2.4 Epidemiology of T2D

2.4.1 Global prevalence of T2DM, prediabetes and undiagnosed diabetes

Diabetes prevalence, deaths related to diabetes, and health expenditure related to diabetes continue to increase across the globe with significant financial, social and health system implications (93). The existing evidence has shown that the prevalence of diabetes is increasing considerably and has become a major public health challenge in many countries. Worldwide, approximately 108 million people had diabetes in 1980, and this number increased fourfold in 2014 estimates (2), and IDF estimated the global prevalence to be 415 million in 2015 (94). In 2017, IDF last publication result indicated that the prevalence of diabetes in adults (aged 18–99 years) is estimated to be 8.4% and predicted to rise to 9.9% in 2045. The global prevalence of IGT was estimated to be 6.7% (4.5–12.1%) in 2015 and 7.8% (5.2–13.9%) in 2040 (93). Almost half of all people (49.7%) -over 224 million adults (18–99 years) were living with undiagnosed diabetes in 2017(95).

2.4.2 Prevalence of T2DM, prediabetes and undiagnosed diabetes in LMICs

The high prevalence of diabetes in LMICs has important financial, social and development implications especially due to shortage of resources and limitations of their health system (95). Globally, about 79% of people living with diabetes live in low- and middle-income countries (95). The prevalence of diabetes was estimated 20.5% (95% CI: 20.0-21.0%) in the large cohort study of 26,680 participants from LMICs, whereas the prevalence of pre-diabetes was 16.0% (95% CI: 15.5-16.5%) and the prevalence of dysglycemia was 36.5% (95% CI: 35.8-37.1%) in this region(96). The highest percentage of undiagnosed diabetes was found in LMICs. In the Africa region, 69.2% of all cases were estimated to be undiagnosed. South-East Asia was estimated to have more than 50% of undiagnosed cases (South-East Asia 57.5%, Western Pacific region 54%) (95). Diabetes prevalence has increased in all rural and urban areas globally but relative growth is faster in LMICs than high-income countries (HICs) (1). There is an increasingly urgent need for these countries' governments to implement policies to decrease the risk factors for T2DM, and ensure proper access to treatment for all T2DM patients (93).

2.4.3 T2DM and, prediabetes prevalence in the Philippines

The Philippines is located in Southeast Asia- in the western Pacific Ocean, and consists of about 7,641 islands, and considered the fifth longest shoreline in the world. There are about 14 regions, 73 provinces, and 60 cities across the archipelago (97). Therefore, individuals from smaller cities have to travel by land and sea to receive special medical care in hospitals located in major cities. The current population of the Philippines is 107,950,000 in 2019, based on the latest United Nations estimates (98), and considered by the World Bank as a lower middle income country and by the United Nations as a developing country (99).

The public healthcare system in the Philippines was devolved in 1992, is delivered through public health and primary healthcare centers linked to local town health centers. Therefore, the responsibility of providing basic healthcare services for the people was handed down to local municipalities and cities. A decade before this healthcare devolution, the country implemented a primary healthcare policy that created a large cadre of community-based health workers locally called “barangay health workers” (BHW). The barangay (village) is the smallest unit of government, a city or a municipality would be composed of a number of barangays (100).

Six of the ten countries projected to have the highest numbers of diabetic patients by 2030 are in Asia and the Philippines is one of them (6). Diabetes in the Philippines is ranked 6^{th} of the top 10 causes of mortality and consequently has been considered an important public health concern(101). A cohort study in 2009, derived from a larger population-based investigation in 1998 was assessed and demonstrated that a 9-year incidence rate of T2DM in the Philippines is about 16.3% (102). The result revealed that the 2007 prevalence rates of all types of blood glucose regulation abnormalities (IGF, IGT and T2DM) was 28 % (102). In 2013, the 8^{th} Philippines national health survey performed by the Food and Nutrition Research Institute of the Philippines showed the prevalence of abnormal glucose regulation in people older than 20 years old was 5.4%, (103). The International Diabetes Federation has estimated that there were 3.72 million diagnosed cases of T2DM in the Philippines with a 6.2% prevalence rate in adults in 2017 (104) and also it is reported that around 1.76 million (2%) people with T2DM remain undiagnosed in 2014 (105).

3. Methods

3.1 Study design

This was a multi-center community-based cross-sectional study aimed at determining T2DM prevalence, and its risk factors in the communities of the Zamboanga Peninsula, Philippines. Personal demographic, anthropometric and lifestyle information was collected using a structured questionnaire. Weight, height, WC and HbA1c test was were obtained through participant measurements.

3.2 Study setting

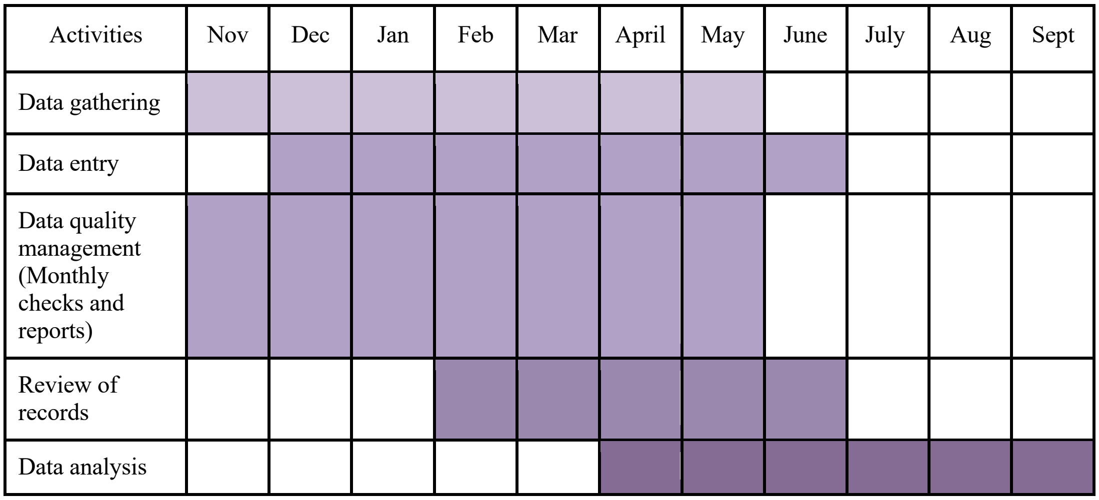
The setting of the study was the Zamboanga Peninsula. It is an administrative region of the Philippines on the island of Mindanao in the southern Philippines consisting of three provinces (Zamboanga del Norte, Zamboanga del Sur, and Zamboanga Sibugay) and two independent cities (Isabela and Zamboanga City) shown in Figure 3-1 (106). Three provinces and two cities are broken down into municipalities, and the municipalities are divided into small villages known as "barangay", the smallest geographic unit in the Philippines (pop. 1-5,000 in rural areas). Each barangay has elected leaders serving under the municipal mayor. The region consists of 67 municipalities and 1,094 barangays with total population of 3,629,783 in 2015 (106). In 2012, this region has the fourth highest poverty incidence of the 17 regions of the Philippines (33.7%) (107, 108).

Figure 3-1: Political map of the Zamboanga Peninsula, Philippines, displaying Zamboanga del Norte, Zamboanga del Sur, Zamboanga Sibugay, Isabela City, and Zamboanga City (106).

Since the Zamboanga Peninsula mirrors poor communities from LMICs with isolated regions, poor infrastructure, and inadequate health resources, it has been selected as a good location for conducting a study. Communities are separated by sea and mountains and connected by inconsistent transportation and communication systems (108).

This study was conducted in 26 communities (barangays). Criteria for community selection included: security, connection with a local champion, feasibility for travel, and facility with refrigerated space for the HbA1c kits (108). The mobile HbA1c test kit only lasts for approximately five minutes in the heat and humidity of the Philippines, so access to refrigerated space in the setting became an inclusion criterion for communities. Data collection, measurements, data entry and review of the records was carried out during an eight-month period from November 2018 to June 2019. The timeline of the study has been illustrated in Table 3-1.

Table 3-1: The CHAP-P survey timeline



3.3 Study participants

All participants were individuals ≥ 40 years old, residents of the Zamboanga Peninsula. The research staff team asked individuals who selected to participate in the study to provide consent, and the survey has been conducted with consenting individuals.

3.4 Sample size

The Community Health Assessment Program for the Philippines (CHAP-P) is a community-wide survey and community sizes vary from 3000 to 20,000 residents (108). The sample size for the survey is n=100 per Barangay of total 26 barangays (2600 participants needed to recruit). Since one of the main study outcomes is HbA1c, this study should be able to detect a difference of 0.5% (SD=1.2%) with an alpha of 0.05 and power of 0.80. One hundred (100) participants have been randomly selected and recruited from each of the 26 barangays involved in the study for this cross-sectional descriptive survey.

3.5 Sample selection

Households have been chosen via door-to-door systematic random sampling conducted by the research team. Within selected households, 40-year age or older individuals were eligible to participate in the survey (108). If there was more than one eligible and willing individual within a household, the last-birthday selection method (109) used to choose a single individual to participate. If there are no eligible or willing participants within a household, the team moved on to the next household based on the systematic random sampling procedure. Participants have been asked to go to a community location for the HbA1c test and provided a small token of appreciation (108).

3.6 The CHAP-P survey tools and measurements

Participants were interviewed by members of the trained research team in their homes. Questionnaires (See Appendix 1) were completed on paper and later entered in the REDCap database (110) by the research team. The survey questionnaire, adapted from a previous study (111) includes questions on demographics; knowledge about diabetes and cardiovascular health; risk factors and behaviors, including the FINDRISC calculator (56); quality of life using the EQ-5D-5 L instrument (112); physical activity using the International Physical Activity Questionnaire (IPAQ)(113); and measurement of weight, height and waist circumference. Then, the participants were invited to the CHAP-P community location to test their HbA1c, after completing the community survey in their homes. HbA1c was tested by the A1CNow + point-of-care device, which was certified by the National Glycohemoglobin Standardization Program (108, 114).

Regarding this study specific objectives, questions on medical history, health behaviors, lifestyle and clinical examination, which included the HbA1c test and anthropometric measurements (height, weight, WC) were analyzed. Measurements performed for weight (in light indoor clothes, to the nearest 100 g using a digital weighing scale, height (without shoes, to the nearest 1 mm using a tape measure, and WC (at a level midway between the lowest rib and the iliac crest, to the nearest 5 mm using a tape measure). Body mass index was then calculated and categorized into three groups (normal, <25; overweight, 25-30; obese, ≥30) based on WHO recommendations (115). BMI was calculated dividing the weight (kg) by the height squared (m2). Health behaviors were assessed including participants' smoking status (never smoked, former smoker who quit, occasional smoker, daily smoker), alcohol consumption assessed by using questions on the number of alcoholic drinks consumed in the previous week, then converted to number of alcohol units consumed per week and categorized as “non-drinker/rarely drink/have stopped drinking” (0 units/week), “light to moderate drinker” (1-5/6-10/11-15 units/week), or “heavy drinker” (≥15 units/week). Overall dietary habits were assessed by multiple choices questions on frequency of vegetables and fruit intake, consumption of fatty foods/fried food/ savoury snacks, and consumption of food/drink with high sugar -with 5 answers including “never”, “2-3 times a month”, “1-2 times a week”, “3-4 times a week” and, “every day”. Physical activity was assessed by questions on the frequency and duration of participation in moderate or vigorous physical activity and categorized in two groups (less than 30 minutes a day or more than 30 minutes a day). Fruits/vegetables intake categorized in two groups (everyday intake or not every day intake), and the answers for other dietary habits questions categorized in two groups including never/rarely intake or weekly/daily intake.

In terms of risk assessment, in order to address all important modifiable risk factors of T2DM in the Philippines, we assessed the risk of T2DM using predictors of a diabetes risk assessment tool that was the most compatible with this population -FINDRISC score (56). This study assessed all predictors used in this scoring system to identify T2DM risk and also health behaviors that are not used in this risk score including alcohol consumption, smoking, high fat / high sugar food intake, etc. Low risk for BMI was defined as being in normal range < 25 kg/m2, according to WHO recommendation and FINDRISC classification, and risk assessment for waist circumference was based on FINDRISC classification (Low risk: men=less than 94 cm, women= less than 80 cm; Elevated risk: men 94–102 cm, women 80–88 cm; High risk: men more than 102 cm , women more than 88 cm). Low risk in the dietary pattern was defined as intake of vegetables and fruits "every day", intake of fatty foods/ fried food/ savoury snacks and food/drink with high sugar "never/rarely" based on published recommendations (35) and FINDRISC classification (56). low risk in physical activity was defined as an average of at least one half-hour per day of vigorous or moderate activity, including brisk walking, in keeping with published guidelines (55) and FINDRISC classification (56). In terms of cigarette smoking, low risk was defined as no current smoking. Concerning alcohol use, low risk was defined as being in the group of "non-drinker/rarely/have stopped drinking".

FINDRISC Categories; The FINDRISC risk assessment model recommended that the risk of developing T2DM within 10 years was "Low" when the total risk score was lower than 7. It is estimated that 1 in 100 will develop the disease within 10 years. When the risk score was between 7–11, the risk is "Slightly elevated" and it is estimated that 1 in 25 will develop the disease. Score 12–14 was "Moderate" risk and 1 of 6 in this group will develop the disease. High risk was defined as a risk score of 15–20 that is estimated 1 in 3 will develop the disease within 10 years. The last category is "Very high" risk with score more than 20 which is estimated 50% of this group (1 in 2) will develop T2DM during the next 10 years (See Appendix 2).

Diagnosis criteria for T2DM and prediabetes prevalence: To diagnose T2DM and prediabetes in the participants, the Philippine Society of Endocrinology and Metabolism (PSEM) could not provide locally acceptable A1c test thresholds (23). The Philippines UNITE for Diabetes Clinical Practice Guidelines for the Diagnosis and Management of Diabetes stated that the HbA1c is currently not yet recommended as a diagnostic test for diabetes mellitus in the Philippines due to unavailability in many areas of the country and the lack of standardization of the test in their setting (116). Since the most popular practice guideline to diagnose T2DM in the Philippines is ADA practice guidelines and many physicians in this country are using this guideline, we used the ADA 2018 practice guidelines(15) to interpret the HbA1c test results. It is noteworthy to mention that ADA 2018 practice guideline and 2018 Canadian guideline – CDA 2018 practice guideline to diagnose type 2 diabetes and prediabetes (22)– is equivalent to ADA 2018 guideline in terms of T2DM diagnosis. However, they are provided different cut-off points to diagnose prediabetes (See Table 1-2).

T2DM related risk factors are prevalent among both rural and urban diabetes settlers, however, it is indicated that urban settlers were significantly more likely to have metabolic risk factors and they were at a higher risk of developing T2DM (35). Therefore, we compared the risk factors among rural and urban areas of the study to understand similarities and differences in the distribution of these risk factors among communities in the Zamboanga Peninsula, Philippines population.

3.7 Data management

Paper data was stored in a locked cabinet in a locked institutional office. Electronic data was stored in an encrypted program (REDCap) or in password-protected files on a secure institutional network. The Study data was anonymized. For the community survey and CHAP-P session data, after the full data set was collected (including the HbA1c test results), data was anonymized (108).

3.8 Ethics

The study received ethics approval from Independent Review Boards in Canada and the Philippines prior to the implementation of the research. The study site started recruiting after receiving ethics approval. All participants were fully informed about the purpose of the study, the benefits obtained from the information gathered, their rights to participate or refuse to answer questions or withdraw from the study (anytime during the data collection or after they leave), and the privacy of information. They were informed about the purpose of the study, risks involved, and their rights to refuse to participate. They also have been given contact information to withdraw their data from the study if they decide to withdraw later. Eligible participants were asked to sign the consent forms if they agree to participate in the study.

Healthcare management for participants with health risks: Participants found to have health risks (high blood pressure or high HbA1c or any other serious health issues) during the study period referred to the nearest healthcare facility to receive immediate service and proper treatment.

Confidentiality and privacy of information: The confidentiality of the participants, their identity, the contact information was secured. We secured all data with participant information. Data collected and entered into an electronic database that is password protected and encrypted and only aggregated data was published and presented.

3.9 Statistical methods and data analysis

All statistical analyses were conducted using SPSS 24.0 software. Statistical significance was set at $p < 0.05$ for the two-sided test. Descriptive statistics were calculated for demographic, anthropometric, and dietary intake and lifestyle variables of the baseline data. Means and standard deviations (SD) were calculated for continuous variables and frequencies and percentages were calculated for the demographic characteristics and categorical variables. The results were summarized in tables and graphs. To compare the outcomes between different genders, age groups and communities, non-parametric (chi-squared) or parametric tests (T-test, ANOVA) were used where appropriate.

4. Results

4.1 General characteristics of the participants

According to the sociodemographic data of 2624 participants interviewed, 2572 cases (98.01%) had valid values; 71.7% were women, 58% aged over 55 years, 67% had some high school or less education, 77% were married, 20% had zero income and 46% of the population had between 1000 Philippine Peso (PHP) to 5000 PHP in income per month. The mean age was 57.4 years, mean weight was 59 kg, mean height was 153.67 cm and the mean BMI was a little more than 25 kg/m2 in the population. Table 4-1 provides more information about the characteristics of the participants.

Table 4-1: Characteristics of the participants (n=2572)

Variable	Mean	SD
Age	57.39	10.41
Weight (Kg)	59.07	12.01
Height (CM)	153.67	8.82
WC (CM)	88.37	11.20
BMI (kg/m2)	25.03	4.75
HbA1c	5.92	1.61
Variable	**Frequency**	**Percent**
Age		
Under 45 years	322	12.5
45–54 years	761	29.6
55–64 years	790	30.7
Over 64 years	699	27.2
Gender		
Male	729	28.3
Female	1843	71.7

Education level		
Completed University or college degree	252	9.8
Some college or university	229	8.9
Completed high school	379	14.7
Some high school or less	1712	66.6
Marital status		
Live-in with partner	99	3.8
Married	1976	76.8
never married	73	2.8
Separated	48	1.9
Widowed	374	14.5
Divorced	2	0.1
Income		
Zero income	526	20.5
1 to 1000	268	10.4
1000-5000	1186	46.1
More than 5000	592	23.0

4.2 The prevalence of T2DM, prediabetes in the participants

Table 4-2 provides information on the distribution of T2DM, prediabetes in the study participants according to ADA 2018 practice guidelines (15).

Table 4-2: The HbA1c level in the participants characterized ADA 2018 guidelines (n=2572)

Variable	Frequency	Percent
HbA1c groups (based on ADA 2018)		
Normal (less than 5.7)	1413	54.9
Prediabetes (5.7 to 6.4)	688	26.7
Diabetes (more than 6.5)	471	18.3

4.2.1 The prevalence of T2DM

Prevalence -sometimes referred to as prevalence rate- is the proportion of individuals in a population who have a specific disease at a specified point in time (point prevalence) or over a specified period of time (period prevalence). Period prevalence is similar to point prevalence, except that the "point in time" is broader (117). In this study, the prevalence is calculated by measuring the presence of T2DM in a randomly selected sample of the population, then dividing it by the total number of people in the sample that it was measured. The presence of T2DM is assessed using HbA1c test results based on ADA 2018 guideline (15) on T2DM and prediabetes diagnosis.

Prevalence = [Persons having a particular disease during a given time period / Population during the same time period] × 10 n (The value of 10 n is usually 1 or 100).

T2DM prevalence = [471/2572] × 100 = 18.3 %; 18 persons out of 100 individuals of the population during 7 months from November to May 2018.

4.2.2 The prevalence of prediabetes

Prevalence = [Persons having prediabetes during a given time period / Population during the same time period] × 100

Prediabetes prevalence based on ADA 2018 = [688/2572] × 100 = 26.7 % (based on ADA 2018 criteria); 27 persons out of 100 of the population during 7 months from November to May 2018.

4.2.3 The prevalence of T2DM and prediabetes in different genders and age groups

Table 4-3 to 4-6 and Figure 4-1, Figure 4-2 shows the distribution of prediabetes and diabetes in different age groups and different genders.

Table 4-3: The prevalence of T2DM and prediabetes in different age groups; n=2572

		Age groups N (%)				
		< 45 years	45–54 years	55–64 years	> 64 years	Total
HbA1c Classification (ADA2018)	Normal	206 (64.0)	422 (55.5)	396 (50.1)	389 (55.7)	1413 (54.9)
	Prediabetes	82 (25.5)	192 (25.2)	217 (27.5)	197 (28.2)	688 (26.7)
	T2DM	34 (10.6)	147 (19.3)	177 (22.4)	113 (16.2)	471 (18.3)
	Total	322 (100.0)	761 (100.0)	790 (100.0)	699 (100.0)	2572 (100.0)

The frequency of abnormal glucose regulation was higher in older people and the highest prevalence of T2DM and prediabetes is observed in 55 to 64 years old group. We carried out the ANOVA test to assess the association of age and abnormal glucose regulation in the participants. The ANOVA result revealed that the difference in the frequency of T2DM / prediabetes was significant between age groups (Table 4-4). There is an association between age and the prevalence of diabetes, prediabetes in this population and it seems the prevalence of these complications increases by age (F test=4.18, $p < 0.05$) except in the last age group that the prevalence goes down.

Figure 4-1: The prevalence of T2DM and prediabetes in different age groups

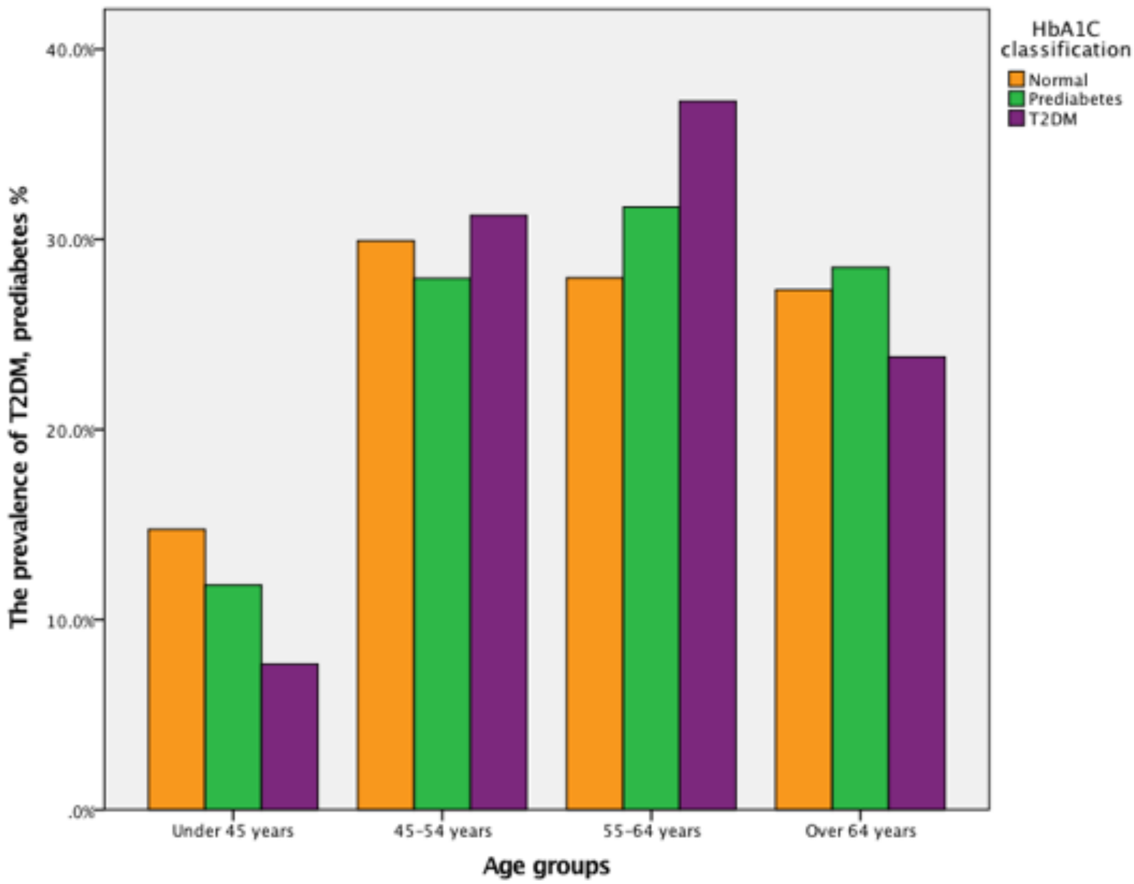


Table 4-4: ANOVA test over age groups and prevalence of T2DM, prediabetes among the participants

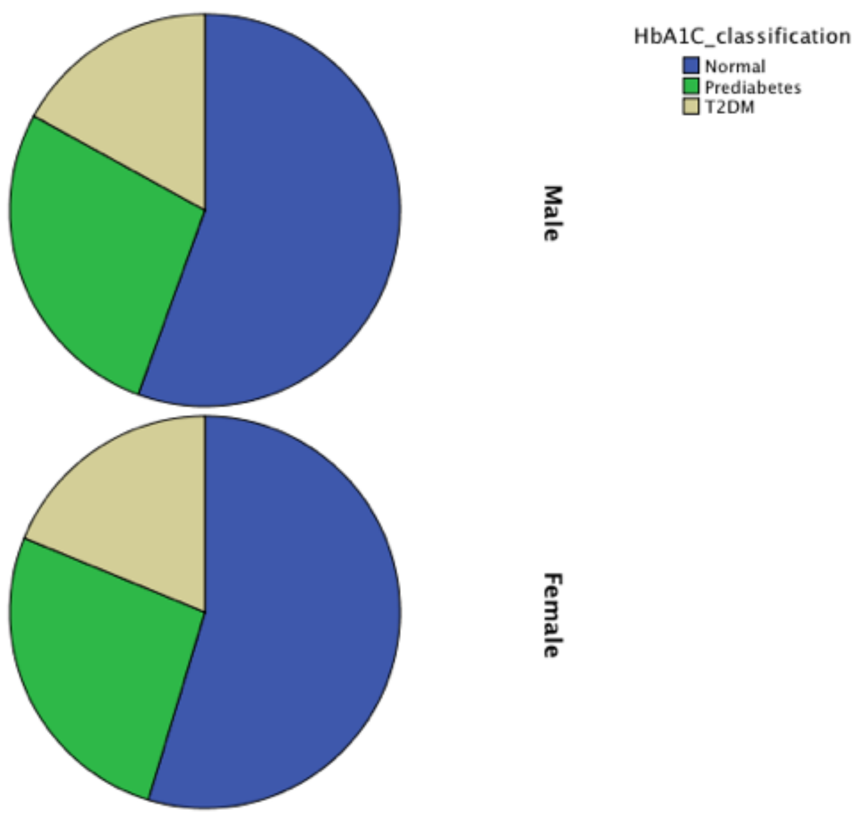
HbA1c classification	Sum of Squares	Degree of freedom	Mean Square	F test	P value
Between Groups	12.85	2	6.43	4.18	.015
Within Groups	4015.68	2611	1.54		
Total	4028.54	2613			

The frequency of abnormal glucose regulation between gender groups has been shown in Table 4-5. The figure 4-2 illustrated pie charts showing the similarity of the two genders regarding different fractions of the HbA1c level.

Table 4-5: The prevalence of T2DM and prediabetes in two genders; n=2572

		genders N (%)	
		Male	Female
HBA1C Classification (ADA2018)	Normal	405 (55.6)	1008 (54.7)
	Prediabetes	200 (27.4)	488 (26.5)
	T2DM	124 (17.0)	347 (18.8)
	Total	729 (100.0)	1843 (100.0)

Figure 4-2: The prevalence of T2DM and prediabetes in different genders; n=2572



The ANOVA test was carried out to assess the association of gender and the prevalence of abnormal glucose tolerance and no significant differences observed between two genders based on ANOVA test result (Table 4-6).

Table 4-6: ANOVA test over gender and prevalence of T2DM, prediabetes among the participants

HbA1c classification	Sum of Squares	Degree of freedom	Mean Square	F test	P value
Between Groups	.27	2	.13	.66	.52
Within Groups	534.42	2620	.204		
Total	534.69	2622			

4.2.4 The prevalence of T2DM and prediabetes in urban and rural communities

One municipality (number 2) among the five municipalities of the study was an urban area and the others were rural regions. According to this result, the urban municipality had the lowest frequency of people with normal glucose regulation and the highest frequency of people with T2DM and prediabetes compared to rural municipalities (Table 4-7).

Table 4-7: The prevalence of T2DM and prediabetes in different municipalities of the study; n=2572

		Municipalities N (%)				
		1-Rural	2-Urban	2-Rural	3-Rural	4-Rural
HbA1c Classification ADA 2018	Normal	296 (51.4%)	258 (43.4%)	219 (55.4%)	431 (70.2%)	209 (53.3%)
	Prediabetes	147 (25.5%)	191 (32.1%)	117 (29.6%)	111 (18.1%)	122 (31.1%)
	T2DM	133 (23.1%)	146 (24.5%)	59 (14.9%)	72 (11.7%)	61 (15.6%)
	Total	576 (100.0%)	595 (100.0%)	395 (100.0%)	614 (100.0%)	392 (100.0%)

Figure 4-3 a) illustrated the frequency of the HbA1c classifications in the region among 5 municipalities. Dividing the participants to two areas (urban vs. rural) gives the Figure 4-3) b bar chart. In this figure the difference between the two areas is more recognizable.

Figure 4-3: a) The prevalence of T2DM and prediabetes in 5 different municipalities; n=2572

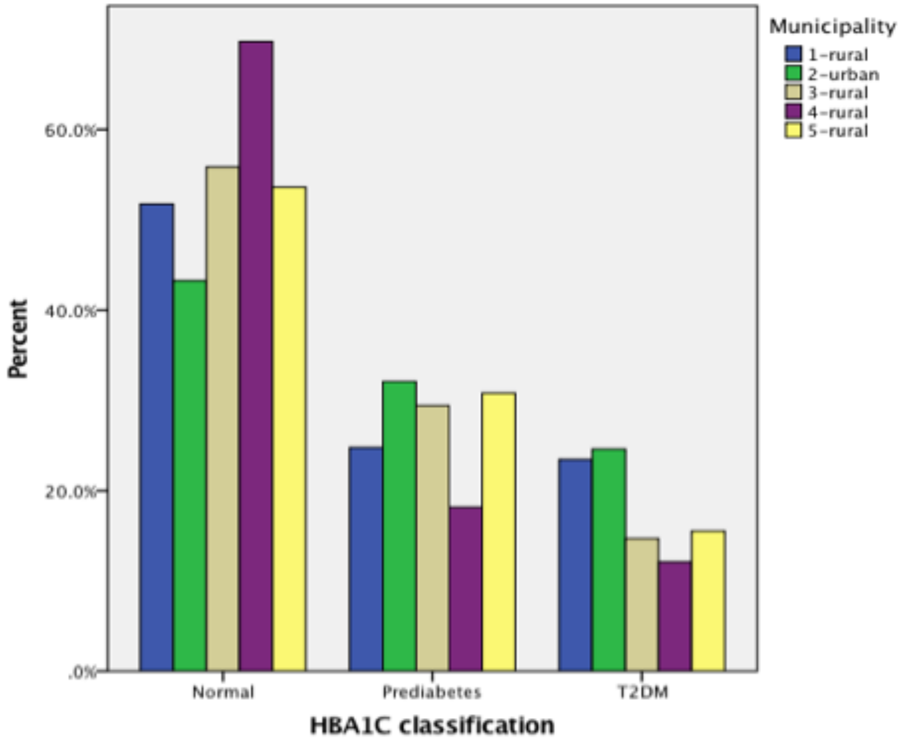
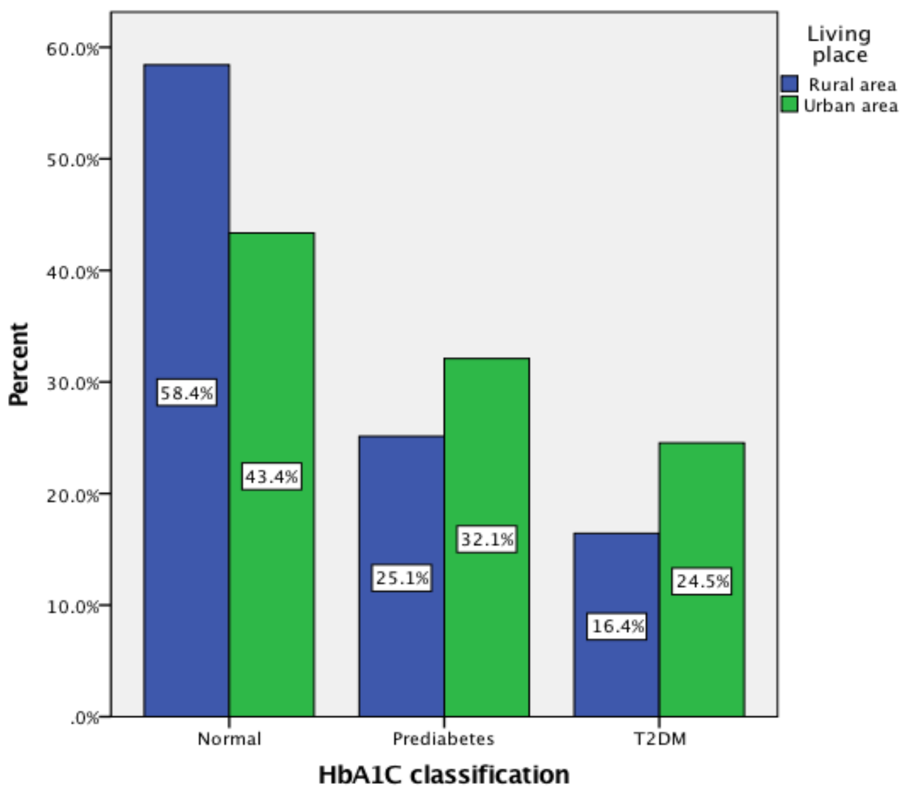


Figure 4-3: b) The distribution of T2DM and prediabetes in urban and rural areas; n=2572



We conducted a Chi-Square test to compare the prevalence of T2DM and prediabetes in the two areas (rural and urban) and, the result revealed that the frequency of this abnormality was significantly different between these areas (Table 4-8). Urban areas had a significantly higher prevalence of diabetes, prediabetes in this population ($p < 0.01$).

Table 4-8: Chi-Square test on the prevalence of T2DM, prediabetes in rural/urban areas

	Value	Degree of freedom	P value
Pearson Chi-Square	43.55	2	0.000
Likelihood Ratio	43.17	2	0.000
Linear-by-Linear Association	40.98	1	0.000
Total cases	2572		

4.3. T2DM risk factors in the participants

4.3.1 Obesity and abdominal obesity in the participants

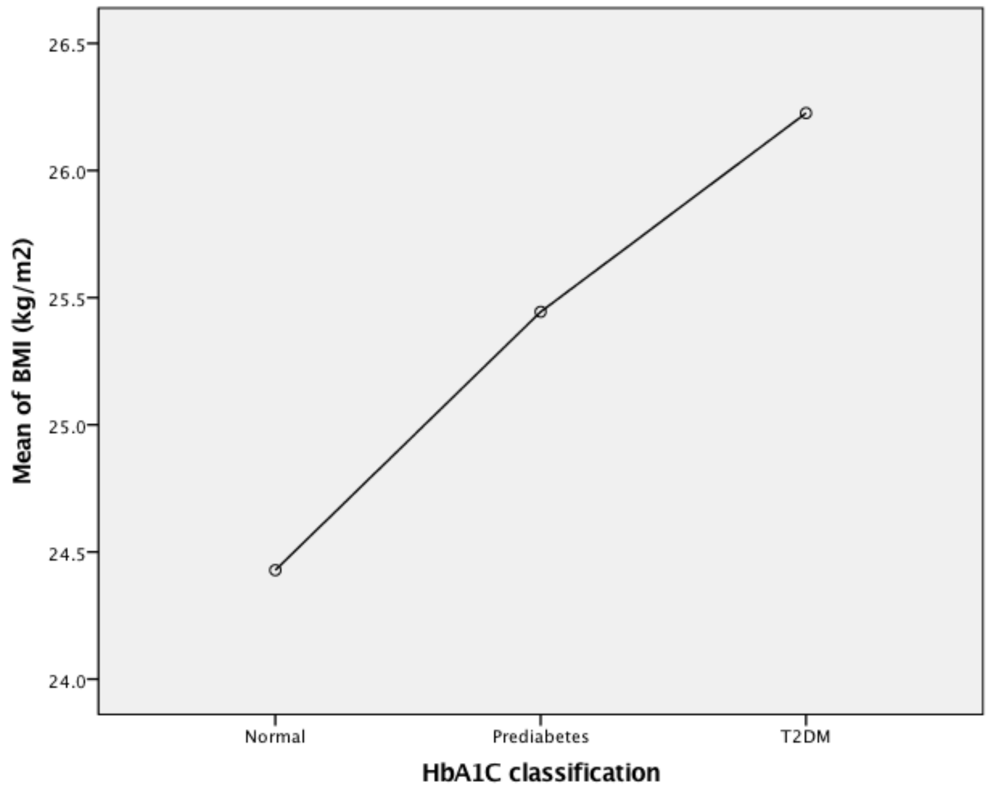
54.4 % of the population had a normal body mass index while 45.6% of the population were overweight (32.1 %) or obese (13.5%) (Table 4-9). Looking at these figures among different glucose level strata, that only 10% of obese people had a normal HbA1c whereas about 60% of individuals with normal BMI had normal HbA1c. Therefore, obesity is more prevalent among people with glucose regulation dysfunction and high BMI was frequent among diabetic and prediabetic individuals. See table 4-10 and figure 4-4 that showed this association between the BMI and the level of HbA1c.

Table 4-9: Obesity and abdominal obesity in normal, diabetic and prediabetic participants (n=2572)

	Normal	*Prediabetes*	*Diabetes*	*Total N (%)*
BMI *Normal* *(<25 kg/m2)*	840 (59.5%)	352 (51.2%)	208 (44.2%)	1400 (54.4%)
Overweight *(25–30 kg/m2)*	427 (30.2%)	227 (33.0%)	171 (36.3%)	825 (32.1%)
Obese *(< 30 kg/m2)*	146 (10.3%)	109 (15.8%)	92 (19.5%)	347 (13.5%)
Waist Circumference *Low risk* *(M >94 cm, W >80 cm)*	559 (39.6%)	224 (32.6%)	102 (21.7%)	885 (34.4%)
Elevated risk *(M 94–102 cm, W 80–88 cm)*	379 (26.8%)	163 (23.7%)	127 (27.0%)	669 (26.0%)
High risk *(M >102 cm, W >88 cm)*	475 (33.6%)	301 (43.8%)	242 (51.4%)	1018 (39.6%)

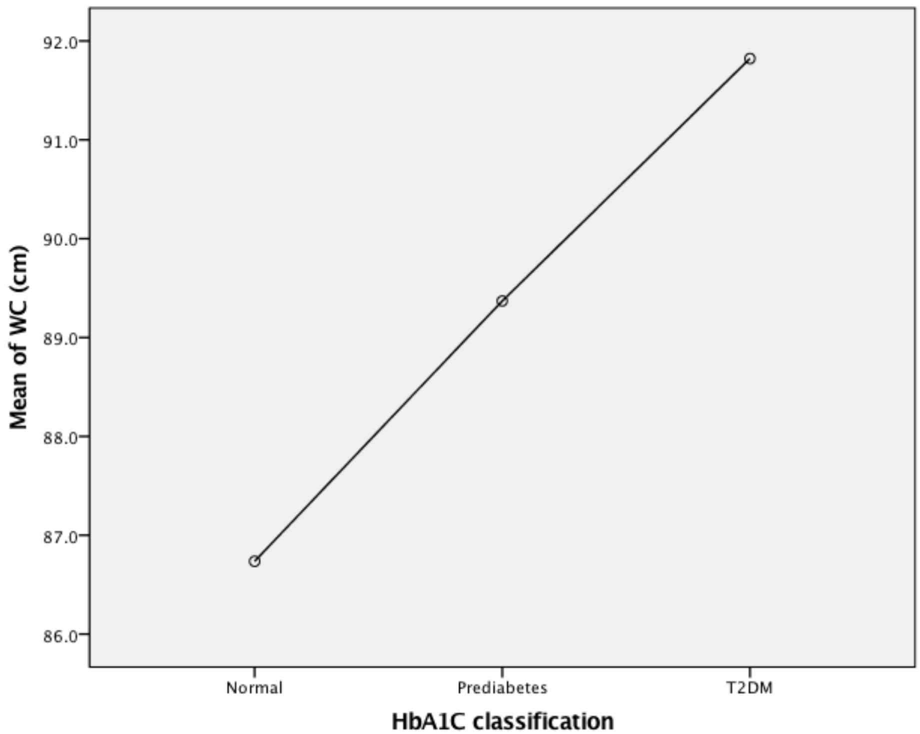
Central obesity was relatively high in the population; over 65% had central obesity -high or elevated WC-, and only 34 % of the population had a WC within the low-risk range. The frequency of high or elevated WC was higher among T2DM and prediabetes groups in the population. The finding suggests that the association of central obesity and glucose abnormalities is another risk factor for T2DM. (See Table 4-9 and Figure 4-5).

Figure 4-4: means plot of the BMI in different HbA1c level factions in the participants; n=2572



Figures 4-4 and 4-5 displayed a negative association between anthropometric indices and level of HbA1c, which shows an increase in BMI and WC above normal level is related to an increase in T2DM and prediabetes prevalence in the population.

Figure 4-5: means plot of the WC in different HbA1c level factions in the participants; n=2572



To test the significance of the difference in anthropometric indices among different HbA1c levels, the ANOVA test was carried out. The result revealed that the association between the BMI and WC measures and the prevalence of T2DM and prediabetes are significant (Table 4-10).

Table 4-10: ANOVA test over the prevalence of T2DM, prediabetes and anthropometric indices; n=2572

		Sum of Squares	df	Mean Square	F	Sig.
WC	Between Groups	10072.51	2	5036.25	41.38	.000
	Within Groups	312693.19	2569	121.72		
	Total	322765.70	2571			
BMI	Between Groups	1302.97	2	651.48	29.54	.000
	Within Groups	56653.66	2569	22.05		
	Total	57956.63	2571			

The prevalence of obesity was compared in different genders and different age groups using ANOVA test. The prevalence of overweight and obesity in females (47.2%) was higher than males (41.4%) (Table 4-11: a). Comparing men and women, there was a significant difference between the two genders and it seems that male participants have significantly lower BMI compared to their females' counterparts ($p< 0.05$).

Table 4-11: a) Obesity and overweight prevalence between different genders in the participants(n=2572)

		Genders N (%)		P value
		Male	Female	
BMI	Normal (<25 kg/m2)	427 (58.6)	973 (52.8)	0.03
	Overweight (25–30 kg/m2)	216 (29.6)	609 (33.0)	
	Obese (< 30 kg/m2)	86 (11.8)	261 (14.2)	
	Total	729 (100.0)	1843 (100.0)	

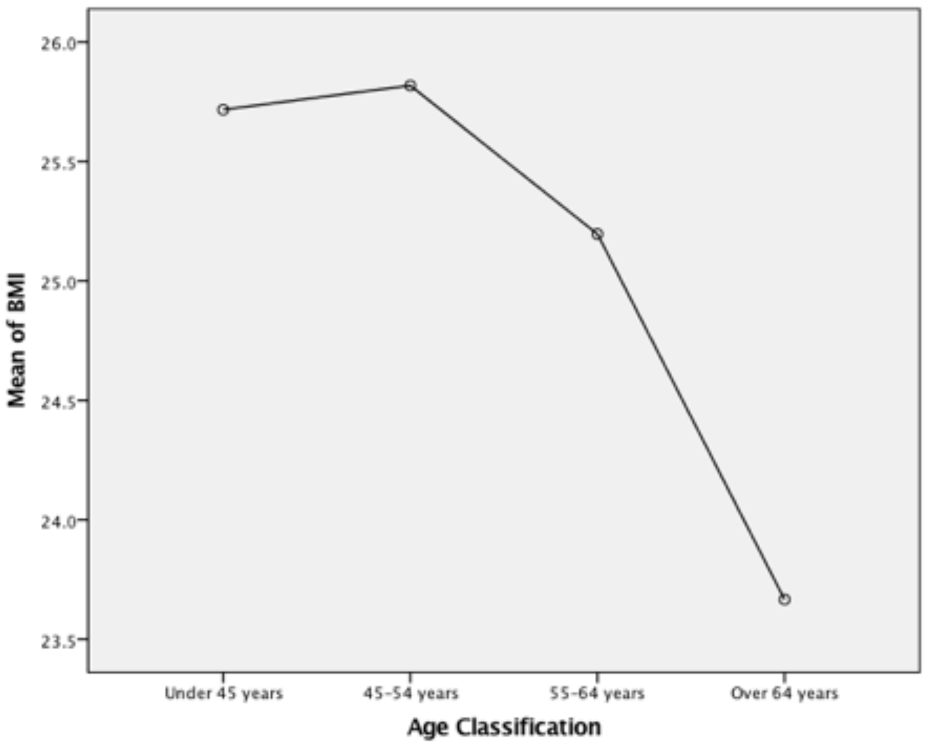
The prevalence of obesity and overweight were significantly different among age groups ($p< 0.01$). the finding suggested that BMI may decrease with age. The older age groups had lower BMIs than younger age groups in this population and this downward trend has been observed in participants older than 45 (See Table 4-11: b and Figure 4-6).

Table 4-11: b) Obesity and overweight prevalence among different age groups in the participants (n=2572)

		Age groups N (%)					P value
		< 45 years	45–54 years	55–64 years	> 64 years	Total	
BMI	Normal (<25 kg/m2)	155 (48.1%)	351 (46.1%)	421 (53.3%)	473 (67.7%)	1400 (54.4%)	0.00
	Overweight (25–30 kg/m2)	118 (36.6%)	284 (37.3%)	254 (32.2%)	169 (24.2%)	825 (32.1%)	
	Obese	49	126	115	57	347	

	(< 30 kg/m2)	(15.2%)	(16.6%)	(14.6%)	(8.2%)	(13.5%)	
	Total	322 (100.0%)	761 (100.0%)	790 (100.0%)	699 (100.0%)	2572 (100.0%)	

Figure 4-6: means plot of the BMI in different age groups in the participants; n=2572



Abdominal obesity was compared in different genders and different age groups. The mean of WC was lower in normal people compared to diabetic or prediabetic patients. (See Tables 4-12: a and b). A significant difference was observed between the two genders regarding their WC measures. The frequency of having normal WC was higher in male participants compared to females ($p < 0.01$).

Table 4-12: a) Central obesity prevalence between different genders in the participants (n=2572)

		Genders N (%)		P value
		Male	Female	
WC	Low risk (M <94 cm, W <80 cm)	517 (70.9%)	368 (20.0%)	0.00
	Elevated risk (M 94–102 cm, W 80–88 cm)	146 (20.0%)	523 (28.4%)	
	High risk (M >102 cm, W >88 cm)	66 (9.1%)	952 (51.7%)	
	Total	729 (100.0%)	1843 (100.0%)	

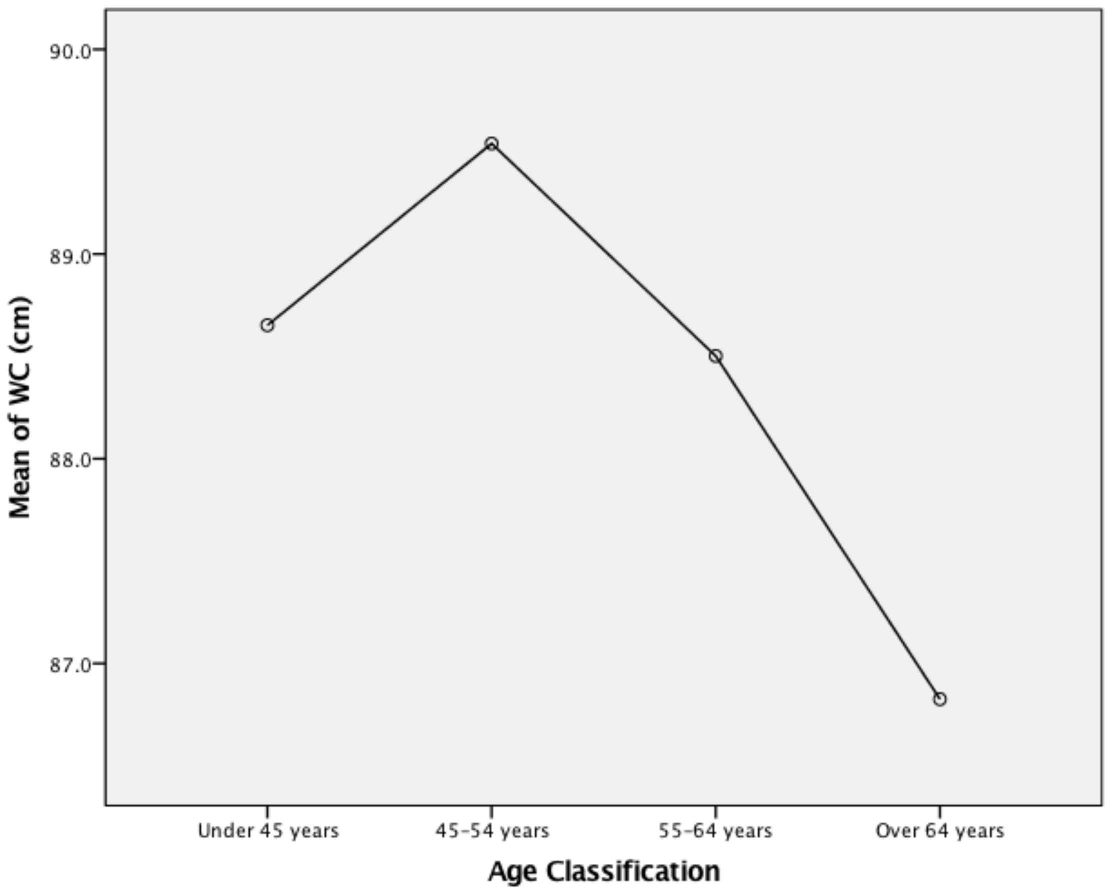
ANOVA test results showed that the prevalence of central obesity was significantly different among different age groups, as well (p< 0.01). The WC tends to decrease after 45 years old in the population, similar to the trend that has been observed in the BMI.

Table 4-12: b) Central obesity prevalence among different age groups in the participants (n=2572)

		Age groups N (%)					P value
		< 45 years	45–54 years	55–64 years	> 64 years	Total	
WC	Low risk (M <94 cm, W <80 cm)	95 (29.5%)	234 (30.7%)	267 (33.8%)	289 (41.3%)	885 (34.4%)	0.00
	Elevated risk (M 94–102 cm, W 80–88 cm)	97 (30.1%)	200 (26.3%)	195 (24.7%)	177 (25.3%)	669 (26.0%)	
	High risk (M >102 cm, W >88 cm)	130 (40.4%)	327 (43.0%)	328 (41.5%)	233 (33.3%)	1018 (39.6%)	
	Total	322 (100.0%)	761 (100.0%)	790 (100.0%)	699 (100.0%)	2572 (100.0%)	

Figure 4-7 illustrates the mean plot of WC among different age groups, presenting the decreasing trend with age that is relatively similar to the one observed with the BMI.

Figure 4-7: mean plot of the WC in different age groups in the participants; n=2572



4.3.2 T2DM lifestyle and behavioral risk factors in the participants

Regarding T2DM modifiable risk factors, based on self-reported lifestyle and health behaviors, 19.8 % of the participants did not have 30 minutes daily physical activity, 36.3% of the participants did not consume fruits and/or vegetables every day; 72.1% and 66.3 % of the participants consumed fatty foods and sweet drinks/high sugar foods regularly, respectively. The consumption of salt was high and almost 91% of the participants reported that they intake salt regularly in cooking or on the table. 80.6 % of the participants never smoked and 6.3% of them were former smokers who quit. The consumption of alcoholic beverages was noticeably low in the population that about 92% of the participants are non-drinker or rarely drink. Overall, 40.4 % of participants had a history of hypertension (HTN) or have been taking medication for high blood pressure. Table 4-13 provided the information on demographics, lifestyle and medical profile of the participants in different strata of glucose tolerance according to the ADA guideline2018.

Table 4-13: Characteristics and risk factors in normal, T2DM, and prediabetes individuals -based on HbA1c test result (CDA 2018); n=2572

Groups	**Diabetes n=471(18.3%)**	**Prediabetes n=688(26.7%)**	**Normal n=1413(54.9%)**	**P value**
A. Demographic Profile				
Age (years)	57.98±9.42	58.84±10.20	56.97±10.80	0.047
Gender				
Female	347 (18.8%)	488 (26.5%)	1008 (54.7%)	0.53
Male	124 (17.0%)	200 (27.4%)	405 (55.6%)	
B. Lifestyle and dietary habits				
Having exercise; at least 30 min/day	378 (80.3%)	555 (80.7%)	1131 (80.0%)	0.91
Having vegetables/fruit; every day	300 (63.7%)	449 (65.3%)	890 (63.0%)	0.51
Fatty food consumption; never/rarely	138 (29.3%)	181 (26.3%)	398 (28.2%)	0.49
Consumption of high sugar drink/food products; never/rarely	176 (37.4%)	216 (31.4%)	476 (33.7%)	0.11
Salt consumption; never/rarely	53 (11.3%)	67 (9.7%)	117 (8.3%)	0.13
Smoking habit				
current smoker	49 (10.4%)	85 (12.3%)	203(14.4%)	0.08
ex-smoker	20 (4.2%)	40 (5.8%)	103 (7.3%)	
non-smoker	402 (85.4%)	563 (81.8%)	1107 (78.3%)	
Alcohol consumption; never/rarely	437 (92.8%)	642 (93.3%)	1291(91.4%)	0.67
C. Medical History				
HTN	239(50.7%)	296(43.0%)	505 (35.7%)	0.00
History of high FPG	125 (26.5%)	61(8.9%)	101(7.1%)	0.00
Family history of diabetes				
none	238 (50.5%)	481(69.9%)	1079 (76.4%)	
first degree relative	207(43.9%)	186 (27.0%)	276 (19.5%)	0.00
other relative(s) only	26 (5.5%)	21 (3.1%)	58 (4.1%)	
HbA1c (%)	8.55±2.06	5.97±0.22	5.03±0.43	0.00

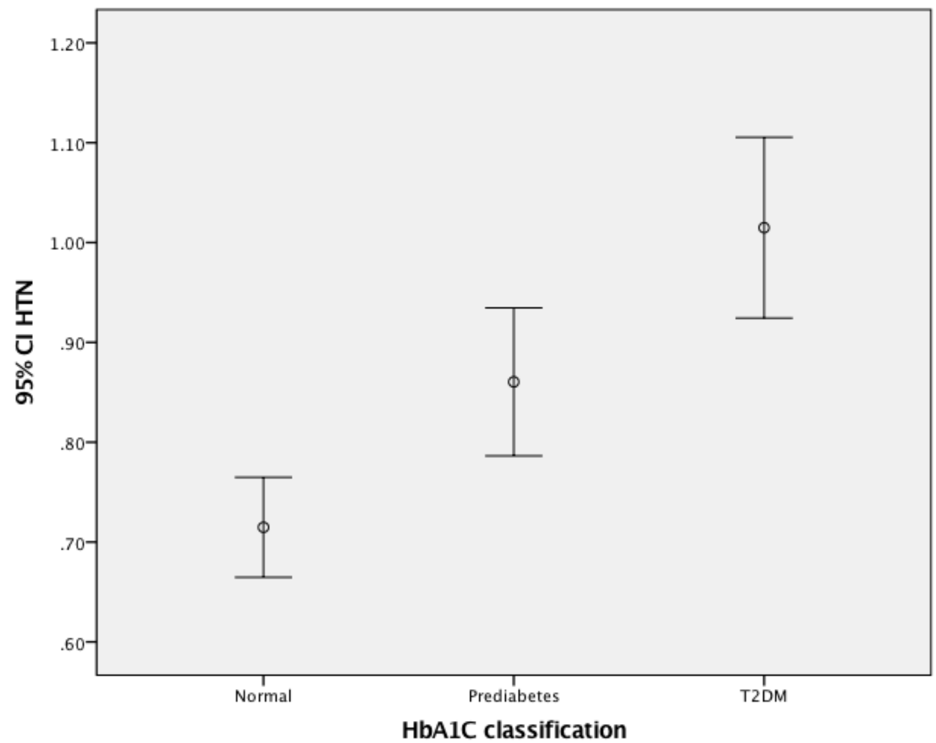
The ANOVA test has been carried out to realize if these mean differences among groups are statistically significant. The test results indicated that there are significant differences among these groups in several variables. The age mean was different among these three groups with normal people tend to be younger (1 to 2 years) compared to prediabetes and T2DM groups and this difference was marginally significant (p=0.047). The frequency of having HTN is higher in T2DM patients and individuals with prediabetes (F=18.6, P<0.01). The frequency of the history of high FPG is also higher in these people (F=73.7, P<0.01). The family history of T2DM is significantly different among participants and the people with T2DM and prediabetes more frequently reported that they have a family member with T2DM (F=59.99, P<0.01).

Comparing different genders using the Chi-square test or ANOVA test (when appropriate), no significant differences were observed among different genders regarding physical activity (p= 0.41), salt consumption (p=0.33), high sugar food intake (p=0.17) and fatty/ fried food consumption (p=0.39). However, Fruit and vegetable consumption was higher in women (p=0.001). 58% of male participants answered the daily intake of fruit and vegetables, whereas this amount was 65% in female participants. The frequency of smoking and alcohol consumption were significantly higher among men than women (p=0.00). 91% of women never smoked whereas 54% of men had answered the same. Alcohol consumption pattern was similar, 96.5% of women were non-drinker, but this portion was 81% among men participants (p=0.00).

4.3.3 Other T2DM risk factors in the participants

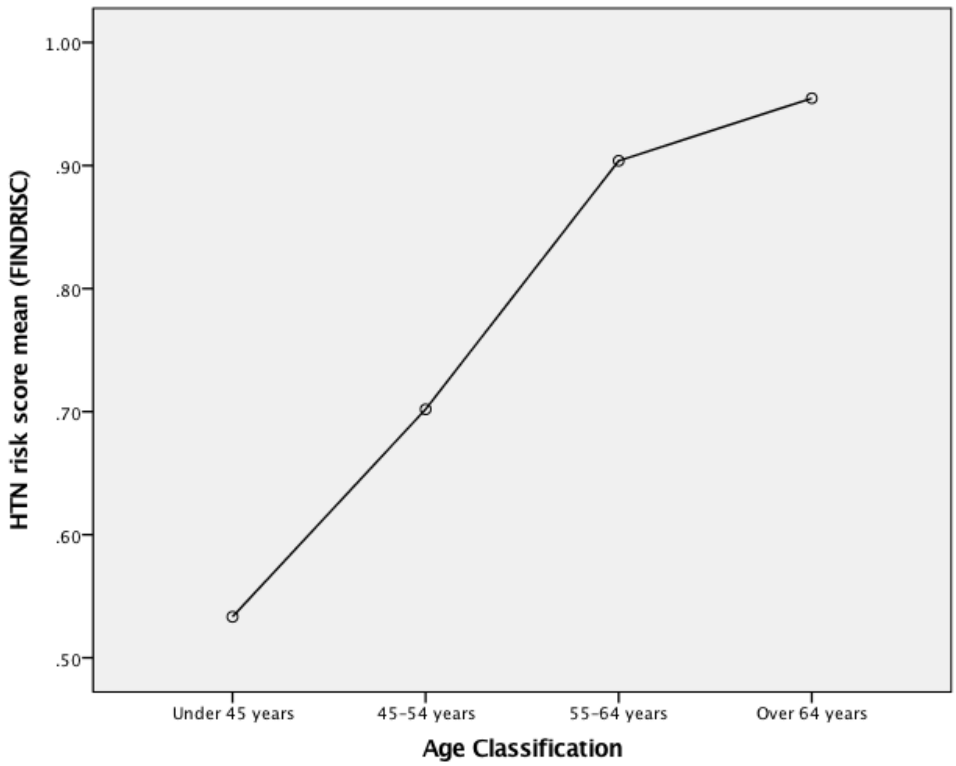
Looking at Table 4-13 results, history of hypertension, history of high FPG and family history of diabetes tended to be higher in individuals with T2DM and prediabetes. In total, 40.4% of participants were taking or have taken blood pressure medication. As previously mentioned, the frequency of having HTN is higher in T2DM patients and individuals with prediabetes compared to people with normal glucose regulation (F=18.6, P<0.01). Figure 4-8 showed the HTN status in three groups.

Figure 4-8: HTN in the participants with regard to their HbA1c level; n=2572



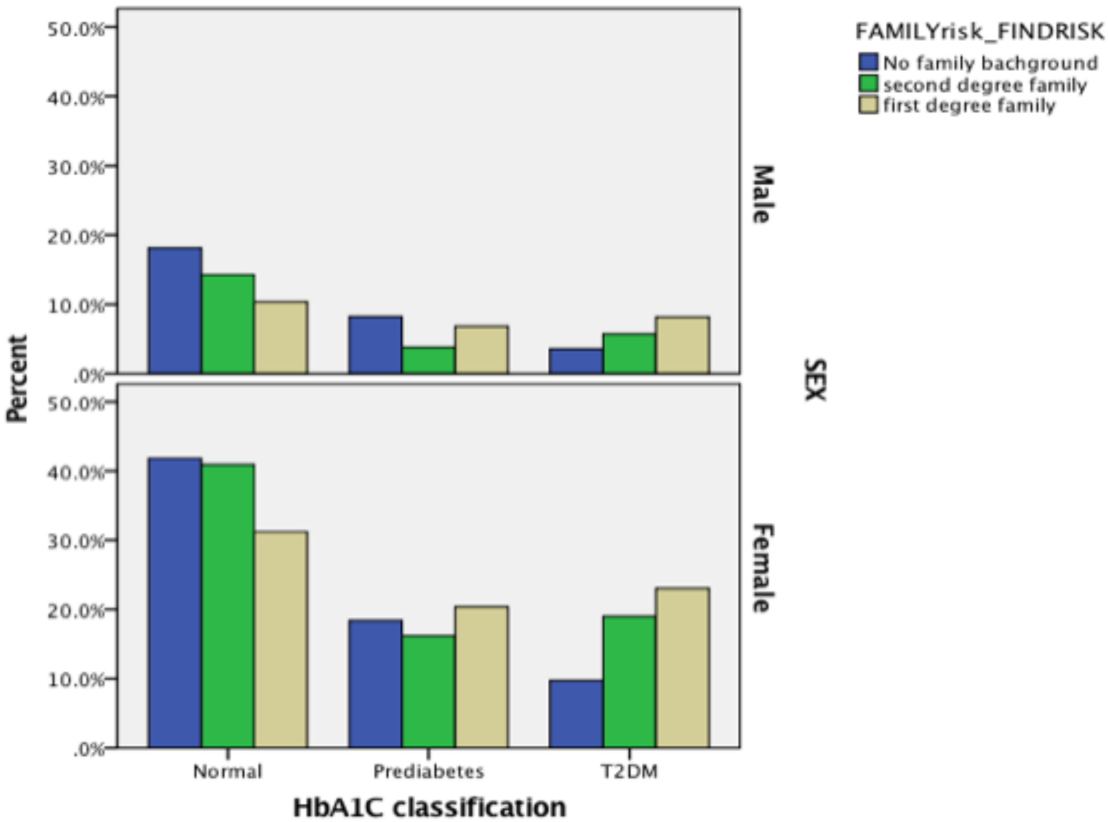
HTN was more prevalent in female participants (42%) than male participants (36.5%), relatively and this difference was significant (p<0.05). The presence or history of having HTN in participants has been compared among different age groups using ANOVA test, and the result showed that the older age groups had a higher prevalence of HTN; p< 0.01 (See figure 4-9).

Figure 4-9: mean plot of the HTN in different age groups in the participants; n=2572



The family history of T2DM is different among participants with regards to their glucose tolerance status. Figure 4-10, bar chart has shown that having a first degree or second-degree family member with T2DM is significantly higher among diabetic or prediabetic patients compared to normal participants ($p<0.01$).

Figure 4-10: Family history of the disease in normal, diabetic and prediabetic men and women; n=2572



4.4 FINDRISC score and categories in the participants

The Finnish Diabetes Risk Scores of the whole study population ranged from 0 to 25, with a mean ± SD of FINDRISC score at 9.95 ± 4.68. The risk of developing diabetes was low in 25.7%, slightly elevated in 36.7%, moderate in 20.0%, high or very high in 17.6% of the population. The distribution of the score among different groups of glucose tolerance has been shown in Table 4-14.

Table 4-14: The FINDRISC score and categories distribution among the participants (n=2572)

		HbA1c classification			Total
		Normal	Prediabetes	T2DM	
FINDRISC groups N (%)	Low	432 (30.9%)	162 (23.6%)	51 (10.9%)	645 (25.2%)
	Slightly elevated	557 (39.8%)	248 (36.1%)	138 (29.4%)	943 (36.9%)

	Moderate	254 (18.2%)	143 (20.8%)	117 (24.9%)	514 (20.1%)
	High	145 10.4%	119 17.3%	137 29.1%	401 15.7%
	Very high	10 (0.7%)	15 (2.2%)	27 (5.7%)	52 (2.0%)
Total		1398 (100.0%)	687 (100.0%)	470 (100.0%)	2555 (100.0%)

Table 4-15 displayed the distribution of FINDRISC score groups among different age groups in the participants. There were significant differences among participants FINDRISC scores based on their age. The frequency of higher FINDRISC score is increasing with the age of participants, and the Female participants had relatively higher scores compared to male participants. Considering the fact that age was one of the predictors in computing FINDRISC score, this significant difference cannot be considered unexpected.

Table 4-15: the FINDRISC category in different age groups of the participants (n=2572)

FINDRISC Groups	Age groups N (%)				P value
	< 45 years	45–54 years	55–64 years	> 64 years	
Low	144 (44.7)	202 (26.5)	163 (20.6)	153 (21.9)	0.047
Slightly elevated	105 (32.6)	302 (39.7)	274 (34.7)	262 (37.5)	
Moderate	55 (17.1)	139 (18.3)	179 (22.7)	141 (20.2)	
High	18 (5.6)	104 (13.7)	156 (19.7)	123 (17.6)	
Very high	0 (0.0)	14 (1.8)	18 (2.3)	20 (2.9)	
Total N (%)	322 (100.0)	761 (100.0)	790 (100.0)	699 (100.0)	

Table 4-16 displayed the distribution of FINDRISC score groups among different genders in the participants. No significant difference was observed between the two genders regarding the FINDRISC score.

Table 4-16: FINDRISC categories in different genders of the participants (n=2572)

FINDRISC Groups	Gender		Total N (%)	P value
	Male N (%)	Female N (%)		
Low	342 (46.9)	320 (17.4)	662 (25.7)	0.531
Slightly elevated	240 (32.9)	703 (38.1)	943 (36.7)	
Moderate	86 (11.8)	428 (23.2)	514 (20.0)	
High	52 (7.1)	349 (18.9)	401 (15.6)	
Very high	9 (1.2)	43 (2.3)	52 (2.0)	
Total N (%)	729 (100.0)	1843 (100.0)	2572 (100.0)	

4.5 Effect of urban/rural living on T2DM risk factors

Table 4-17 has shown the distribution of different variables among different municipalities (urban and rural areas) including the frequency / mean of BMI, WC, FINDRSIC score, diet and lifestyle factors (consumption of fruit and vegetables, consumption of sugar and salt, consumption of fatty food and physical activity) and also monthly income are different among the participants based on the area of residency.

Table 4-17: Distribution of different variables among five municipalities (urban and rural areas) (n=2572)

Variables	**n (%)**					**P value**
	Municipality 2 (Urban)	**Municipality 1 (Rural)**	**Municipality 3 (Rural)**	**Municipality 4 (Rural)**	**Municipality 5 (Rural)**	
Age						
Under 45 years	61 (10.1%)	71 (11.9%)	53 (13.2%)	82 (13.3%)	64 (16.2%)	
45–54 years	181 (30.1%)	193 (32.2%)	119 (29.7%)	176 (28.5%)	106 (26.8%)	
55–64 years	197 (32.8%)	187 (31.2%)	116 (28.9%)	179 (29.0%)	123 (31.1%)	0.31
Over 64 years	162 (27.0%)	148 (24.7%)	113 (28.2%)	180 (29.2%)	103 (26.0%)	
Gender						
Male	145 (24.4%)	183 (31.8%)	118 (29.9%)	178 (28.7%)	107 (27.3%)	0.02
Female	450 (75.6%)	393 (68.2%)	277 (70.1%)	438 (71.3%)	285 (72.7%)	

Education level Completed college/ Univ. Some college/ Univ. Completed high school Some high school or less	87 (14.6%) 85 (14.3%) 107 (18.0%) 316 (53.1%)	57 (9.9%) 41 (7.1%) 89 (15.5%) 389 (67.5%)	13 (3.3%) 18 (4.6%) 43 (10.9%) 321 (81.3%)	43 (7.0%) 44 (7.2%) 92 (15.0%) 435 (70.8%)	52 (13.3%) 41 (10.5%) 48 (12.2%) 251 (64.0%)	0.00
Income Zero income 1 to 1000 1000-5000 More than 5000	272 (45.7%) 20 (3.4%) 143 (24.0%) 160 (26.9%)	39 (6.8%) 59 (10.2%) 319 (55.4%) 159 (27.6%)	112 (28.4%) 70 (17.7%) 167 (42.3%) 46 (11.6%)	37 (6.0%) 94 (15.3%) 355 (57.3%) 128 (20.8%)	66 (16.8%) 25 (6.4%) 202 (51.5%) 99 (25.3%)	0.00
HbA1c groups Normal (< 5.7) Prediabetes (5.7-6.4) Diabetes (≥ 6.5)	350 (58.8%) 99 (16.6%) 146 (24.5%)	373 (64.8% 70 (12.2%) 133 (23.1%)	278 (70.4%) 58 (14.7%) 59 (14.9%)	493 (80.3%) 49 (8.0%) 72 (11.7%)	273 (69.6%) 58 (14.8%) 61 (15.6%)	0.03
Physical Activity at least 30 min/day	475 (79.4%)	436 (72.9%)	347 (86.5%)	519 (83.7%)	323 (81.6%)	0.52
Having vegetables/fruit (every day)	419 (69.7%)	323 (53.7%)	321 (80%)	366 (58.8%)	243 (60.9%)	0.00
Fatty food consumption (never/rarely)	120 (20.2%)	230 (39.9%)	101 (25.6%)	208 (33.9%)	106 (27.0%)	0.00
Consumption of high sugar drink/food products (never/rarely)	185 (31.1%)	35 (6.1%)	90 (22.8%)	248 (40.4%)	115 (29.3%)	0.4
Salt consumption (never/rarely)	102 (17.1%)	182 (31.6%)	41 (10.4%)	29 (4.7%)	30 (7.7%)	0.0
Current smoker	66(11.00%)	80 (13.30%)	55(13.70%)	96(15.50%)	47(11.80%)	0.24
Alcohol consumption (never/rarely)	537 (90.3%)	525 (91.1%)	373 (94.2%)	583 (95.0 %)	353 (90.1%)	0.17
FINDRISC groups Low Slightly elevated Moderate High Very high	114 (19.2%) 210 (35.3%) 140 (23.5%) 114 (19.2%) 17 (2.9%)	121 (21.0%) 215 (37.3%) 121 (21.0%) 107 (18.6%) 12 (2.1%)	155 (39.2%) 128 (32.4%) 59 (14.9%) 48 (12.2%) 5 (1.3%)	169 (27.5%) 233 (37.9%) 115 (18.7%) 85 (13.8%) 12 (2.0%)	155 (39.2%) 128 (32.4%) 59 (14.9%) 48 (12.2%) 5 (1.3%)	0.00
Waist Circumference Low risk Elevated risk High risk	172 (28.7%) 148 (24.7%) 280 (46.7%)	225 (37.4%) 148 (24.6%) 228 (37.9%)	172 (43.4%) 110 (27.8%) 114 (28.8%)	195 (31.4%) 147 (23.7%) 279 (44.9%)	141 (35.3%) 126 (31.6%) 132 (33.1%)	0.00
BMI Normal Overweight Obese	288 (47.9%) 210 (34.9%) 103 (17.1%)	295 (49.1%) 198 (32.9%) 108 (18.0%)	284 (70.8%) 93 (23.2%) 24 (6.0%)	324 (52.2%) 218 (35.1%) 79 (12.7%)	233 (58.4%) 123 (30.8%) 43(10.8%)	0.00
Self-reported HTN	262(45.5%)	248(41.7%)	146(37.0%)	237(38.6%)	147(37.5%)	0.03

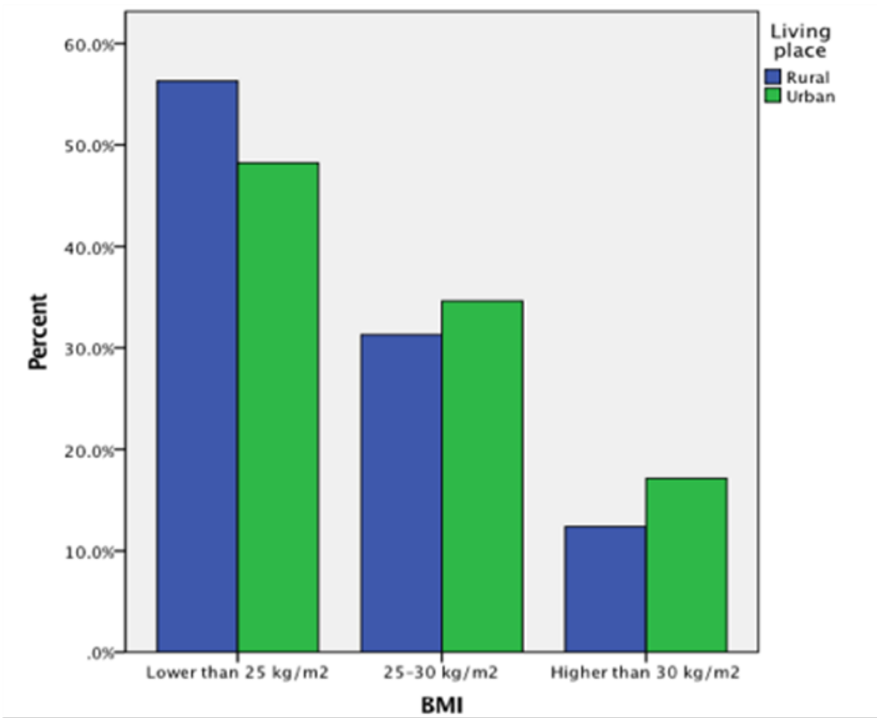
ANOVA test was used to compare results among different municipalities. Except for age, physical activity, high sugar food intake, alcohol consumption, and smoking, the other variables frequencies were significantly different among these five municipalities (See Table 4-17, P values). Looking at the table, for education, the urban area had the highest frequency of people with university/ college degree and the lowest frequency of people with some high school or less education and also the highest frequency of people with zero income (45.7%). Although the present data analysis showed that several dietary habits (salt, fruit/vegetable and, fatty food consumption) are significantly different among five municipalities, the only urban community was not the one with higher or lower frequency among them. Therefore, we could not find any association between living in urban/ rural areas and physical activity, lifestyle or diet.

Self-reported HTN was significantly different among these 5 municipalities but when compared between the two areas (urban vs. rural), the frequency of HTN in the rural areas was 40.1% against 41.7% in urban areas. Using the chi-square test, there was no significant difference between the two areas (p=0.5).

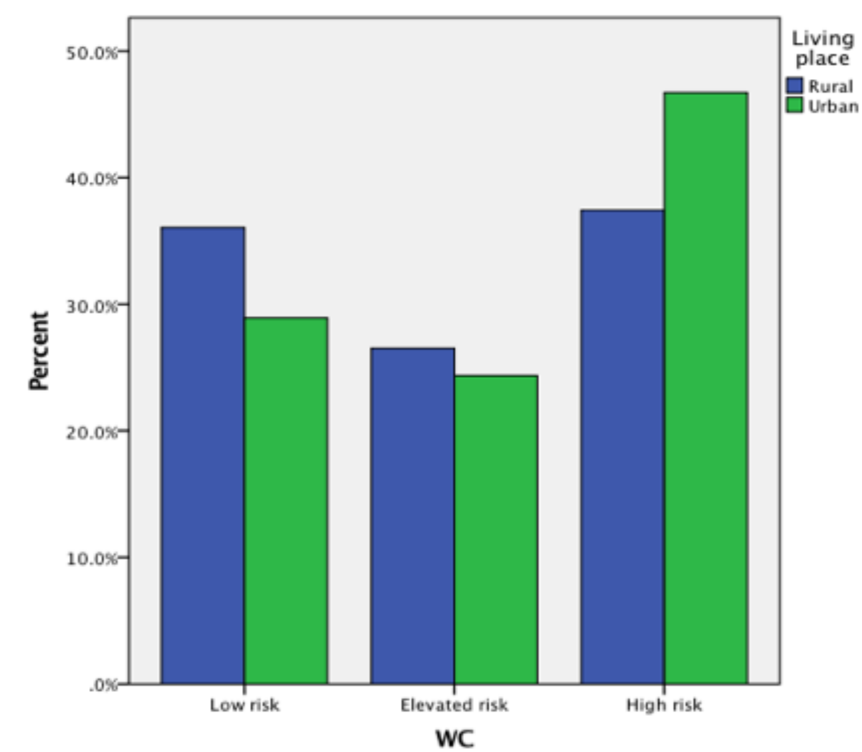
Indeed, the most important observed differences were BMI, WC, FINDRSIC score and HbA1c level among participants in different regions. HbA1c was discussed in the previous section (see section 4.2.4). Urban areas had a significantly higher prevalence of diabetes, prediabetes in this population ($p < 0.01$). The frequency of being at high risk of developing T2DM based on the FINDRISC score was significantly higher in urban areas ($p<0.01$). Anthropometric indices were significantly higher in the urban municipality compared with the rural areas ($p<0.01$). Figure 4-10 has shown the differences between two bar charts.

Figure 4-11: Anthropometric indices among participants with regard to their place of residency (n=2572); A) BMI bar chart B) WC bar chart

A)


Living place
Rural
Urban
Percent
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
.0%
Lower than 25 kg/m2
25-30 kg/m2
Higher than 30 kg/m2
BMI

B)


Living place
Rural
Urban
Percent
50.0%
40.0%
30.0%
20.0%
10.0%
.0%
Low risk
Elevated risk
High risk
WC

5. Discussion

The objectives of this study were to determine the prevalence of T2DM and prediabetes and to identify T2DM modifiable risk factors that contribute to the development of T2DM in the Zamboanga Peninsula, Philippines.

5.1 Methodology of the study

In this community based cross-sectional study, we used door-to-door sampling method to recruit participants and collect data. Although door-to-door surveying is not the dominant mode of surveying, it is the most common sampling method in rural areas and developing countries that do not have the mailing, internet and telecommunication infrastructure required to make the other methods feasible. Door-to-door methods are often seen as intrusive for participants, expensive for researchers, and dangerous for interviewers when using other survey methods are feasible (118). Consequently, few studies provide details about the advantages of door-to-door surveys and its benefits for public health research (119).

Door-to-door methods are common for conducting health screenings (120) and several large scale studies have been conducted through door-to-door surveys. For example, the World Health Organization (WHO) uses a combination of telephone surveys and household face-to-face interviews to collect data. The National Health and Nutrition Exam Survey in the USA used door-to-door sampling procedures to conduct health surveys that followed by clinical examinations (121-123). Community-based research studies, public health community outreach programs and also research studies have used door-to-door methods to make relationships with community residents, hire community members, build trust and engagement with the community and recruit study participants (120).

In 2016, Khan and colleagues (124) used door-to-door survey method to estimate the prevalence of Parkinson's disease (PD) in Pakistan. They stated that the approach had some advantages in prevalence surveys compared with record-based methods that may underestimate the prevalence rate, especially in countries and regions with limited access to medical centers. The study also reported that the prevalence rates of PD estimated through door-to-door methods are generally higher than record-based method surveys in Asian countries (124). In general, door-to-door sampling method is a valuable choice for community health surveys however, personal safety should be a primary consideration for interviewers and investigators involved in this method (120).

In this epidemiological study, we had required sampling and data collection strategies that could maximize our ability to obtain data from a representative population sample. Therefore, we used door-to-door sampling that was feasible to conduct especially in these rural areas to randomly select a community sample for participation in the study.

We used cross-sectional design because it is the most suitable design to measure the determinants of health or the prevalence of health outcomes, or both, in a population at a point in time or over a short period. Cross-sectional studies provide a portrait of the frequency of a disease and other health-related characteristics in a population. The other application of cross-sectional design lies in planning and decision making in health care. For example, policymakers who are planning a T2DM prevention program need to know the burden of the disease, identify the high-risk population, assess the health needs of the population and the prevalence of different risk factors in the population, so they can tailor prevention programs or interventions accordingly. A prospective cohort study was the other option for this research however, due to lengthy and, higher expenses, the cross-sectional design had been chosen that was more suitable considering the time and budget limitations of the project.

Regarding the main outcome of the study and measurements, this study used HbA1c test to measure the outcome and uncovered a higher prevalence rate of T2DM in the Zamboanga Peninsula reign of the Philippines compared to previous studies in the country. To the best of our knowledge, no study to date used HbA1c to detect abnormal glucose regulation in the Filipino population. Choosing the OGTT test or the FPG test gives the researchers the opportunity of using healthcare settings to measure their outcome of interest, but for the HbA1c test, they will need to provide the standardized test kits for their participants in the proper setting and this will increase the study expenses. Therefore, it seems reasonable that most studies prefer to use the method that is easily accessible at a lower cost.

Considering the inconvenience of performing OGTT test for participants and day-to-day variability in FPG level, HbA1c has been recommended as a tool to diagnose T2DM by International Expert Committee and ADA (125). In addition, several studies evaluated the agreement between HbA1c and FPG in the diagnosis of diabetes and prediabetes. In 2017, one study (126) which screened 3523 Vietnamese individuals with both measurements revealed that there is a significant discordance in the diagnosis of diabetes and prediabetes between FPG and HbA1c measurements, and FPG appeared to underestimate the burden of both undiagnosed diabetes and prediabetes considerably in this population. Their data also showed 29% of individuals identified having prediabetes by FPG, were classified as diabetic by HbA1c test. In 2018, Lim WY and colleagues evaluated the performance of HbA1c against FPG among 3540 community-dwelling Singapore residents of Chinese, Indian and Malay race (127). Their data indicated that the current screening method (only FPG and an OGTT as a follow-up test) would miss a significant number of individuals with abnormal glucose regulation. Soria and colleagues (102) reported detecting an additional 9.6% of T2DM using 2HPG, that had not been detected by FPG (102). Although an FPG level >126 mg/dl and a 2HPG level>200 mg/dl should identify the same individuals, but they may not coincide. Therefore, they suggested the use of 2HPG postload alongside with FPG in first step screening for true diabetics, IGTs, and IFGs diagnosis. They suggested that the combination of HbA1c $\geq 6.1\%$ and FPG ≥ 5.6 mmol/L (100 mg/dL) for screening would improve the identification of diabetic and prediabetic patients. In one study (2014) in Taiwan (128), researchers investigated the prevalence of undiagnosed abnormal glucose regulation in patients undergoing coronary angiography by using both HbA1c and OGTT. Their finding showed the prevalence of diabetes was 19.9% in patients undergoing coronary angiography based on OGTT, which increased to 28.0% when HbA1c was used as a diagnostic measurement in addition to OGTT. The prevalence of prediabetes was also higher by HbA1c compared to OGTT (128). They concluded that HbA1c was an appropriate alternative to OGTT for screening abnormal glucose regulation and, the application of HbA1c test will significantly improve the implementation of screening for T2DM and prediabetes in these patients. The current findings emphasized that HbA1c is a suitable alternative to FPG as a first-step screening test for T2DM diagnosis in an Asian population with a high prevalence of the disease.

Therefore, there is considerable evidence that implies diagnostic criteria based on FPG measurement is relatively insensitive in the detection of T2DM or prediabetes and HbA1c measurement improves the sensitivity of screening especially in high-risk populations (129). The International Expert Committee in 2009 (125) stated that HbA1c measurement has noticeably superior technical attributes compared with the measurement of FPG, with less biologic variability, less pre-analytic instability, and is also more clinically convenient. HbA1c is a more stable biological index than FPG, especially to measure chronic hyperglycemia compared with plasma glucose concentrations that are known to fluctuate within and between days. Therefore, HbA1c test has been chosen in this study as a diagnostic criterion for screening abnormal glucose regulation in the Philippines. Furthermore, there is some evidence that mean HbA1c levels are different between ethnicities, with Asians having higher levels than Whites (130), and this difference could result in an ethnic-related difference in the estimation of T2DM and prediabetes prevalence. Conclusively, we believe the higher prevalence that has been observed in this study compared to other studies probably is caused by more sensitivity and accuracy of the diagnostic criteria this study used -HbA1c measurement instead of FPG index- in this Asian population.

We applied ADA 2018 guideline to diagnose T2DM and prediabetes due to the vast use of this guideline among clinicians, healthcare providers and guideline developers in the Philippines. The ADA 2018 cut-off for T2DM diagnosis is >6.5%, and for patients at risk for T2DM (pre-diabetes) is 5.7% to 6.4%. HbA1c is not recommended by Unite for Diabetes Philippines guideline (a coalition of organizations caring for Individuals with T2DM including PSEM), because the method must be certified and approved by the National Glycohemoglobin Standardization Program. Due to unavailability or lack of standardization of the test in almost all parts of country healthcare settings, PSEM did not recommend this test and its result cannot be used for diagnosis. In this study, we used a certified HbA1c test and made sure that all measurements had been done under the regulation of the National Glycohemoglobin Standardization Program.

It should be mentioned that during this study, I, a master student, was involved in two phases; first data gathering phase to help with data quality management including monthly reports on the penetration rate, and data cleaning and, second data analysis phase.

5.2 Prevalence of T2DM and prediabetes

This study provided evidence that the prevalence of T2DM and prediabetes is remarkably high in this population. The results demonstrated that the prevalence of T2DM is 18.3% and the prevalence of prediabetes is 26.7% that shows a significantly high prevalence of glucose regulation dysfunction in this region of the country. Comparing to other study results, we found some similarities in the high prevalence of T2DM in the Philippines. One 9-year cohort study (from 1998 to 2007) among Filipinos (102) showed the incidence of T2DM was 16.3% and the prevalence of T2DM was 28.0%. The study used the combination of FPG, 2HPG to diagnose T2DM and prediabetes based on the WHO 1999 criteria (11). Although this study reported a higher prevalence rate, the researchers acknowledged that they could not eliminate the bias of over-estimating the burden of T2DM and prediabetes in their sample. They used a restricted sample population (47%) of the 5th National Nutrition Survey in the Philippines and interviewed only 1445 respondents out of 4541 participants of the main study. The participants -≥18 years old- were residents of 6 regions proportionally those with a denser population (mainly urban area) and representing the three biggest island groups in the country. Researchers believed that the migration of healthy participants or their disagreement to provide consent for reexamination and a high frequency of death (304 subjects) or loss of follow-up in the study population were the reasons for the likely overestimates of morbidity.

The prevalence of T2DM in our participants is higher than that reported in a nationally representative survey of Filipino adults. The 6th Philippines National Nutrition and Health Survey (131) showed diabetes prevalence in 2003 at 4.6% and it has been increased in the 7th Philippines National Nutrition and Health Survey (132) to 7.2% in 2008. These surveys were conducted in rural and urban areas within all 17 regions of the country and only used FPG results to determine the prevalence of T2DM. Philippines National Nutrition Survey 2013-2014 (103) was the 8th national survey and the sample size was 45,047 households (65865 adults) that recruited using a stratified three-stage sampling design. T2DM prevalence based on PSEM guideline was 5.4% and the IFG prevalence was 12.8%. The survey also reported that a higher proportion of adult males (10.9%) had IFG or T2DM than adult females (9.1%) and the adult individuals with high FPG were more common in the urban areas (6.4%) and among the richest wealth index (8.3%) and among those in the 60- to 69-year age group in both genders (12.6%). In addition, the International Diabetes Federation listed comparative prevalence of T2DM in the Philippines to be 7.7% in 2010 and 9.65% in 2012; and estimated the proportion of undiagnosed diabetes at 5.88% (133). These figures are lower than the present study findings. The Philippines National Nutrition surveys assessed adults ≥ 18 years old from all regions of the country. These studies used WHO 1999 guideline for T2DM and prediabetes diagnosis and measured only FPG.

Our study method of measurement (HbA1c test), the diagnostic criteria (ADA 2018), participants age range (≥ 40 years old) and the geographic area (only one region of the country) are different from the Philippines national surveys that we believe these are reasons for this difference in the estimate of prevalence. To explain more about the difference between the diagnostic criteria, based on ADA 2018 practice guideline, the cut-off of 126 mg/dl for diabetes diagnosis and the cut-off for prediabetes is FPG of 100 mg/dL (5.6 mmol/L) to 125 mg/dL (6.9 mmol/L). However, WHO guideline (1999, 2006) recommended cut-off of 126 mg/dl for diabetes and 110 mg/dl to 125 mg/dl for prediabetes. Therefore, WHO guideline users estimate would be certainly lower than our study estimate in prediabetes prevalence because of using higher cut-off.

A community-based study for screening T2DM conducted in several cities in the Philippines in 2010 reported 8.6% prevalence rate of T2DM and 9.1% prevalence rate of prediabetes in the population using stratified random sampling based on population lists available from the local government health services (N = 1752, age ≥ 20 years old) (83). This study used OGTT to screen participants for abnormal glucose regulation. Neither this study nor any of the above-mentioned studies used HbA1c test to detect abnormal glucose regulation. As we mentioned in the previous section, by using the HbA1c test for diagnosis, we provided a more accurate estimate of the prevalence in the region in this study compared to the FPG test in other studies.

5.3 T2DM risk factors in the population

We found the high prevalence of hypertension in the region based on the self-reported questionnaire. Overall, 40.4% of the participants had a history of hypertension (were taking or have taken HTN medication). This figure was about 50.7 % among diabetic patients, 46% in prediabetes individuals and 36.5% in healthy people. HTN tended to be more prevalent in female participants (42%) than male participants (36.5%) significantly and also this finding suggests that the prevalence of HTN is significantly higher in the older age groups. There was no significant difference in the prevalence of HTN in rural and urban areas.

High blood pressure remains to be a growing health concern in the Philippines. Despite some efforts to reduce the prevalence of this disease in the country, HTN is still prevalent. In 2016, a retrospective observational study reported that the prevalence of HTN in the overall prevalence of hypertension among adult patients was 47% in the province of Leyte, Philippines. Approximately 46% of adult females and 49% of adult males were diagnosed with Hypertension (134). PRESYON 3 (2013), a prospective, multi-staged, stratified nationwide survey on hypertension found that the prevalence of hypertension in the Philippines was 28% (135). The 8th National Health and Nutrition Survey in 2013 (103) revealed about 22.3% of the population were hypertensive; this data was lower than the 25.3% in their 2008 prevalence (7th survey) (132). In addition, they found that the prevalence of HTN was higher in males (25.1%) than females (19.9%) generally. Based on their findings HTN prevalence is slightly higher among urban areas compared with rural residents, and Zamboanga with 17.2% had one of the lowest HTN prevalence rates among all regions in the Philippines. Morales and colleagues reported the result of survey that covered the whole Philippines indicating 33.3% high blood pressure prevalence in the Filipino population- 37.5% in men and 28.8% in women (136). In 2014, one study evaluated the prevalence of metabolic syndrome in 3,072 participants from Manila and four nearby areas in the Philippines (137). They reported a significantly higher prevalence rate of HTN in males (46.9%) than in females (34.3%) in > 40 years old age group. Also, another study reported 51% history of HTN in older Filipino adults in 2013 (138). These figures show that the present result regarding the overall prevalence of 40.4% of the presence or the history of hypertension is consistent with the other research studies finding in the population. Several studies reported that HTN was more prevalent in males that was in contrast with this study's findings. The majority of participants in the present study were women (over two-third of the participants), therefore we found that HTN was more prevalent in women with 42% prevalence rate.

This study found an association between having diabetes / prediabetes and high blood pressure. It has been shown in several prospective cohort studies that people with high blood pressure are almost 2.5 times more likely to develop T2DM compared to their non-hypertensive counterparts (139-141). The Women's Health Study, a prospective study of 38,172 women revealed that HTN and hypertension progression are independent predictors of T2DM(140). Another retrospective study reported that T2DM is independently associated with HTN and this relationship has been consistent over a period of 10 years (142). Therefore, this study result is consistent with previous studies that reported this association.

This study results showed 45.6% of the population were overweight (32.1 %) or obese (13.5%). The prevalence of overweight and obesity were significantly higher in females (47.2%) than males (41.8%). Abdominal obesity was about 65% in all participants, 29.2% in males and 79.9% in females. In addition, the result revealed both BMI and WC were significantly higher in the urban area compared with the rural areas.

Comparing this result to other studies, Morales (136) reported abdominal obesity in 27.3% of men ≥ 40 years old and 56.9% of women≥ 40 years old in Filipinos. World Health Organization published the Philippines diabetes profile report in 2016 (143) that indicated 22.3% overweight and 4.7% obesity in the population ≥30 years old with higher prevalence in women than men. The 8th National Health and Nutrition Survey in 2013 (103) revealed 31.1% of adults were overweight or obese in the Philippines. The survey revealed that the proportions of overweight/obese almost doubled from 16.6% to 31.1% in the twenty-year period from 1993 to 2013 in the population of ≥ 20 years old in the country. They also reported that more females had abdominal obesity than males. Abdominal obesity were four and eight times, more common among female adults than their male counterpart in different age groups.

This study result showed an association between having diabetes / prediabetes and high BMI, high waist circumference. This result was consistent with other research studies that demonstrated the risk of T2DM was significantly associated with greater BMI, and greater WC (126, 144, 145). In 2019, one cross-sectional study in China revealed that the predicted probability of T2DM increased as the BMI increased in all age groups (141). A systematic review and meta-analysis of studies in India indicated that obesity showed a significant strong association with hypertension and T2DM in studies conducted in India (146). Another study finding confirmed that the risk of developing BMI-associated T2DM is higher in some ethnics. They indicated that the impact of an increasing BMI on the risk of developing diabetes was greater for Asians compared with other ethnic groups (147).

Our result confirmed an association between having diabetes / prediabetes and family history of diabetes. Many studies reported that family history of diabetes is associated with an increased prevalence of T2DM and this risk factor currently uses in many practice guidelines and risk assessment tools for the screening and diagnosis of T2DM(148, 149) Those with a first or second-degree family member with T2DM are more susceptible to suffer from the disease compared with those without family history of T2DM. The estimated risk for the developing of T2DM increases approximately by 2-4 times when one parent or both have this condition. Both genetic factors and, environmental components have been associated with a higher incidence of T2DM. This pattern reported in the studies from different ethnicities in China, Mideast, America and Europe (148-152).

The present study did not find any significant association between diet or physical activity and the development of abnormal glucose tolerance. Although no statistical significance was found between sedentary lifestyle and T2DM, the association between BMI and waist circumference with HbA1c level showed that more overweight and obese subjects became diabetic as compared to the normal BMI subjects, particularly, in the female gender who presented a higher prevalence of obesity and overweight.

Based on this study figures 19.8 % of the participants did not have at least 30 minutes of physical activity daily. WHO Philippines diabetes country profiles report (143) stated 11.5% of men and 17.3% of women were physically inactive (total 14.4%).The 8th National Health and

Nutrition Survey in Filipinos (103) revealed there were more insufficiently physically active among female adults (52.9%) than male adults (37.0%). Their finding showed about 50% of the population in some areas were insufficiently physically active and adults in the urban areas and the richest wealth index engaged in less physical activity than others. In addition, one study results in Filipino elderly indicated that older adults had mostly sedentary lifestyle despite not having difficulty performing physical activities of their daily living (138).

This study finding indicated that the consumption of alcoholic beverages was noticeably low and more than 90% of the participants are non-drinker or rarely drink which is in contrast with the other similar studies in the Philippines. The National Health and Nutrition Surveys (103, 120) indicated the prevalence of alcoholic drinkers almost doubled from 26.9% in 2008 to 48.2% in 2013. A higher proportion of males (69.8%) are consumers and only 28.7% of females were current drinkers. Since the majority of the present study participants were women (72%), it was not unexpected that the number of drinkers would be lower than the other studies considering the fact that men are the main consumers of alcoholic beverages in this population.

The result showed that more than 80% of the participants are nonsmokers and about 6% are past smokers who quitted. It is in accordance with the National Health and Nutrition Surveys results (103, 132) that indicated the prevalence of smoking among adult Filipinos went down from 31.0% in 2008 to 25.4% in 2013. The decrease was partly from people who stopped smoking and mostly from people who avoided smoking.

This study reported that the risk of developing diabetes was high or very high in 17.6% of the population based on the FINDRISC model. In addition, 20.0% of the participants were in a moderate risk of developing the disease. No study to date has used the FINDRISC assessment tool in the Philippines as a method of screening the risk of T2DM and prediabetes. Two studies evaluated the performance of the tool in the population and found it more reliable than similar risk assessment tools in the population (83, 84).

5.4 Limitations

Several limitations deserve to be mentioned. First, cross-sectional nature of this study determines that all participants in both urban and rural areas are not followed up, thus we don't know the impact of any probable changes in T2DM risk factors including obesity and health behaviors on the T2DM incidence and prevalence and its related complications in the region. The is a need for prospective cohort studies to assess the long-term effect of any change in the outcome of interest on T2DM and prediabetes prevalence. Second, the current study may not necessarily reflect the true prevalence of T2DM and related complications at a national level it was a regional study in only one province of the Philippines. Third, some information of participants was obtained from the questionnaire based on the participant self-report, thus, results might be adversely affected by recall bias or social desirability bias. Fourth, we didn't test FPG to compare the result with HbA1c to remove the false positive or false negative cases, thus the risk of overestimating should not be rejected.

6. Conclusion

The aim of this study was to determine the prevalence of T2DM and prediabetes and to evaluate the T2DM risk factors that affect the population of Zamboanga Peninsula, Philippines. The Philippines is among ten countries that IDF projected to have the highest numbers of diabetic patients by 2030. This study findings have revealed that the prevalence of T2DM and prediabetes is higher than expectations considering previous studies results, in particular, IDF projections for the Philippines diabetes, prediabetes and undiagnosed diabetes prevalence rates. This study revealed the prevalence of T2DM and prediabetes is high in this region compared with findings of the previous studies in the country, reaching over 45% based on ADA 2018 criteria using HbA1c measurement. This result suggested that the application of HbA1c test can improve the reliability of T2DM and prediabetes screening. Our findings emphasized that HbA1c is a suitable alternative to FPG as a first-step screening test for T2DM diagnosis in an Asian population with a high prevalence of the disease. Lack of recommendation of the HbA1c test in the current diagnostic practice guidelines in the Philippines can be a drawback in efforts for the screening and prevention programs of T2DM. This finding showed that there is a need to reevaluate alternative diagnostic methods that are more accurate than FPG for the screening of T2DM and prediabetes in the primary health care system in the country.

The present study finding indicated that obesity and overweight in 45.6% of the population, abdominal obesity in 65% of the population, and presence or history of elevated blood pressure in 40.4% of the population. Therefore, these risk factors were noticeably common in over 40 years old population of the region. The study result revealed obesity and central obesity are associated with abnormal glucose tolerance and the prevalence of overweight, obesity and central obesity were significantly higher in females than males in the population. Our result confirmed numerous previous studies finding toward association of family history of T2DM and hypertension as risk factors for the development of T2DM. Our study has confirmed to the existing and increasing evidence that family history of T2DM particularly within first-degree relatives is a potential risk factor to the development of this disease. This study results also indicated that the association between increased BMI, increased WC and abnormal glucose tolerance. In addition, the result showed that advancing age is a risk factor for the development of T2DM as it was associated with higher prevalence of diabetes and prediabetes in the communities. We did not find any significant association between the gender of participants and abnormal glucose regulation.

In summary, there was an increase in the prevalence of diabetes in 2018 compared to previous studies. Based on the Philippines National Health and Nutrition Survey in 2013 about 5.4% of the population had T2DM and 22.3% of the population were hypertensive that is evidently lower than this study findings. The aging population, obesity and hypertension and higher incidence of T2DM with these factors are expected to drive further increases in the disease burden in the region. It is possible to achieve a significant weight loss by lifestyle interventions in the primary health care setting in individuals at high risk for T2DM. This weight loss is associated with a reduction in the risk of developing T2DM. Thus, further action like implementing prevention programs in primary healthcare are needed for a sustained risk reduction of diabetes in the region. The early detection and diagnosis of prediabetes and T2DM in the Philippines is demanded not only because of its rapidly increasing prevalence but also of the significant burden of the condition and its complications on the country, and the population. This growing epidemic of diabetes is likely to increase demand for resources and health services. T2DM poses a big economic burden on the country’s resources not only in terms of financial resources but also human resources to take care of the growing number of diabetic patients. Future health policymaking will need to address this issue. The earlier the policymakers are aware of the disease burden the better because it provides a groundwork for decision making from allocation of the required resources to design and implement the prevention and management programs.

In conclusion, this finding highlights the need for public health efforts to improve T2DM and prediabetes risk factors and prevalence in this population.

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Appendices

Appendix 1: The CHAP-P questionnaire

Appendix 2: FINDRISC score calculation instruction

Appendix 1: The CHAP-P questionnaire

CHAP-P Survey
Thank you for taking part in the health survey about blood pressure and diabetes. All information will be kept confidential in a locked cabinet and in password protected computer in the research office of the ___________________________________. Only summary information will be used in any reports.

Demographic Information

Please provide us with some information about yourself. This information will help us to know more about people who are completing this survey.

First Name: _______________________ Middle Initial: _____________________
Last Name: ________________________

Date of Birth: _ _ / _ _ / _ _ _ _
DD MM YYYY

1. Are you male or female?
- ☐ Male
- ☐ Female

2. Please check off which of the following ethnic groups your biological (blood) parents belong to: (Best Guess if Unknown)

Mother	Father	
☐	☐	East Asian (Chinese, Vietnamese, Filipino, Korean, etc.)
☐	☐	South Asian (East Indian, Pakistani, Sri Lankan, etc.)
☐	☐	White(Caucasian)
☐	☐	Black (Afro-Caribbean)
☐	☐	Other non-white (Latin American, Arab, West Asian)

3. What is the highest level of education that you have completed?
- ☐ Some high school or less
- ☐ Completed high school
- ☐ Some college or university
- ☐ Completed University or college degree

4. What is your current marital status? Check the one best answer
- ☐ Married
- ☐ Living Common-law
- ☐ Widowed
- ☐ Separated

- Divorced
- Single, never married

Health Status and Quality of Life

5. In general, would you say your health is:
- Excellent
- Very good
- Good
- Fair
- Poor

By placing a tick in one box in each group below, please indicate which statements best describe your own health state today.

6. Mobility
- I have no problems in walking about
- I have some problems in walking about
- I am confined to bed

7. Self-Care
- I have no problems with self-care
- I have some problems with washing or dressing myself
- I am unable to wash or dress myself

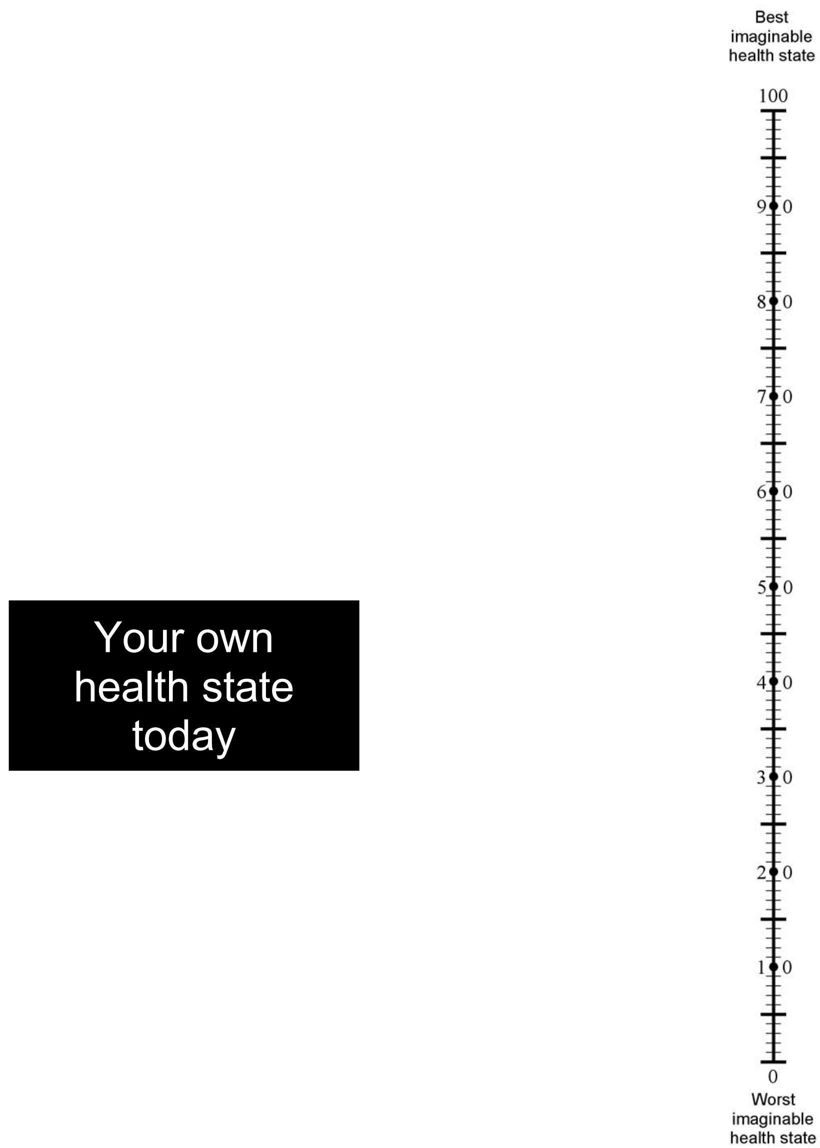
8. Usual Activities (e.g. work, study, housework, family or leisure activities)
- I have no problems with performing my usual activities
- I have some problems with performing my usual activities
- I am unable to perform my usual activities

9. Pain/Discomfort
- I have no pain or discomfort
- I have moderate pain or discomfort
- I have extreme pain or discomfort

10. Anxiety/Depression
- I am not anxious or depressed
- I am moderately anxious or depressed
- I am extremely anxious or depressed

To help people say how good or bad a health state is, we have drawn a scale (rather like a thermometer) on which the best state you can imagine is marked 100 and the worst state you can imagine is marked 0.

11. We would like you to indicate on this scale how good or bad your own health is today, in your opinion. Please do this by drawing a line from the box below to whichever point on the scale indicates how good or bad your health state is today.



Knowledge and Risk Factors

12. Please try to answer the questions below by circling your answer to the statements below

1High blood pressure is a risk factor for heart attacks and strokes	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
2Diabetes is a risk factor for heart attacks and strokes	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
3High blood pressure can cause other serious health problems	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
4Diabetes can cause other serious health problems	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
5High blood pressure becomes more common with aging	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
6Diabetes becomes more common with aging	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
7You can tell if you have high blood pressure (without a blood pressure cuff) because you will probably feel unwell	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
8Lifestyle changes such as stopping smoking and weight loss can decrease blood pressure	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
9The following blood pressure is considered to be high: 140/90	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
In the general population the following things can contribute to people having high blood pressure:					
10 (i) having a stressful lifestyle	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
11 (ii) drinking too much alcohol	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
12 (iii) eating too much salt	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False

13 You are at risk of developing diabetes if you are obese.	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
14 Eating too much sugar and other sweet foods is a cause of diabetes.	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
15 People who have family members with diabetes have an increased risk of developing diabetes.	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
16 Diabetes can be cured.	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
17 High blood pressure can be treated by exercise and weight loss	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
18 To reduce the risk of diabetes you need to eat well and exercise regularly.	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False
19 The recommended blood pressure for most adults is less than 120/80.	Definitely True	Maybe True	Not Sure or Don't know	Maybe False	Definitely False

13. When was the last time you had your blood pressure taken?

☐ Less than 6 months ago
☐ 6 months to less than 1 year ago
☐ 1 year to less than 2 years ago
☐ 2 years to less than 5 years ago
☐ 5 or more years ago
☐ Never

14. Have you ever been told by a doctor or nurse that you have high blood pressure OR have you ever taken high blood pressure pills?

☐ Yes
☐ No or Don't know

15. Have you have your cholesterol levels checked in the past 2 years?

☐ Yes
☐ No

16. Have you have your blood sugar levels checked in the past 2 years?

☐ Yes
☐ No

17. Do you know what your most recent blood pressure reading was?

☐ Yes - What was it? _______/_______ mmHg; Date of measurement ___________
☐ Don't remember
☐ Don't know – wasn't told

18. Have you ever been found to have high blood sugar either from a blood test, during an illness, or during pregnancy?

- ☐ Yes
- ☐ No or Don't know

19. Have you ever given birth to a large baby weight 9 pounds (4.1 kg) or more?(Skip if male)

- ☐ Yes
- ☐ No or Don't know

20. Have any of your blood relatives ever been diagnosed with diabetes? Check all that apply.

- ☐ Mother
- ☐ Father
- ☐ Brothers/Sisters
- ☐ Children
- ☐ No/Don't know
- ☐ Other

21. Do you have any of the following health problems? Check all that apply.

- ☐ Heart Problems
- ☐ High Blood Pressure
- ☐ High Cholesterol
- ☐ Stroke
- ☐ Diabetes
- ☐ None of the above

22. How tall are you and how much do you weigh?

Weight: _______pounds OR__________ kg

Height: ___ft.____in. OR ______ cm

- ☐ Don't Know

23. Using a tape measure, place it around your waist at the level of your belly button. Measure after breathing out (do not hold your breath) and write your results on the line below. Then check the box that contains your measurement.

- ☐ Measured: Waist circumference: ____ inches OR ____centimeters

- ☐ Estimated : Pant size _________________

24. Do you usually do some physical activity such as brisk walking for at least 30 minutes each day? This activity can be done while at work or home.

- ☐ Yes
- ☐ No

26. International Physical Activity Questionnaire (IPAQ)
The questions in the following table will ask you about the time you spent being physically active in the last 7 days. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. Think about all the activities that you did in the last 7 days. Think only about those physical activities that you did for at least 10 minutes at a time. Please check "Not done" if you did not do the physical activity asked. Also write the number of minutes or hours per day you did the physical activity in question.

Physical Activities	Number of Days per week	Number of hours or minutes per day
During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling? (Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal.)	____ #days per week ____ Not done	____ # minutes per day OR ____ # hours per day
During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, or bicycling at a regular pace? (Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Do not include walking.)	____ #days per week ____ Not done	____ # minutes per day OR ____ # hours per day
During the last 7 days, on how many days did you walk for at least 10 minutes at a time? (This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.)	____ #days per week ____ Not done	____ # minutes per day OR ____ # hours per day
During the last 7 days, how much time did you spend sitting (at a desk, while driving, visiting friends, reading, or sitting or lying down to watch television) on a week day?	____ #days per week	____ # minutes per day OR ____ # hours per day

Now, some questions about the foods you eat.

27. How often do you eat vegetables or fruit?
- ☐ Everyday
- ☐ Not every day; If so how often do you eat them in a week?
- ☐ 4-5 times a week
- ☐ 2-3 times a week
- ☐ Once a week

☐ Less than once a week

28. How often do you eat fatty food, e.g. fried food or savoury snacks?
☐ Never
☐ 2-3 times a month
☐ 1-2 times a week
☐ 3-4 times a week
☐ Every day

29. How often do you eat/drink food/drink with high sugar, e.g. cookies, chocolate, candies, softdrink?
☐ Never
☐ 2-3 times a month
☐ 1-2 times a week
☐ 3-4 times a week
☐ Every day

30. How often do you add salt to your food at the table or in cooking?
☐ Never
☐ Rarely
☐ Sometimes
☐ Often
☐ Always

The next questions are about smoking

31. Are you a/an: (Check the one best answer)
☐ Daily smoker
☐ Occasional Smoker
☐ Former smoker who quit – Go to Question 41
☐ Never smoked – Go to Question 43

32. If you are a smoker, do you:
☐ Have no plans to quit
☐ Have thought about quitting
☐ Have a plan to quit smoking
☐ Initiated the plan to quit smoking
☐ Never smoked

33. If you are a current or ex-smoker, how much do you now, or did you previously, smoke on average per day?
|__|__| cigarettes per day |__|__| cigars per day |__|__| pipes per day

34. If you are an ex- smoker, how many years ago did you stop? (If less than one year, please answer with a zero)

|__|__| Years

Now, some questions about your alcohol consumption.

35. How many drinks of alcohol do you drink in an average week? Check the one best answer
- ☐ Non-drinker/rarely/have stopped drinking
- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ More than 15

36. How often in the past 12 months have you had 5 or more drinks on one occasion?
- ☐ Never or Less than once a month
- ☐ Once a month
- ☐ 2 to 3 times a month
- ☐ Once a week
- ☐ More than once a week

Now a few questions about the stress in your life

37. In general, how would you rate your ability to handle unexpected and difficult problems, for example, a family or personal crisis? Would you say your ability is:
- ☐ Excellent
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor

38. In general, how would you rate your ability to handle the day-to-day demands in your life, for example, handling work, family and volunteer responsibilities? Would you say your ability is:
- ☐ Excellent
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor

Health Utilization and Access

39. Overall, how would you rate the availability of health care services in your community?
- ☐ Excellent
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor

40. Where do you go to get information about keeping your heart healthy? Please put a checkmark in the box for up to 3 most useful sources:
- ☐ Family member or friend
- ☐ Media (print ads, television)
- ☐ Educational brochures or pamphlets
- ☐ Traditional healer
- ☐ Public doctor or nurse/midwife
- ☐ Private doctor or nurse/midwife
- ☐ Other, Specify: ___________________________

41. Where do you go to get information about preventing diabetes? Please put a checkmark in the box for up to 3 most useful sources:
- ☐ Family member or friend
- ☐ Media (print ads, television)
- ☐ Educational brochures or pamphlets
- ☐ Traditional healer
- ☐ Public doctor or nurse/midwife
- ☐ Private doctor or nurse/midwife
- ☐ Other, Specify: ___________________________

42. Is there a place that you usually go to when you are sick or need advice about your health?
- ☐ Yes
- ☐ No

43. If yes, what kind of place is it? Check all that apply
- ☐ Midwife/Nurse in the Health Center
- ☐ Rural Health Unit Doctor
- ☐ Local Hospital
- ☐ Private Doctor
- ☐ Traditional healer
- ☐ Other - Specify ______________

Perceived Concern and Understanding of Risk (Encircle the correct response between 1 to 7)

44. How concerned are you about High blood pressure?

1 2 3 4 5 6 7

Not at all concerned Extremely concerned

45. How concerned are you about Diabetes?

1 2 3 4 5 6 7

Not at all concerned Extremely concerned

46. How well do you feel you understand your risk of Hypertension (High blood pressure)?

1 2 3 4 5 6 7
Do not understand Completely Understand

47. How well do you feel you understand your risk of Diabetes?

1 2 3 4 5 6 7
Do not understand Completely Understand

48. How important is it for you to increase your intake of fruit and vegetables in your diet?

1 2 3 4 5 6 7
Not at all important Extremely important

49. How important is it for you to decrease your intake of food with high salt intake?

1 2 3 4 5 6 7
Not at all important Extremely important

50. How important is it for you to increase your physical activity?

1 2 3 4 5 6 7
Not at all important Extremely important

51. Is there anything you intend to do to improve your physical health in the next year?
- ☐ Yes
- ☐ No

52. If yes, what is that?
- ☐ Start / Increase exercise, sports / physical activity
- ☐ Lose weight
- ☐ Change diet / improve eating habits
- ☐ Increase fruit and vegetable intake
- ☐ Quit smoking / reduce amount smoked
- ☐ Drink less alcohol
- ☐ Reduce stress level
- ☐ Receive medical treatment
- ☐ Other, Please specify ____________________________

53. Are you seriously considering increasing your fruit and vegetable intake?

- Yes
- No

54. If you are currently smoke daily or occasionally, are you seriously considering quitting smoking within the next 6 months?

- Yes
- No
- Not applicable

How confident are you, that in the next year, you will be able to:

55. Improve your Physical activity

1 2 3 4 5 6 7
Not at all confident Extremely confident

56. Increase your fruit and vegetable intake

1 2 3 4 5 6 7
Not at all confident Extremely confident

57. Reduce your alcohol intake

1 2 3 4 5 6 7
Not at all confident Extremely confident

58. Quit smoking

1 2 3 4 5 6 7
Not at all confident Extremely confident

59. Reduce stress

1 2 3 4 5 6 7
Not at all confident Extremely confident

Thank you for taking part in the survey!

Appendix 2: FINDRISC score calculation instruction

https://www.diabetes.fi/files/502/eRiskitestilomake.pdf

Finnish Diabetes Association

TYPE 2 DIABETES RISK ASSESSMENT FORM

Circle the right alternative and add up your points.

1. Age

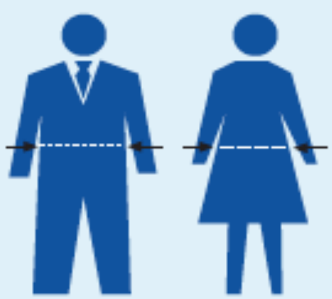
0 p. Under 45 years
2 p. 45–54 years
3 p. 55–64 years
4 p. Over 64 years

2. Body-mass index
(See reverse of form)

0 p. Lower than 25 kg/m²
1 p. 25–30 kg/m²
3 p. Higher than 30 kg/m²

3. Waist circumference measured below the ribs (usually at the level of the navel)

	MEN	WOMEN
0 p.	Less than 94 cm	Less than 80 cm
3 p.	94–102 cm	80–88 cm
4 p.	More than 102 cm	More than 88 cm



4. Do you usually have daily at least 30 minutes of physical activity at work and/or during leisure time (including normal daily activity)?

0 p. Yes
2 p. No

5. How often do you eat vegetables, fruit or berries?

0 p. Every day
1 p. Not every day

6. Have you ever taken medication for high blood pressure on regular basis?

0 p. No
2 p. Yes

7. Have you ever been found to have high blood glucose (eg in a health examination, during an illness, during pregnancy)?

0 p. No
5 p. Yes

8. Have any of the members of your immediate family or other relatives been diagnosed with diabetes (type 1 or type 2)?

0 p. No
3 p. Yes: grandparent, aunt, uncle or first cousin (but no own parent, brother, sister or child)
5 p. Yes: parent, brother, sister or own child

Total Risk Score

☐ The risk of developing type 2 diabetes within 10 years is

Lower than 7	Low: estimated 1 in 100 will develop disease
7–11	Slightly elevated: estimated 1 in 25 will develop disease
12–14	Moderate: estimated 1 in 6 will develop disease
15–20	High: estimated 1 in 3 will develop disease
Higher than 20	Very high: estimated 1 in 2 will develop disease

Please turn over

Test designed by Professor Jaakko Tuomilehto, Department of Public Health, University of Helsinki, and Jaana Lindström, MFS, National Public Health Institute.

Finnish Diabetes Association

WHAT CAN YOU DO TO LOWER YOUR RISK OF DEVELOPING TYPE 2 DIABETES?

You can't do anything about your age or your genetic predisposition. On the other hand, the rest of the factors predisposing to diabetes, such as overweightness, abdominal obesity, sedentary lifestyle, eating habits and smoking, are up to you. Your lifestyle choices can completely prevent type 2 diabetes or at least delay its onset until a much greater age.

If there is diabetes in your family, you should be careful not to put on weight over the years. Growth of the waistline, in particular, increases the risk of diabetes, whereas regular moderate physical activity will lower the risk. You should also pay attention to your diet: take care to eat plenty of fibre-rich cereal products and vegetables every day. Omit excess hard fats from your diet and favour soft vegetable fats.

Early stages of type 2 diabetes seldom cause any symptoms. If you scored 12–14 points in the Risk Test, you would be well advised to seriously consider your physical activity and eating habits and pay attention to your weight, to prevent yourself from developing diabetes. Please contact a public-health nurse or your own doctor for further guidance and tests.

If you scored 15 points or more in the Risk Test, you should have your blood glucose measured (both fasting value and value after a dose of glucose or a meal) to determine if you have diabetes without symptoms.

BODY-MASS INDEX

The body-mass index is used to assess whether a person is normal weight or not. The index is calculated by dividing body weight (kg) by the square of body height (m). For example, if your height is 165 cm and your weight 70 kg, your body-mass index will be 70/(1.65 x 1.65), or 25.7.

If your body-mass index is 25–30, you will benefit from losing weight; at least you should take care that your weight doesn't increase beyond this. If your body-mass index is higher than 30, the adverse health effects of obesity will start to show, and it will be essential to lose weight.

BODY-MASS INDEX CHART