A GIS-Based Analysis of the Incidence and Prevalence of Type 2 Diabetes in Saudi Arabia.

By

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ABSTRACT

This research investigates type 2 diabetes (T2D) and its risk factors, analyzes its prevalence and progression, and identifies which risk factors affect different regions of Saudi Arabia by utilizing the 2013 Saudi Health Interview Survey.

Our findings showed a high prevalence of T2D in Saudi Arabia (11.5%), with the highest in Hail and Aseer at 16.9% and 15.3%, respectively. On the other hand, Eastern had the lowest at 7.9%.

Overall, we found that age and BMI were the most effective predictors. Age was the most effective, impacting all thirteen regions. The group aged 65 years and older had the highest risk; the 45- to 64-year-old age group, however, had the highest number of diagnoses. Al-Madinah had the highest prevalence of T2D in this age group at 56.9%. The 15- to 44-year-old group had the highest risk in Aseer at 4.8%. In Northern Borders, the odds ratio was the highest for the 65 plus age group, at 59.15. BMI was an effective predictor of T2D in nine regions. In Eastern, the odds ratio for the obese group was 4.3 compared to people of normal weight. In Al-Jouf, obese women had the highest percentage of T2D at 44.44% of cases.

Work status was an important risk factor in Tabuk, Eastern, Al-Jouf, and Aseer. The retired group had the highest prevalence in these regions, except for Aseer where the employed group had the highest risk; retired people in Aseer are still involved in farm work, which may contribute to fewer T2D cases. Smoking status was an effective predictor in Hail, Al-Qassim, Riyadh, and Makkah. Ex-smokers had the highest incidence of T2D. Marital status was an effective predictor for Hail, Al-Qassim, and Riyadh. The divorced group had the highest prevalence of T2D. Education was an effective predictor for Riyadh and Aseer; the illiterate group had

the highest risk. Diet was a good predictor only in Aseer. Shisha and hookah use were effective predictors in Riyadh.

Understanding this data can help lower the prevalence of diabetes, provide better diabetes care, and lower healthcare costs for the Ministry of Health.

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CHAPTER 1: INTRODUCTION

Diabetes is increasing widely in the world. According to the World Health Organization (WHO), diabetes will be the seventh reason for death in the world by the year 2030 [1]. Diabetes type 2 is a condition in which the distal tissues become resistant to insulin. Too much glucose can lead to serious health problems. Diabetes and its complications are a major cause of health care costs and morbidity and mortality in the world. In 2012, the estimated cost of diagnosed diabetes was $245 billion in the U.S.; the CDC further estimated that, "After adjusting for age group and sex, average medical expenditures among people with diagnosed diabetes were about 2.3 times higher than expenditures for people without diabetes" [2]. According to the International Diabetes Federation (IDF), ***Saudi Arabia*** is the first country in the gulf countries for diabetes comparative prevalence in 2014. In addition, Saudi Arabia stands fourth in the Middle East and North Africa for the number of people with diabetes in 2014.

1.1 Statement of the Problem

Diabetes is the second leading cause of the death in the Kingdom of Saudi Arabia [3]. To improve and prevent diabetes in Saudi Arabia we must understand diabetes care. Numerous small studies have provided information on diabetes control and treatment profile; however, none had data as extensive as that in this national survey.

There are 13 regions in Saudi Arabia, all of which are covered by the Ministry of Health. Each region faces different diabetes risk factors, and, to provide better care and lower healthcare costs, the Ministry's resources must be well-managed due

to high costs related to diabetes and its complications. In a study on the economic effects of diabetes in Saudi Arabia, Alhowaish stated that, “People diagnosed with diabetes, on average, have medical healthcare expenditures that are ten times higher ($3,686 vs. $380) than what expenditures would be in the absence of diabetes” [4]. As of 2015, a study on the cost of diabetes in the Kingdom of Saudi Arabia assessed the current spending to be about 17 billion Riyals. When accounting for the undiagnosed, this projection rises to 27 billion Riyals. Future predictions suggest that, if all Saudi citizens with glucose intolerance progress to diabetes, that number could increase to 42 billion Riyals [5].

1.2 Goal and Objective

The goal of this study is to investigate and understand the relationship between type 2 diabetes and its risk factors, specifically within the regions of Saudi Arabia. Our objective is to analyze diabetes prevalence and its progression using the Ministry of Health’s national survey. This knowledge can then be used to lower the prevalence of the disease and provide better diabetes care.

1.3 Background:

Located in southwestern Asia, the Kingdom of Saudi Arabia (KSA) shares borders with bodies of water, the Arabian Gulf and the Red Sea, and with countries such as Kuwait, Jordan, United Arab Emirates, and Yemen, among others. Saudi Arabia is divided into 13 regions, also called emirates. These regions are Al Riyadh, Makkah Al Moukarrama, Madinah, Qassim, Eastern Region, Aseer, Tabuk, Hail, Northern Borders, Jizan, Najran, Al-Baha, and Al-Jouf.

Riyadh and Qassim are in the center of Saudi Arabia. Makkah Al Moukarrama, and Madinah are located in western Saudi Arabia. Eastern is in the east, Aseer is in the southeast, Tabuk is in the northwest, Hail and Al-Jouf are in the north, and the Northern Borders are in the northeast. Jizan, Najran, and Al-Baha are located in southwestern Saudi Arabia.

The KSA has made extensive efforts in enhancing wellbeing in recent decades. The Kingdom has seen a large change in its sickness profile, transitioning from transmittable, maternal, and perinatal causes and towards non-transferable ailments. The main sources of death for females in the KSA in 2010 were ischemic coronary illness (IHD) and then cerebrovascular infection, at 18% and 17% of deaths. Similarly, IHD was the main source of death for men after traffic deaths and cerebrovascular infections. Diabetes mellitus positioned 6th, accounting for 3.7% of deaths in men; in females, it positioned seventh, at 3.8% of deaths in 2010. Raised blood pressure, raised fasting plasma glucose (FPG), and raised body-mass file (BMI) were risk factors for death among men of any age positioned second, third, and fourth in 2010; in females, these hazards positioned first, fourth and third. Dietary hazard components ascribed to 25% and 24% of deaths among men and females separately, while in both males and females, physical movement was positioned as the 6th hazard figure for death in 2010.

The Ministry of Health of the KSA improved its wellbeing network by starting a 5-year cooperation with the Institute for Health Metrics and Evaluation (IHME) in 2012 to actualize a wellbeing information network in the Kingdom. The initial step of this coordinated effort is to actualize a populace-based observational framework that incorporates different information sources to track the hazard components for chronic illness locally. This framework will have important data ranging from

financial situations and wellbeing risks to illness frequency and the subsequent course of hospitalizations, outpatient visits, and utilization of and adherence to mediation. It will empower the Kingdom to acquire data with respect to wellbeing results, wellbeing hazard components, wellbeing administration, and financial determinants. Moreover, it will permit them to assess and act upon inconsistencies in wellbeing in the Kingdom of Saudi Arabia. Saudis face the highest risk of diabetes, at 32.8%, and this number is predicted to rise further. [6].

1.4 Symptoms and Causes

Type 2 diabetes has a variety of symptoms, and many of them develop slowly over long periods of time[7]. Some of these symptoms can include:

1- increased thirst

2- urination, resulting from sugar buildups in the bloodstream, and

3- increased hunger, due to insufficient insulin to move sugar into cells for energy, which can also lead to fatigue.

4- weight loss, because the body cannot properly utilize the sugar consumed.

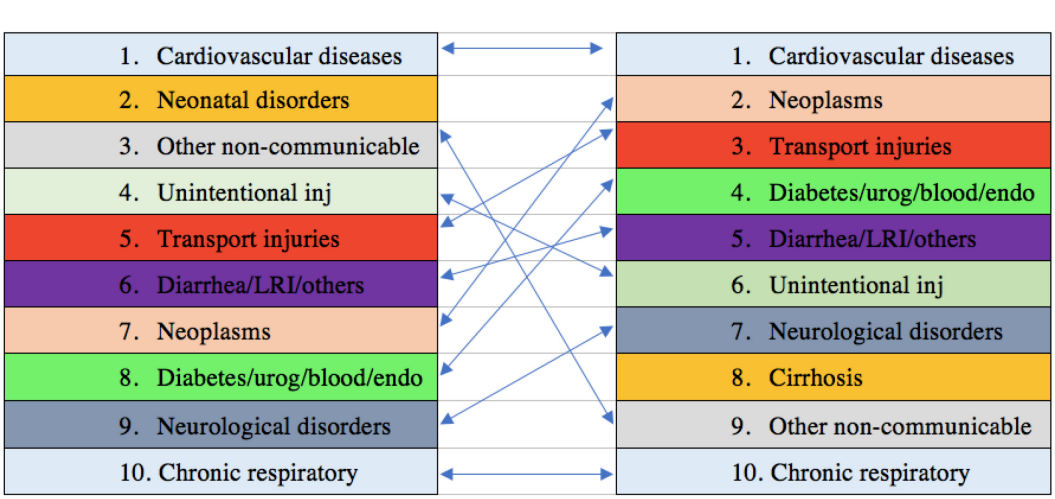
5- Blurry eyesight

6- Frequent infections

7- Slow healing

8- Dark skin (also known as acanthosis nigricans).

Table 1: Saudi Arabia: Both sexes, All ages, Death per 100,000



SAUDI ARABIA:

For both sexes and all ages, diabetes was ranked No. 8 in 1990 and No. 6 in 2016.

For males 15—49 years old, diabetes was ranked No. 7 1990 and No. 6 in 2016 [6].

For males 50—69 years old, diabetes was ranked No. 5 in 1990 and No. 4 in 2016.

For males 70+ years old, diabetes was ranked No. 3 in 1990 and No. 3 in 2016.

For females 15—49 years old, diabetes was ranked No. 7 in 1990 and No. 5 in 2016.

For females 50—69 years old, diabetes was ranked No. 3 in both 1990 and 2016.

For females 70+ years old, diabetes was ranked No. 2 in both 1990 and 2016.

UNITED STATES:

For both sexes and all ages, diabetes was ranked No. 4 in 1990 and 2016 in the U.S [8].

For males aged 15-49, diabetes was ranked No. 9 in 1990 and No. 6 in 2016.

For males aged 50-69, diabetes was ranked No. 4 in 1990 and No. 3 in 2016.

For males aged 70+, diabetes was ranked No. 5 in 1990 and 2016.

For females aged 15-49, diabetes was ranked No. 5 in 1990 and No. 6 in 2016.

For females aged 50-69, diabetes was ranked No. 3 in 1990 and 2016.

For females aged 70+, diabetes was ranked No. 4 in 1990 and 2016.

WORLD:

For both sexes and all ages, diabetes was ranked No. 8 in 1990 and No. 5 in 2016.

For males aged 15-49, diabetes was ranked No. 9 in 1990 and 2016.

For males aged 50-69, diabetes was ranked No. 6 in 1990 and No. 4 in 2016.

For males aged 70+, diabetes was ranked No. 6 in 1990 and 2016.

For females aged 15-49, diabetes was ranked No. 9 in 1990 and No. 7 in 2016 [9].

For females aged 50-69, diabetes was ranked No. 5 in 1990 and No. 3 in 2016.

For females aged 70+, diabetes was ranked No. 6 in 1990 and 2016.

1.5 Significance of the Study

Defining the relationship between type 2 diabetes and its risk factors is important because of the high death rates and high costs associated with this disease. The first step in understanding this relationship is identifying which risk factors affect each of the 13 regions of Saudi Arabia. Once these risk factors have been identified, the KSA will have more effective healthcare that will can lower the prevalence of diabetes as well as diabetes-related spending.

1.6 Research Questions and Associated Hypotheses:

Research Question 1 (RQ1). Is there a relationship between diabetes and demographics (region, age, sex, education, marital status) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia?

Null Hypothesis 1 (H0). There is no statistically significant relationship between the prevalence of diabetes and demographic (region, age, sex, education, marital status) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Alternative Hypothesis 1 (HA). There is a statistically significant relationship between the prevalence of diabetes and demographic (region, age, sex, education, marital status) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Research Question 2 (RQ2). Is there a relationship between diabetes and behavior (smoking) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia?

Null Hypothesis 2 (H0). There is no statistically significant relationship between the prevalence of diabetes and behavior (smoking) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi

Arabia.

Alternative Hypothesis 2 (HA). There is a statistically significant relationship between the prevalence of diabetes and lifestyle (smoking) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Research Question 3 (RQ3). Is there a relationship between diabetes and lifestyle (diet, BMI) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia?

Null Hypothesis 3 (H0). There is no statistically significant relationship between the prevalence of diabetes and lifestyle (diet, BMI) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Alternative Hypothesis 3 (HA). There is a statistically significant relationship between the prevalence of diabetes and lifestyle (diet, BMI) among thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

CHAPTER 2: LITERATURE REVIEW

2.1 General Overview of Previous Literature

The three major types of diabetes are gestational, type 1, and type 2. Gestational diabetes is temporary and occurs during pregnancy. It is associated with a long-term risk of type 2 diabetes. GDM occurs at a high rate in Saudi women. In a study of 954 pregnant women, 211 of them showed abnormal glucose. Several factors contributed to this, such as the age of the woman, her BMI, her blood pressure, and the history of GDM in her or her family, among others. If the mother suffered from GDM, this led to a higher risk of neonatal hypoglycemia, a low Apgar score, and induction of labor. Newborns whose mothers suffered from GDM often had a higher birth weight than their non-GDM counterparts [10].

Type 1 diabetics, however, need a daily administration of insulin for survival, and its causes are unknown. In this type of diabetes, patient's pancreas produces little or no insulin. This is a chronic condition once known as juvenile diabetes. Most people living with diabetes have type 2. It is associated with excess body weight and a lack of physical activity, and, in recent years, has been occurring more often in children, though it was once only seen in adults. With type 2, a patient's body either doesn't make enough insulin or becomes resistant to it. K.M. Venkat Narayan refers to these as type 2B and 2A, respectively [11].

Over the past thirty years, the number of type 2 diabetics has increased drastically all over the world, regardless of income level. In 1980, 108 million people lived with diabetes; by 2014, that number had increased to 422 million. There are many causes and risk factors for diabetes. Obesity, high fat in the blood, high blood pressure, and a lack of physical activity, for example, all contribute to a

patient's likelihood of developing diabetes. Exposure to viral diseases can also affect the development of the disease. A patient's genetic factors also impact diabetes: if a parent or sibling has type 1 diabetes, a patient is more likely to develop it themselves.

Many complications can develop from diabetes. The risk for cardiovascular diseases, such as coronary artery disease, angina, heart attack, stroke, and atherosclerosis, are drastically increased by diabetes. High blood sugar can damage capillaries and cause tingling, numbness, or pain associated with neuropathy and retinopathy. Nerve damage in lower limbs can prevent a patient from feeling pain; this can lead to ulcers, particularly on the feet. Excess sugar can also lead to kidney problems, gingivitis, and osteoporosis. In 2012, diabetes caused 1.5 million deaths, and high blood glucose caused an additional 2.2 million through complications such as heart attacks, blindness, kidney failure, and even lower limb amputation, among others. The risk of a lower limb amputation, for example, is 10 to 20 times higher for diabetic patients than their nondiabetic counterparts.

Approximately 43% of diabetes-related deaths occur before the age of 70 and can be prevented by a healthier lifestyle and/or better management of the disease. This includes regular screening for diabetes and its complications, patient education, the promotion of regular exercise and proper diet, and a small group of generic medicines [12]. Medical examinations are required and of the utmost importance for diabetics. Blood pressure and weight should be checked at each visit. Their feet should be checked every six months, and their accumulative sugar every six to 12 months. Cholesterol, triglycerides, and eyes should be examined yearly [13]. Access to affordable treatment and medication is important for the

survival of all diabetics, and a global goal aims to stop the increase in both diabetes and obesity by 2025.

The International Diabetes Federation estimates that over 400 million adults live with diabetes; that estimate is expected to surpass 592 million in the year 2035, with 5 million deaths yearly. In Saudi Arabia, there are 1,851,080.00 diabetics over the age of 15. The Saudi Health Information Survey Handbook 2013 expects that number to increase to 4,300,000.00 by 2030 [14].

2.2 Risk Factors

Various risk factors affect the prevalence of diabetes. To reduce the risk of mortality, it is important to reduce the pervasiveness of the disease [15].

In a ten-week study of 392 patients at Specialist Hospital in Jordan, 247 had a history of diabetes or were diagnosed during their hospital visit; many of these patients were elderly. Increased diabetes screening will decrease the risk of diabetes-based complications [16].

To lower the prevalence of diabetes in Jordan, the self-administered ARABRISK screening tool has identified that age, BMI, and high blood glucose were the best predictors. Knowing these risk factors will help Jordanians reduce their risk of developing diabetes [17].

Changes in lifestyle can also prevent the risk of type 2 diabetes [18].

2.2.1 Sex

Men and women require different types of diabetes care and education. Physicians should stress self-care education and benefits to their male patients. Since women tend to already possess more background knowledge, their physicians should focus on weight management and primary prevention; screenings for

depressive symptoms in women already diagnosed would also benefit them [19].Many risk factors impact women more than men. Overall, women with diabetes face increased risks in the development and prognosis of diabetic complications, such as a higher risk of developing coronary artery disease (CAD), cardiovascular diseases, hypertension, and dyslipidemia, among others [20]. Another study found several differences in how diabetic men and women experience issues such as glucose regulation, heart disease, morbidity and mortality, among others. They also found that improvements in total and cardiovascular mortality in the past 30 years have not helped diabetic women, and more gender-specific care is needed [21]. An analysis of more than 698,782 people from 102 studies found that diabetes accounted for approximately 11% of vascular deaths and that hazard ratios for coronary heart disease were higher and more fatal for women than men. [22]. Unfortunately, diabetic women often obtain less treatment for risk factors of CHD than their male counterparts [23].

In June 2009, a study showed that diabetes was higher among females than males. Obesity is linked as one of the strongest risk factors for diabetic females. Women younger than 50 years are at a higher risk than their male counterparts for developing diabetes, at 34.1% compared to 25.1% [24]. A study examining the link between increased triglycerides (TG) and decreased high-density lipoprotein cholesterol (HDL-C) found that both are risk factors for T2DM, particularly in women and lean participants [25]. In another study assessing risk factor control in both male and female patients, researchers found that male patients generally had better blood pressure and glycemic control than female patients in the same age groups [26].

Though many risk factors affect women more than men, some do affect men more prominently. A study of T2DM in King Abdulaziz Housing City (ISKAN) in Saudi Arabia found that 59.3% of patients had uncontrolled diabetes, which affected men more commonly than women, hence the previously mentioned need for gender-based care and education. Despite this, the study found that the overall prevalence of T2DM was lower than previously reported figures [27]. In the Saudi Arabia, diabetes diagnoses have increased from 10.6% to 32.1% over the course of 17 years, between 1989 and 2006. The prevalence of DM has risen more among men than women [28].

2.2.2 Age

In a population survey of Jeddah, the strongest predictor of DM and prediabetes was age: almost half of residents aged 50 or over had DM, followed by another 10-15% with prediabetes. This survey did not employ any clinical testing, so, with the use of one, it is possible that these numbers could be even higher [29]. This is true for other populations as well. A study of more than 150,000 Japanese adults predicts an increase in diabetes diagnoses only because of Japan's aging population. When calculated using a fixed population, diabetes diagnoses do not change [30].

Overall, a study on fasting plasma glucose and diabetes found, after collecting and analyzing data from 199 countries and territories over many years, that the prevalence of glycaemia and diabetes are rising. This is due to population growth, ageing, and the increase of age-specific prevalence [31].

A study on three different Palestinian populations found that age was an important risk factor in predicting diabetes: the risk was 36 to 434 times greater for the forty

to sixty-five age group than for the 19 and under group [32]. Furthermore, they also found that refugee status and marital status affected diabetes risk.

2.2.3 Education

To help most effectively, a patient's literacy level and understanding of self-care skill must be considered [33]. In Chinese population aged between 25-64 years, diabetes risk factors are increasing with lower levels of education, family history of diabetes, elderly people, higher income and higher mean BMI. Lifestyle, lack of physical activity and fast food also affect diabetic patients [34].

A study on oral mucosal lesions found that while various tobacco habits increased the likelihood of lesions, men with lower education, a tobacco habit, and diabetes faced the highest risk for potentially malignant lesions [35].

Education can affect a patient's ability to understand their medication as well. While most Saudi patients reported taking their diabetes medication, one self-reported study found that 60% of patients were not taking their medication the correct number of times and 50% were not taking them at the correct time of day [36].

A study of 288 participants from eastern Saudi Arabia found a correlation between participants' levels of education and their understanding of prevention and risk factors associated with DM. Less than half of the participants could correctly name risk factors or possible prevention strategies; those that did identified obesity and weight loss, respectively. Based on this information, additional health education efforts are needed to raise awareness and understanding, especially considering that other studies—conducted in Pakistan, America, Canada, and Europe—also found a correlation between knowledge of DM and level of education [37].

Other studies, such as one in Oman, reported a negative correlation between age and knowledge of DM risk factors and prevention; older participants were less likely to understand DM risk factors and prevention than younger participants. Because of this, the most effective health education programs would address both the undereducated and older segments of the populace [38].

2.2.4 Marital Status

After accounting for factors such as age and family history, one study found that unmarried men faced a higher risk for T2D, at 16%. Widowhood was also associated with an increased risk [39]. A study of more than 38,000 American men found a correlation between marital status changes and poor nutritional behaviors. Remarried men were more likely to consume vegetables and experience an increase in BMI while widowed or divorced men were less likely to do so, and therefore more likely to experience a drop-in BMI. Widowed men were also more likely to drink alcohol [40].

In a study of more than 9000 American adults, participants were interviewed twice, with a gap of ten years between meetings; the study found a correlation between a change in marital status and body weight. Women married at both interviews were less likely to experience weight changes than women unmarried at the first interview but married by the second. Men who were divorced/separated for both interviews and men who became widowed by the second interview were most likely to have lost weight than men married for both interviews [41].
Since some research has found that marriage is a protective factor against cardiovascular diseases, which are often complications of diabetes, it is probable that being married would offer protection against hypertension and diabetes as well

[32]. This study also found that those who were married or engaged were three times as likely to have diabetes than those who were single; those who were divorced, separated, or widowed were almost four times as likely.

2.2.5 Work Status

Work status can affect the development of diabetes in a variety of ways. A study of 402 participants split into a control and T2DM group found that the T2DM members cited higher levels of work-related stress. Other risk factors included alcohol consumption, family history, triglycerides, and obesity. To lower the occurrence of T2DM in the working population, the study recommends employers decrease work-related stress when possible or assist their employees in managing their stress [42]. An assessment of more than 5,500 men and women found that both under- and over-worked employees faced a higher risk of diabetes. They also found that work social support had an inverse relationship with the prevalence of diabetes cases [43]. Another study on the correlation between diabetes and occupation found that employees working more than 40 hours each week had a higher risk for diabetes. Those working 20 hours or less faced a decreased risk for developing diabetes [44].

Even the method used to arrive at work can impact diabetes development. A study of 14,000 Finnish men and women found that middle-aged people with high or moderate physical activity–whether done at work, as transportation, or in their free time–faced significantly lower risk for developing T2DM [45].
Gender-specific work status risks also affect the population. A study on the relationship between sex and T2DM found that the correlation between night work and diabetes is more prevalent for women [46]. Another study on the effect of

employment changes on newly diagnosed T2DM patients found that chronic unemployment and losing a job both correlate to a higher mortality risk, though the association is stronger with unemployment. Men in the middle class are most strongly affected by a change in job status [47]. A study of five urban areas in Germany and more than 8,000 people found a correlation between sex and the prevalence of T2DM. Employment status affected women's risk; social class impacted the risk level of both men and women, but women more; and neighborhood employment affected men more prominently [48]. A study focusing on the relationship between obesity and occupational status on the Fasting Blood Glucose levels of middle-aged women found BMI to be a good indicator of a high T2DM risk level. They found no significant relationship between occupational status and diabetes [49].

Shift work, which includes night work and rotating shifts, was independently associated with poor sleep, diabetes, and hypertension. The risk for diabetes is particularly high for people who worked shifts for 20+ years [50]. Those who worked shifts had a higher instance of self-reported diabetes, even when adjusting for sex and BMI. Shift work had a significant impact on BMI but not on sex [51].

2.2.6 Income

A study of five districts in NanJing, China found a positive correlation between the occurrence of diabetes and FAI, a measure of social class: The higher a participant's socio-economic status, the more likely he or she is to develop diabetes. Members of the middle and high FAI groups face double the risk level of the lower group [52].

2.2.7 BMI

Between 1997 and 2010, the average person increased their intake of soft drinks by 1.9 gallons per year. This increase led to a higher risk of overweight and obesity, particularly in low- and middle-countries countries, and has also led to an increase risked for diabetes [53]. A separate study assessing T2DM risk factors for native Asian Indians found that BMI and obesity are the most relevant factors in assessing their likelihood for developing diabetes [54].

A study of almost 4000 adults between 2012 and 2015 in eastern Democratic Republic of the Congo found an association between those with an above-normal waist circumference and the prevalence of diabetes mellitus (DM), though they did not find a correlation between DM and BMI. Of the participants in the DM group, 26.9% were abdominally obese while the percentage of general obesity was only 9.8%. During the three-year period of the study, abdominal obesity increased by 23% while general obesity increased by only 7.8%. This study found associations between DM and age, waist circumference, and blood pressure [55].

A study on obesity in China found that diets with a high glycemic index lead to metabolic problems, such as appetite regulation, which can then lead to obesity and a higher risk for cancers, cardiovascular complications, and type 2 diabetes. In people suffering from obesity, a high glycemic load was strongly associated with type 2 diabetes in the Chinese population, a problem compounded by the inclusion of Western foods and sugary beverages. High glycemic diets and obesity are a serious health risk for the Chinese population [56].

A study comprised of 402 citizens in Turaif, Saudi Arabia found that 4.5% of participants were diabetic and another 7.5% were pre-diabetic, suggesting a need for further diabetes education in Turaif. Their research also found a correlation

between diabetes or pre-diabetes diagnoses and the patient's sex, age, and BMI [57]. Interviews with 702 citizens of Arar, Saudi Arabia, revealed that diabetes mellitus knowledge existed but was incomplete: though many participants were aware of risk factors (such as a lack of exercise or an unhealthy diet), less than 25% knew about complications such as retinopathy and declining vision. Furthermore, less than 25% named frequent thirst and urination as symptoms of DM. The results of this survey suggest that further prevention and knowledge campaigns would benefit the citizens of Arar [58].

A dental clinic at King Saud University in Riyadh screened 283 patients for hypertension and diabetes mellitus through a medical history interview and BMI, glucose, and blood pressure measurements. The researchers found that nearly half of the participants were at risk for hypertension and more than 10% had a high diabetes risk. These results suggest that DM screenings benefit all patients, even those with no family history of either of these diseases [59]. A study of 85 Saudi Arabians found a relationship between T2D patients who were obese and the risk of cardiovascular disease; these participants had increased adipocytokines, plasma insulin, and inflammatory markers (such as TNF-α, IL-6 and hsCRP, for example) [60].

A survey of 10,735 Saudi Arabians found a strong correlation between diabetes, hypercholesterolemia, and hypertension, though different risk factors predisposed men and women to these conditions. In total, 28.7% of participants were considered obese, with a higher incidence rate for women; obesity in women was connected to marital status, level of education, hypertension, and predisposition to chronic diseases. For men, marital status and hypertension were also risk factors, but so were poor dietary choices, a lack of physical activity, and diagnoses of other

chronic conditions such as diabetes or hypercholesterolemia [61]. A study of US adults found that diabetes diagnoses increase alongside BMI. 25% of adults with diabetes do not control their diet well; 50% of adults with diabetes are obese [62].

A study of European populations found that women are diagnosed with T2D at a higher BMI than men in the same age group, which explains why T2D is more common among middle-aged men than women [63]. A study of Asian countries found a correlation between a higher BMI and an increased prevalence of diabetes. These results were strongest in participants under 50 years of age, in smokers, in those with lower levels of education, and particularly in the groups from India and Bangladesh [64]. The consumption of soft drinks increased by almost 2 full gallons per person per year between 1997 and 2010. This change is correlated with weight increases, which are linked to diabetes [65].

2.2.8 Diet

Carbohydrates are an energy source in food, and the balance between these carbohydrates and the insulin in a diabetic patient's body determines how much their blood glucose will rise after a meal. Foods like fruit, milk, and yogurt, for example, are mostly carbs and affect blood glucose more than foods such as meat, vegetables, and fats. A balanced meal plan will include meat-based proteins, vegetables like broccoli, and small amounts of healthy fats, such as nuts [66]. A study examining self-reported diet and exercise habits of patients with type 2 diabetes found that 82% of participants were overweight or obese, 69% did not exercise as often as recommended, and 62% did not eat enough fruits or vegetables, therefore exposing them to higher risk [67]. A meta-analysis of ten large studies with more than 190,000 subjects found that a healthy diet correlates to a reduced

risk of type 2 diabetes. Consumption of fruit, vegetables, whole grains, fish, and poultry slowed the progression of the disease, as did lowering the consumption of red meat, refined food, starches, and sugary drinks [68].

A study on the impact of antidiabetic fruits, vegetables, beverages, oils, and spices found that the consumption of some fruits and vegetables reduced the incidence of type 2 diabetes. These hypoglycemic effects may correlate to the presence of flavonoids, alkaloids, and anthocyanins, which act similarly to insulin, or to their ability to induce insulin secretion from pancreatic β-cells [69]. A study examining the glycemic index (GI) found that a low-GI diet helped and/or delayed complications arising from diabetes. However, there is some controversy surrounding the GI [70].

A meta-analysis of 16 cohorts found that a high consumption of whole grains correlates inversely with the risk for type 2 diabetes. Refined grains are associated with a higher risk. Because of this, the study suggests that refined grains should be replaced with two servings of whole grains daily to lower the risk for diabetes [70]. Sugary beverages should be avoided as well. A study examining the link between the onset of type 2 diabetes and sugar- and artificially-sweetened beverages discovered that neither type of beverage is likely to help prevent diabetes [71]; therefore, these drinks should be avoided as well.

Red meat can also pose a diabetes risk. In US adults, an increase in cardiometabolic deaths from heart disease, strokes, and type 2 diabetes correlates with a high intake of unprocessed red meat (+14.4% [95% UI, 9.1%-19.5%]). To reverse this, it is important to address patients' dietary habits [72]. Red meat does not affect diabetes risk alone, though; it can also impact the development of other diseases, such as a cancer. A study on the link between processed red meat and

colorectal cancer risk found that high consumption of processed meat led to a higher risk for this type of cancer, likely due to chemicals naturally in the meat or those added during processing and cooking.

There is limited evidence connecting unprocessed red meat with risk for disease [73]. A study on the risk factors of red meat, such as beef and veal, found that increased consumption of both red meat and processed meat, such as ham, bacon, and sausages, led to a higher risk for cardiovascular diseases and various types of cancer including prostate, breast, colorectal, and pancreatic [74]. A study of more than 300 pooled/meta-analyses and systemic reviews revealed that plant-based food consumption better protects against diet-related chronic disease than animal-based foods. Red and processed meats increased the risk for these diseases, and grains proved better than fruits and vegetables. Tea provided the most protection from these diseases, and soft drinks the least [75].

A study examining red and processed meats and the risk for coronary heart disease and type 2 diabetes found that a higher risk for coronary heart disease is associated with the consumption of processed meat, mainly due to its increased levels of sodium. Overall, neither unprocessed nor processed red meat is beneficial [76]. Lower meat consumption can be beneficial in lowering one's diabetes risk. A study on vegetarian and low-meat diets found a correlation between low-meat consumption and lower risk factors for diseases such as type 2 diabetes and coronary heart disease. That said, care must be taken to ensure that vegetarian diets particularly do not result in nutrient deficiencies [77].

Dairy consumption, particularly yogurt, is another area of importance. A recent study has revealed that consumption of regular-fat diary, such as milk, cheese, and yogurt, does not directly correlate to weight gain or a higher risk for

cardiovascular disease as previously thought [78]. A meta-analysis of 17 studies suggests that increased diary consumption, including low-fat products and cheese, correlates to a decreased of type 2 diabetes [79]. Observational studies suggest that type 2 diabetes risks can be lowered by the consumption of plant-based and certain animal-based foods, such as diary – this includes milk, yogurt, cheese, and whey protein. These foods contain important vitamins and minerals and improve glucose control as well as insulin secretion and sensitivity [80].

Regarding women specifically, more than 37,000 women completed a questionnaire on their dairy consumption in high school; they were then followed to identify their risk for type 2 diabetes in middle age. The study found that those who consistently ate dairy throughout their life had a lower risk of type 2 diabetes [81]. Various studies have found that yogurt specifically is beneficial in lowering one's risk for diabetes. Another study, this one of more than 150,000 men and women over almost 4 million person-years of follow-up, found an inverse correlation between yogurt intake and diabetes. Other dairy products, however, did not impact diabetes risk factors [82]. Furthermore, a meta-analysis of more than 500,000 people and 22 observational studies found that, overall, dairy consumption, particularly yogurt, inversely affected the risk for type 2 diabetes [83]. A study of more than 100,000 people done by Harvard School of Public Health found that eating a serving of yogurt daily decreased patients risk for type 2 diabetes by 18%. Though it will require further testing, they hypothesize that yogurt's probiotics might improve insulin sensitivity and ease inflammation [84].

A study examining diet in context with the prevention of type 2 diabetes found that there is no universal strategy to prevent the disease. Instead, the study suggests that maintaining a healthy body weight and consuming plant-based foods

(instead of meat products and grains) are the best ways to decrease the risk for diabetes [85]. A comprehensive review of nutrition and policy science suggests looking at the big picture by evaluating overall health and diet strategies. This review stresses the importance of overall diet patterns, versus focusing on a single nutrient; it proposes that understanding the complexity of food on weight loss is more important than counting calories alone. Personalized nutrition depends more on a patient's lifestyle than on their genetics. They suggest that increased consumption of fruit, yogurt, nuts, and fish is beneficial while red meats, processed meats, and refined foods are not; further study is needed on organic, non-genetically modified, and grass-fed products, among others [86].

2.2.9 Smoking

Smoking cigarettes, pipes or cigars all have the same risk of diabetes. Quitting smoking may lead to weight gain, which is associated with a higher risk of diabetes, but the long-term benefits surpass this risk [87]. Smoking is correlated with risk of type 2 diabetes among elderly men and middle aged women [88]. This is due, in part, to the fact that smoking increases insulin resistance and central fat accumulation, both of which increase a smoker's risk for diabetes and cardiovascular diseases.

The amount smoked affects the diabetic risk level. One study showed that those who smoked 25 cigarettes daily or more had a high risk of type 2 diabetes [89]. Thus, those who smoked two packs or more per day had a higher rate of diabetes than those who never smoked. In men, the increase was 45% and in women, 74%. Smoking cessation reduced the diabetes rate in men after 5 years and in women after 10. Therefore, women face an increased diabetes risk [90].

In Saudi Arabia, 78% of smokers are men aged between 21 and 50 and married. They tend to have a lower level of education and work as manual laborers, businessmen, army officers, or in an office [91]. A study on oral mucosal lesions found that while various tobacco habits increased the likelihood of lesions, men with lower education, a tobacco habit, and diabetes faced the highest risk for potentially malignant lesions [92]. Furthermore, approximately 11% of female Saudi college students smoke. Though the prevalence of smoking was not affected by college, age, or GPA, the study did find that students with a higher family income were more likely to smoke [93].

Cigarette smoking particularly may pose an increased risk of noninsulin-dependent DM. One study assessed the connection between smoking and the occurrence of noninsulin DM in women. Over 12 years, researchers found that the relative risk of diabetes was 1.42 for women who smoked 25+ cigarettes a day compared to nonsmokers [94].

Other forms of tobacco consumption can also impact the risk of diabetes. Hookah use has increased among young adults in the U.S., particularly among female, Hispanic, and non-Hispanic black students [95]. Flavored non-cigarette tobacco product (NCTP) use is prominent among US adults in the form e-cigarettes, hookah, and cigars. Young adults are most likely to choose sweet flavors in their tobacco products [96]. One study assessed the impact of cigarette and qalyan (hookah) smoking on serum nitric oxide (NO) metabolites (NO(x)) concentration. They found that active smoking of either cigarettes or qalyan was associated with high serum NO(x) levels [97].

Like cigarettes, snus, a Swedish smokeless tobacco, increases a user's likelihood of developing type 2 diabetes. Because the risk between both substances

is similar, this study's findings suggest that it is the nicotine that increases a user's type 2 diabetes risk [98]. Another study, this one on German waterpipe (shisha) smoking, revealed that many young adults partake at least occasionally, with boys being more likely to smoke than girls. There are many health risks associated with shisha smoking, though adolescents often underestimate them [99].

However, a study aimed to educate diabetic smokers on the risks presented by smoking found that patients were more likely to make healthier choices in their smoking behaviors and better control their glycated hemoglobin levels after participating in the study [100]. Further education may benefit this group and others. Those who do not actively smoke are still at risk for developing T2DM – the overall OR for this group is 1.27 [101].

Those who quit smoking have, for the first three years, a higher diabetes risk. After that initial period, ex-smokers' risk decreased from a hazard ratio of 1.91 to 0 over a period of 12 years [102]. Nonsmoking women who were exposed to secondhand smoke occasionally or regularly had a higher risk of diabetes than those who avoided secondhand smoke. This study found that ex-smokers' risk of developing diabetes decreased over time; that said, their risk for diabetes was still higher 20-29 years after quitting. Active smokers had the highest chance of developing T2D [103]. Due to weight gain associated with quitting smoking, obese ex-smokers are at a higher risk for further health problems associated with additional weight gain. This group puts on the most weight after quitting smoking. On the other hand, obese continuing smokers are unlikely to gain weight; instead, their weight will remain the same or decrease [104]. A study on the general population in the UK found that quitting smoking is correlated to impermanent increases in BMI [105].

Ex-smokers are associated with a higher risk for both diabetes and impaired fasting glucose (IFG) due, in part, to weight gain associated with quitting smoking [106]. A study of more than 135,000 postmenopausal women found that ex-smokers had the highest risk of diabetes in their first three years after quitting. Their risk decreased to match never-smokers after 10 years. Lighter smokers who quit did not experience the higher risk of diabetes that heavier smokers do [107].

2.2.10 Hypertension

Raised blood pressure gives patients with type 2 diabetes a high risk of diabetic complications. Thus, reducing blood pressure can reduce the risk of complications; those with a systolic blood pressure of less than 120mm Hg have the lowest risk [108].

2.3 Complications

Many complications can arise out of diabetes. One study examining the link between senior citizens' frailty and their likelihood of disability or death found that those with diabetes had a lower functional status; for this reason, it is important to regularly examine a senior's frailty [109]. In a study of 401 T2DM patients, retinopathy affected more than a third. The onset of the disease was linked to insulin use as well as other factors [110]. Patients with low HRQol face a direct risk of developing T2DM. Factors negatively affecting this are old age, obesity, a history of high glucose, and lack of physical activity [111]. A study of 100 Saudi diabetes patients found that, while the association between diabetes and depression is not significant, the correlation does exist: 37% of T1DM patients and 37.9% of T2DM patients suffered from depression [112].

Diabetes poses several risks for women and their children during pregnancy. In a study of 1718 pregnancies at King Fahad Medical City, T2DM mothers faced a higher risk for maternal and neonatal complications when compared to mothers with GDM: Half of the mothers with T2DM experienced preterm labor, and 33% of their neonates were admitted to the NICU, compared to 5% in the GDM group [113]. A study in France found that GDM is linked to an increased risk of adverse perinatal outcomes, though the increase is moderate. The risk is lower in non-insulin-treated GDM than in its insulin-treated counterpart [114]. Insulin-treated GDM usually poses a higher risk of adverse perinatal outcomes than its non-insulin-treated counterpart [115].

Men and women face different kinds of complications from diabetes. A study of 3,849 patients with diabetes found that men were more likely to receive medical attention for treatable CHD risk factors than women [23]. Men and women have different experiences with DM: Women are more likely to develop CAD, hypertension and GDM. They face a higher risk of death from cardiovascular diseases, and experience insulin resistance, due to issues such as polycystic ovary syndrome. Efforts to help women specifically should include risk factor control for CAD, follow-up with children of women with GDM, and weight control [20]. Furthermore, another study showed that nondiabetic men experienced a 36.4% decline in age-adjusted heart disease mortality compared with a 13.1% decline for diabetic men. Age-adjusted heart disease mortality declined 27% in nondiabetic women but increased 23% in diabetic women. These patterns were also found for all-cause mortality and ischemic heart disease mortality [116].

While most Saudi patients reported taking their diabetes medication, one self-reported study found that 60% of patients were not taking their medication the

correct number of times and 50% were not taking them at the correct time of day [36].

2.4 Similar Work

Our study looks at type 2 diabetes in each of the thirteen regions of the Kingdom of Saudi Arabia. A similar study also using the 2013 SHIS data looked at all types of diabetes in Saudi Arabia as a whole. In total, 13.4% of Saudi citizens older than 15 suffered from some form of diabetes; however, only 8.5% reported this on the survey. 43.6% of the people diagnosed as diabetic by the blood tests were previously undiagnosed—a risk most associated with older individuals—and an additional 15.2% suffered from borderline diabetes. 91.0% of those diagnosed with diabetes had been prescribed medication, and 70.9% of these patients had their diabetes under control, leaving almost 400,000 people with the disease uncontrolled. This study found that the most reliable risk factors in predicting diabetes were age, sex, and personal history of hypertension and hypercholesterolemia; factors such as marital status, education level, amount of physical activity, and diet did not impact the risk of diabetes [110].

CHAPTER 3: METHODOLOGY

3.1 Data Sample Size

A multistage stratified probability test was created to select the review members while guaranteeing probability proportionate to the estimate for every stratum. Stratification was based the 13 districts of the Kingdom: Al Riyadh; Makkah Al Moukarrama; Eastern Region; Northern Borders; Madinah; Jizan; Aseer; Najran; Qassim; Tabuk; Hail; Al-Jouf; and Al-Baha.

The Census Bureau of the Kingdom of Saudi Arabia has isolated the Kingdom into small bunches of families (averaging around 140 in each group) and named them identification units. These units fill in as essential testing units (ETU) for the study. The quantity of families in each ETU relies on the populace size, concentration and geological spread of the region. Subsequently, congested urban communities have more family units in an ETU when contrasted with more dispersed country regions.

A probability corresponding to the size specimen of an ETU was arbitrarily chosen from each of the 13 regions. 14 family units from each ETU were arbitrarily chosen and reached out to, for a sum of 12,000 families total. An aggregate of 10,827 finished the overview and were encouraged to visit their neighborhood healthcare centers. The other 1,173 participants finished some portion of the program or completed it, yet the chosen adult did not finish Module 2 (Questionnaire and Physical Measurements).

The areas in the study that were directed at the families (Modules 1 and 2) had a 90% response rate (10,827/12,000). An aggregate of 5,941 people went to the neighborhood centers to have their blood tested. The area of the review that was

regulated at the facility (Module 4) had a response rate of 55% (5,941/10,827) or a last response rate of 49.5% (5941/12,000). All study weights were post stratified to the general Saudi populace and to the structure of the chosen adults. Henceforth, the procedure balanced for self-choice bias in the facility part of the study. Members who went to the center tended to be older and female, with certain pre-conditions. Subsequently, our weights represented this predisposition.

3.1.2 Study operations

The MOH has executed and regulated the operation of the study, including arranging and directing fieldwork and preparing gathered information. MOH staff managed everyday specialized operations, including enrollment, preparing the field and information handling staff, and the supervision of the workplace and field operations.

Financial support was given by the Kingdom of Saudi Arabia. The Institute for Health Metrics and Evaluation (IHME) gave specialized help as needed.

A pilot study was directed to acquaint the interviewers with the operation and issues that may be experienced in the field. Based on this experience, the survey was finalized, and a last preparation was directed in every locale before the beginning of the study.

Privacy

All meetings were directed with the respondent without someone else from the family. Every respondent was distinguished by a personal identifier (HHID) and not by his or her name. The program was regulated to the leader of the family or the

most learned individual of the house if the leader of the family was not present at the primary contact. The list incorporated all individuals from the family recorded by their date of birth.

Survey Design

The SHIS is based on a multi-phase agent test of adults aged 15 years or more. The study covered all locales in the Kingdom of Saudi Arabia proportional to their size. This review appraised the pervasiveness of some of the hazard elements of non-communicable illnesses through conversation, physical examination and research facility examination of blood tests of participants.

Participants

To obtain data for the 2013 Saudi Health Interview Survey (SHIS), the Ministry of Health (MOH) arbitrarily and proportionally chose households from the Kingdom of Saudi Arabia, which was separated into 13 regions. A randomly chosen adult of either sex over 15 years of age was selected to participate, for a total of N=10,435 Saudi participants.

Materials

Lenovo laptops were utilized to direct and transmit the information by means of a secure link to the MOH. For the first part of the survey, a qualified professional measured height, weight, and blood pressure using Omron HN286 and Omron M6 Comfort. A lab in King Fahd Medical City in Riyadh analyzed blood samples; they measured HbA1C with COBAS INTEGRA 400 plus. We used SPSS v. 23 for analyses.

Study Design

Our study has a retrospective, quantitative, correlational design. The quantitative, correlational design examines potential relationships between variables. Our data is archival; the SHIS was conducted in 2013. Because of this, we can only examine the correlation between variables; we cannot intervene or change the data.

The independent variables are the participants':

a) Region

There are 13 regions in Saudi Arabia. Each one was assigned a code as follows: Riyadh was 1, Makkah was 2, Eastern was 3, Tabuk was 4, Aljawf was 5, Northern Borders was 6, Al-Madinah was 7, Al-Qassim was 8, Hail was 9, Aseer was 10, Jizan was 11, Najran was 12, and Al-Baha was 13.

b) Tobacco Use

Tobacco use was broken down three separate ways. The first was overall smoking status, where the three categories were those who had never smoked (1), ex-smokers (2), and daily smokers (3). Second, tobacco use was broken down by cigarette use. These categories were assigned values as follows: 0 denoted non-smokers, 1 was light smokers, 2 was moderate smokers, and 3 was heavy smokers; [117] splits them up as follows: heavy smokers have more than 25 cigarettes a day; moderate smokers have between 15 and 24 each day; and light smokers have fewer than 14 per day. Finally, tobacco use was also broken down by shisha and hookah use, with the following categories: 0 for non-smokers, 1 for low usage, and 2 for high usage.

c) Diet

There are two categories within diet: high glycemic and low glycemic. According to the Harvard Medical School, "The glycemic index is a value assigned to foods based on how slowly or how quickly those foods cause increases in blood glucose levels" [118]. A low value on the GI means that a food will release sugar slowly; these foods are good for people with diabetes because their blood sugar will not fluctuate quickly—and potentially out of control—as it might with high glycemic foods [119].

Using the University of Sydney's [120] and Harvard University's [118] glycemic index calculators, we classified foods such as juice, vegetables, eggs, cheese, and soda as high glycemic or low glycemic. We also added rice, which was not included in the original survey but is a staple in Saudi Arabian cultural dishes. High glycemic diets were broken down into two categories: high-high glycemic and low-high glycemic, assigned codes of 1 and 2, respectively. Low glycemic diets were also broken down into two categories: high-low glycemic and low-low glycemic, assigned codes of 1 and 2, respectively.

d) Weight (BMI)

Body Mass Index, or BMI, is a tool that assigns a numerical value to a person's height and weight. It is calculated using the following formula: BMI = x KG / (y M * y M), where x is a person's body weight in kilograms and y is their height in meters[121]. BMI values between 19 and 24 are considered normal weight; between 25 to 29 are considered overweight; and 30 and higher are considered obese. Our study assigned codes to these three groups as follows: normal weight (1), obese (2), and overweight (3).

e) Sex

Men and women were assigned the following codes: 1 was male, and 2 was female.

f) Age

The SHIS survey interviewed participants aged 15 and older. We broke age down into three categories: 15- to 44-years-old; 45- to 64-years old; and 65 years old and older. These three categories were assigned codes of 1, 2, and 3, respectively.

g) Work Status

Work status was broken down into three categories: employed, unemployed, and retired. Respectively, they were assigned codes of 1, 2, and 3.

h) Education

Education was broken down into four groups: illiterate, literate, graduates of high school or technical schools, and graduates of colleges or universities as well as postgraduates. They were assigned the following codes: the illiterate group was 1, the literate group was 2, high school and technical school graduates were 3, and the college/university/postgraduate group was 4.

i) Marital Status

This category was broken into down into three groups: never married; married; and divorced, separated, and widowed. Respectively, they were assigned numbers 1, 2, and 3.

The dependent variable is type 2 diabetes.

Procedure

We used SPSS v.23 to analyze the data that came from the SHIS survey. One tool within this software is frequency. It allows users to visualize the data distribution for individual variables. Frequency is run using the following steps: Analyze >Descriptive Statistics > Frequencies.

We also used the Chi square feature to compare variables with one another. To do this, we used the crosstab feature on SPSS, which can be found using the following steps: Analyze > Descriptive Statistics > Crosstabs. Cross tabulation (crosstabs) helps users understand the correlation between each variable (region, diet, sex, work status, education, BMI, smoking status, marital status, and age) and T2D.

To identify correlations between socio-demographic factors and outcome variables, we used a logistic regression model in SPSS. The logistic regression model measured the correlation between the risk factors and how they may impact the prevalence of T2D. We used binary logistic regression on all variables; those that had a $p \leq 0.05$ in the analysis of effect were considered significant. This was calculated based on the information gathered from those who completed the full survey. We also computed the odds ratios for each independent variable to understand the strength of their relationships with the prevalence of T2D.

CHAPTER 4: DATA ANALYSIS METHODS

4.1 Data Analysis

We will use SPSS v.23 for statistical analysis. All inferential tests will be two-sided and will utilize a 95% significance level. We will also utilize mean, median, standard deviation, and range to understand central tendencies in continuous variables as well as frequencies and percentages for categorical variables. These variables include region, sex, age, work status, education, marital status, tobacco use, diet, weight.

Hypothesis testing for all research questions will be done with binary logistic regression. This is because the dependent variable has two levels—yes and no—which makes binary logistic regression the best choice.

4.2 Research Questions and Associated Hypotheses

Research Question 1 (RQ1). Is there a relationship between diabetes and demographics (region, age, sex, education, marital status) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia?

Null Hypothesis 1 (H0). There is no statistically significant relationship between the prevalence of diabetes and demographic (region, age, sex, education, marital status) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Alternative Hypothesis 1 (HA). There is a statistically significant relationship between the prevalence of diabetes and demographic (region, age, sex, education, marital status) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Research Question 2 (RQ2). Is there a relationship between diabetes and behavior (smoking) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia?

Null Hypothesis 2 (H0). There is no statistically significant relationship between the prevalence of diabetes and behavior (smoking) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Alternative Hypothesis 2 (HA). There is a statistically significant relationship between the prevalence of diabetes and lifestyle (smoking) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Research Question 3 (RQ3). Is there a relationship between diabetes and lifestyle (diet, BMI) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia?

Null Hypothesis 3 (H0). There is no statistically significant relationship between the prevalence of diabetes and lifestyle (diet, BMI) among people of thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

Alternative Hypothesis 3 (HA). There is a statistically significant relationship between the prevalence of diabetes and lifestyle (diet, BMI) among thirteen regions (Al Riyadh, Makkah Al Moukarrama, Eastern Region, Tabuk, Al-Jouf, Northern Borders, Madinah, Qassim, Hail, Aseer, Jizan, Najran, and Al-Baha) of Saudi Arabia.

4.3 Results

4.3.1 Descriptive analysis

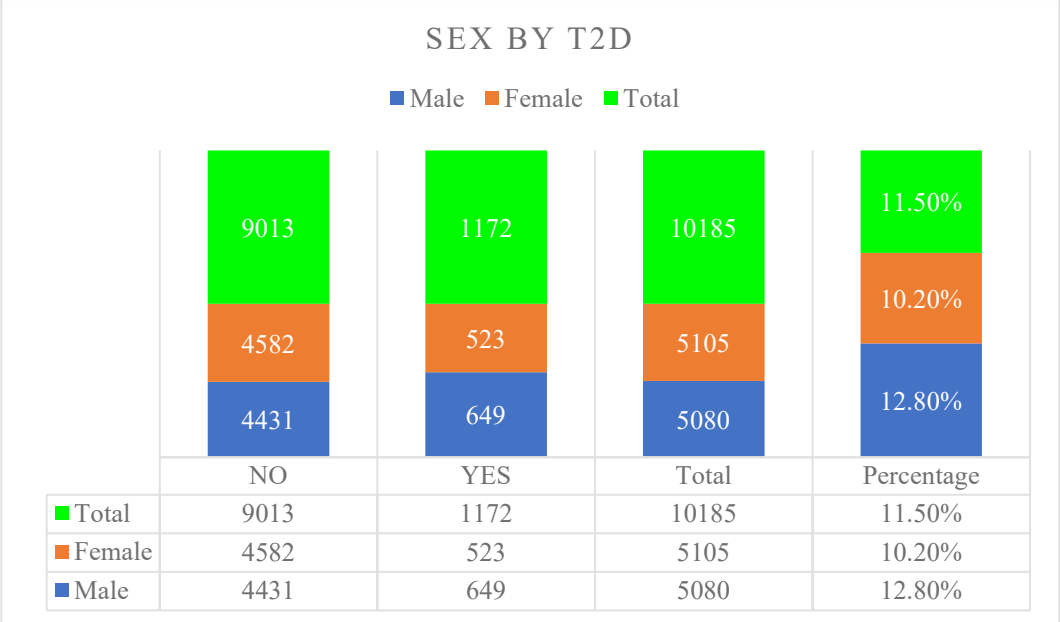
The national survey included 13 regions. The frequency of those regions was: Al Riyadh 1875 (18.4%), Makkah Al Moukarrama 1488 (14.6%), Eastern Region 759 (7.5%), Tabuk 621 (6.1%), Al-Jouf 461 (4.5%), Northern Borders 497 (4.9%), Madinah 633 (6.2%), Al-Qassim 414 (4.1%), Hail 611 (6.0%), Aseer 924 (9.1%), Jizan 698 (6.9%), Najran 659 (6.5%), and Al-Baha 545 (5.4%). The survey identified 1172 (11.5%) as diabetic (type 2).

Among the participants, 5080 (49.9%) were male and 5105 (50.1%) female. The mean age was 38.0223 ± .16031 years (range: 15-105). In our study, most of the participants were between the ages of 15 and 44, for a total of 4834 (69.9%), followed by 2235 (21.9%) aged 45-64 years, and 831 (8.2%) aged 65-105 years. The marital status of most of the participants was married, at 6607 (64.9%),

followed by never married at 2716 (26.7%), and divorced/separated/widowed at 835 (8.2%). In our study, the highest percentage of participants were employed, at 3950 (38.8%), 2627 (25.8%) unemployed, and 1162 (11.4%) retired. As for smoke status, 8412 (82.6%) said they never smoked, 1238 (12.2%) smoked daily, 507 (5.0%) Ex-smoker. For smokeless cigarettes, such as e-cigarettes, 10026 (98.4%) had never smoked, 59 (.6%) did not currently use them, 53 (.5%) smoked daily, 13 (.1%) smoked but not daily. Among the participants, 974 (9.6%) had hypertension. Most participants, 3384 (33.2%), could read and write and had completed intermediate school, 2961 (29.1%) completed high school or technical school, 2449 (24%) completed college/university/post graduate, and 1374 (13.5%) couldn't read or write. Among the sample BMI, 3315 (32.5%) participants were overweight, 3300 (32.4%) were obese, and 3222 (31.6%) were at a healthy weight. Among participants diagnosed with diabetes, 1172 (11.5%) had T2D.

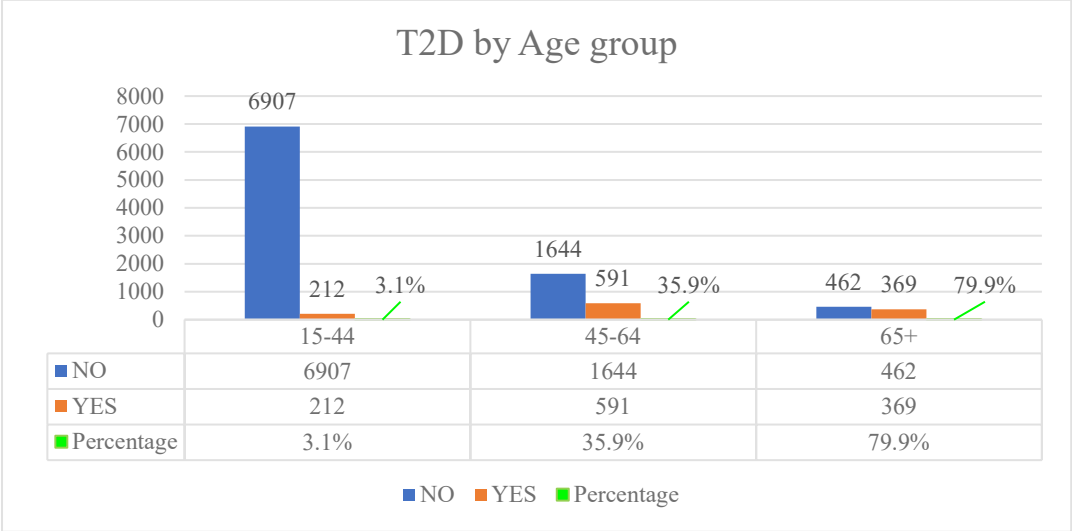
Table 2: Prevalence of T2D in Different Regions in Males and Females

Regions	No.	T2D	Percentage
Riyadh	1875	176	9.4%
MAKKAH	1488	160	10.8%
Eastern	759	60	7.9%
Tabuk	621	50	8.1%
Al-Jouf	461	47	10.2%
Northern Borders	497	54	10.9%
AL-MADINAH	633	103	16.3%
Al Qaseem	414	52	12.6%
hail	611	103	16.9%
Aseer	924	141	15.3%
Jizan	698	67	9.6%
Najran	659	72	10.9%
Al-Baha	545	87	16.0%



	NO	YES	Total	Percentage
Total	9013	1172	10185	11.50%
Female	4582	523	5105	10.20%
Male	4431	649	5080	12.80%

Figure 1: Prevalence of T2D in Different Males and Females



	15-44	45-64	65+
NO	6907	1644	462
YES	212	591	369
Percentage	3.1%	35.9%	79.9%

Figure 2: Prevalence of T2D in Different Age Groups in Males and Females

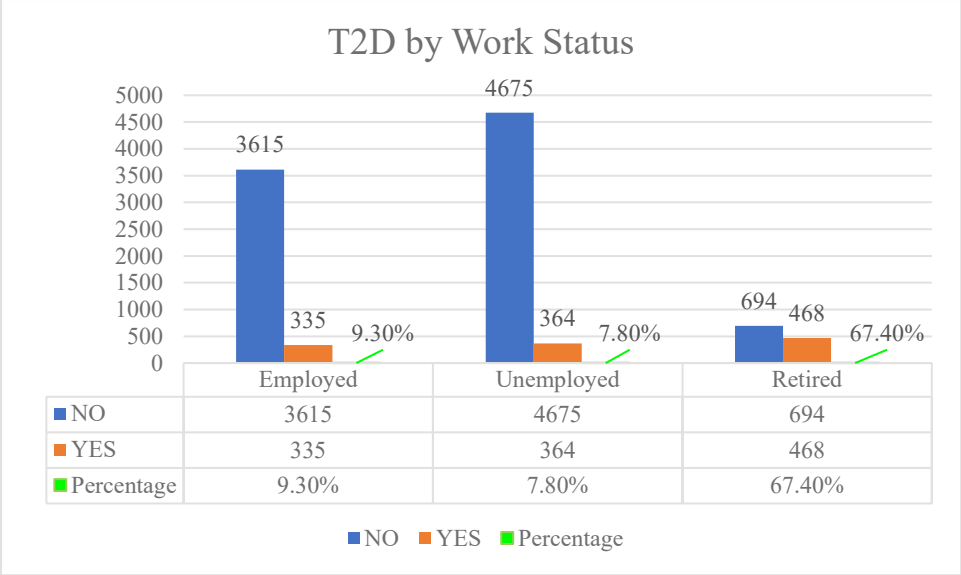


Figure 3: Prevalence of T2D by Work Status

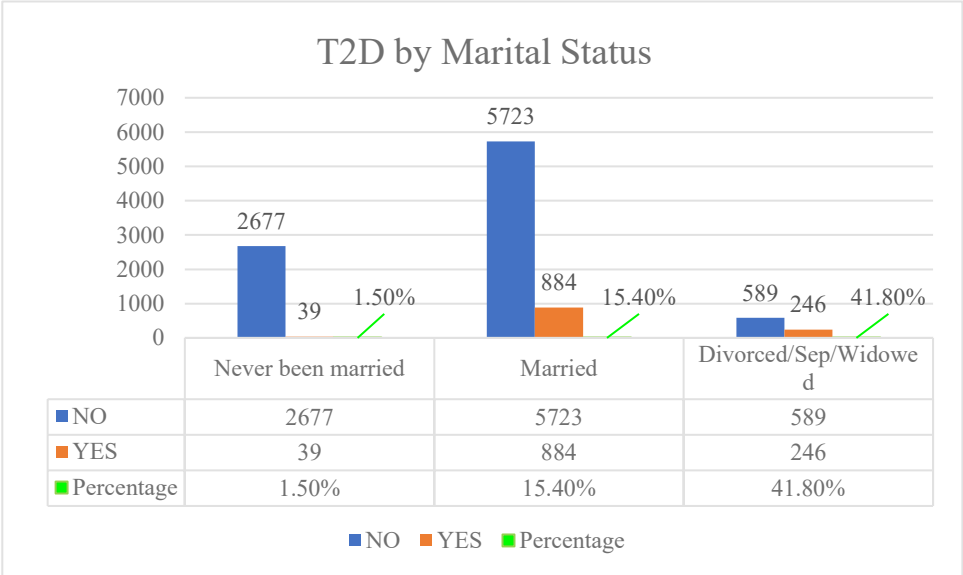


Figure 4: Prevalence of T2D in Different Marital Status in Males and Females

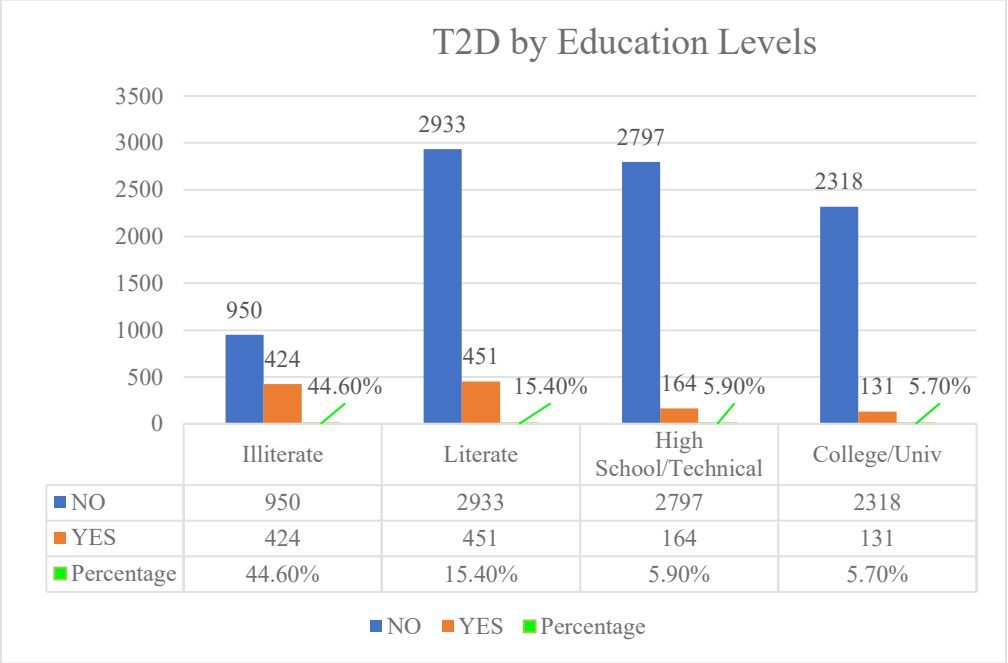


Figure 5: Prevalence of T2D in Different Education Levels in Males and Females

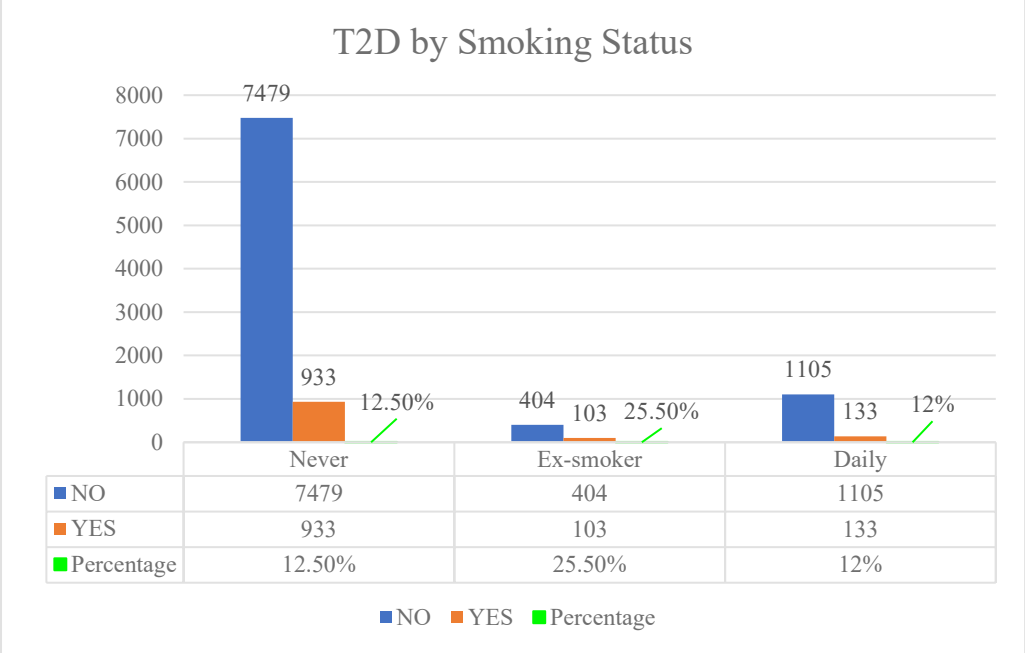


Figure 6: Prevalence of T2D by Smoking Status

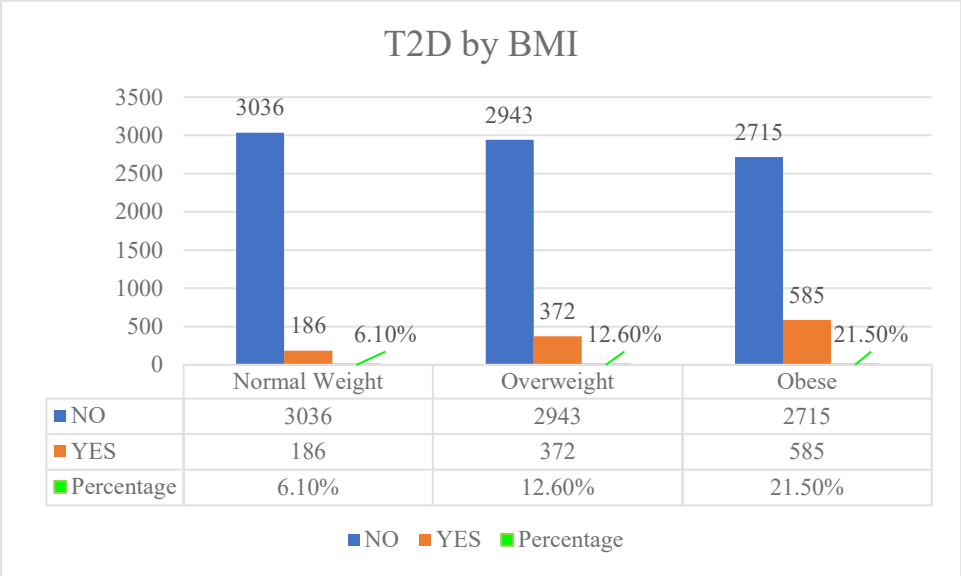


Figure 7: Prevalence of T2D in Different Weight Categories

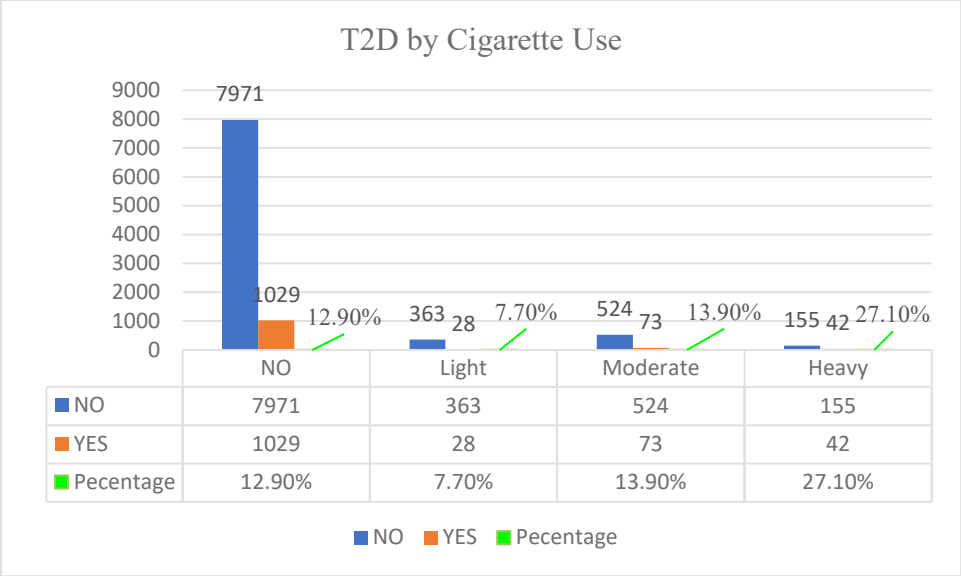


Figure 8: Prevalence of T2D by Cigarette Use

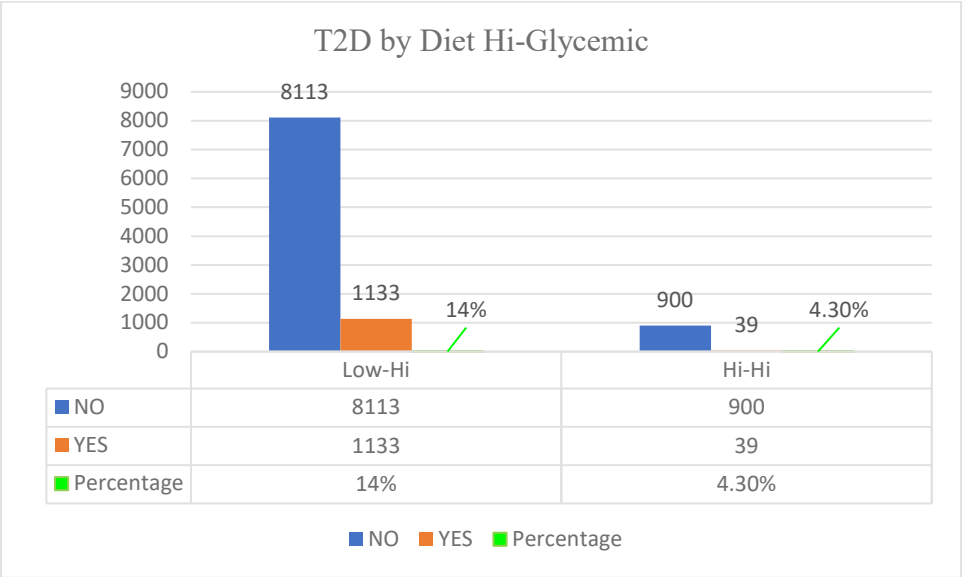


Figure 9: Prevalence of T2D by High Glycemic Diets

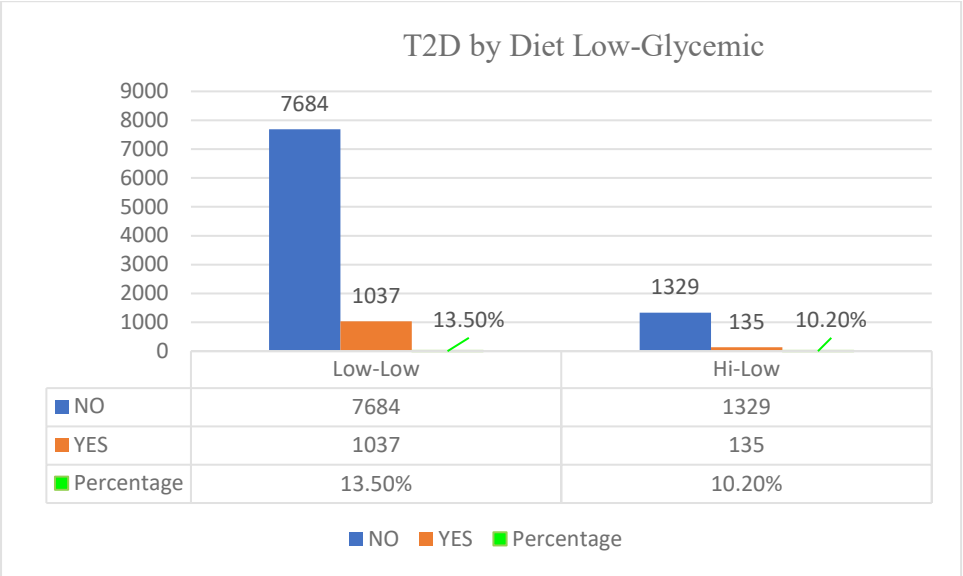


Figure 10: Prevalence of T2D by Low Glycemic Diet

4.3.2 Prevalence of T2D Maps

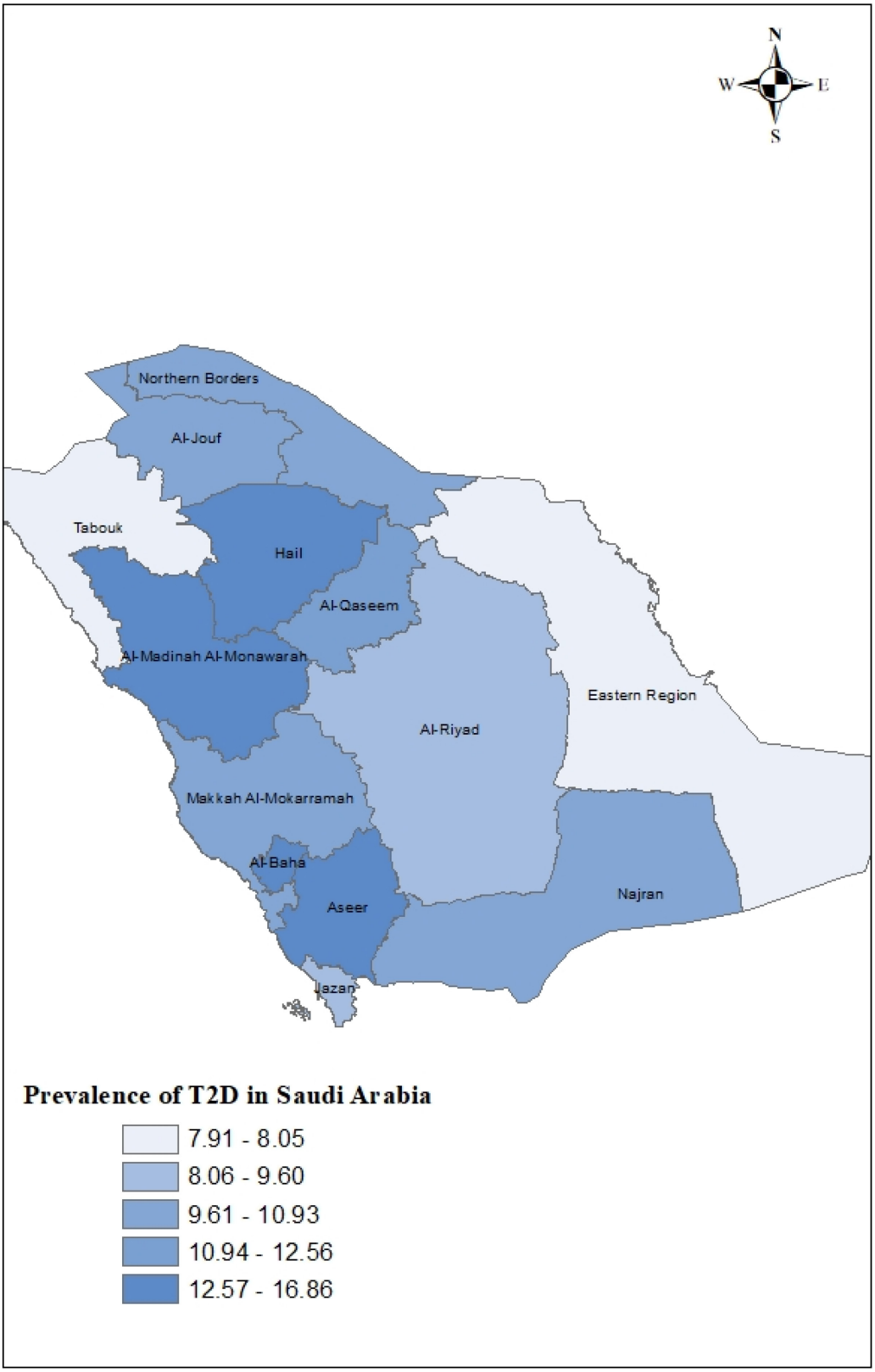


Figure 11: Prevalence of T2D in Saudi Arabia

In most regions, the most affected age group is the 45- to 64-year-olds. In Al-Baha, however, the male 65+ group is most affected; they make up 27.59% of T2D patients in that region. The 45- to 64-year-old group makes up only 11.49% of total cases in Al-Baha. This is not true for the women of this region, though. For women, the 45- to 64-year-old age group makes up 29.89% of cases in Al-Baha and the 65+ group makes up only 19.54% of cases in Al-Baha.

In Jizan as well the male 45- to 64-year-old group does not make up the bulk of T2D diagnoses. In this region, this group accounts for only 11.94% of diabetes cases. The 65+ group accounts for 19.4% of total cases in Jizan. The data follows a similar pattern in Al-Jouf, where the 15- to 44-year-old and the 65+ age groups each account for 17.02% of diabetes diagnoses in that region; the 45- to 64-year-old group accounts for only 14.89% of total cases in Jizan. In Eastern, it is the female groups that are outliers. Females aged 15- to 44-years-old make up 15% of diabetes diagnoses in Eastern; the older groups (45-64 and 65+) account for 13.33% and 11.67% of cases in Eastern, respectively.

For the 45- to 64-year-old age group, the men in Tabuk had the highest prevalence of T2D, at 38% of the cases in that region. The women of this age group had the highest prevalence of T2D in Al-Jouf, at 34.04% of total cases in that region. The lowest prevalence for this age group is the men in Al-Baha, who have 11.49% of cases in that region. The prevalence for women in this age group in Al-Baha is much higher; the prevalence there is 29.89% of total cases in Al-Baha. The lowest for women in this age group is in Eastern, at 13.33% of total cases in that region.

The lowest prevalence of T2D for men was in Northern Borders in the 15- to 44-year-old group, where they accounted for 3.7% of total cases in this region.

The highest prevalence for this group was in Al-Jouf, at 17.02% of total cases in Al-Jouf. For women in this age group, the lowest prevalence was 3.75% of total cases in Makkah and the highest was also in Eastern at 15% of total cases in Eastern. Though Eastern has lowest overall prevalence of diabetes, it is interesting that women in the 15- to 44-year-old age group make up the largest percentage of T2D cases in this region; the men of this age group make up 16.67% of total cases in Eastern, which is the second highest for this group out of all the regions.

In Al-Baha, the male and female 15- to 44-year-old age groups each made up 5.57% of total diagnoses in Al-Baha. The results for Aseer are similar: the women of this age group made up 9.93% of total cases in Al-Baha, and the men made up 9.22% of total cases in Al-Baha. This suggests that these two age groups have similar habits.

In the 15- to 44-year-old age groups in Northern, the women have almost double the diagnoses of men, at 7.41% versus 3.7% of total cases in this region. This is not true in all of the northern regions of Saudi Arabia. In Al-Jouf the opposite is true of this age group: men have almost quadruple the diagnoses as their female counterparts, at 17.02% of total cases in Al-Jouf versus the women at 4.26% of total cases in Al-Jouf. This could be due in part to a lack of exercise and other poor lifestyle choices.

Overall, women in the southern region of Saudi Arabia are more affected by T2D than men. In Jizan, Al-Baha, and Aseer, women make up a larger percentage of T2D diagnoses. This contrasts with our overall finding that men make up more of T2D cases than women do.

In most regions, the male 65+ group had more diabetes diagnoses than the women in that same age group. One exception to this is Al-Qassim, where 65+

women made up 17.31% of T2D cases in that region versus 15.38% of cases in that region in the men of that age group. Another exception is Najran, where the 65+ female age group made up one quarter of the total diagnoses in that region; the men were slightly lower at 23.69% of total cases in that region. The final exception is Al-Jouf, where both of the 65+ age groups made up 14.81% each of cases in that region.

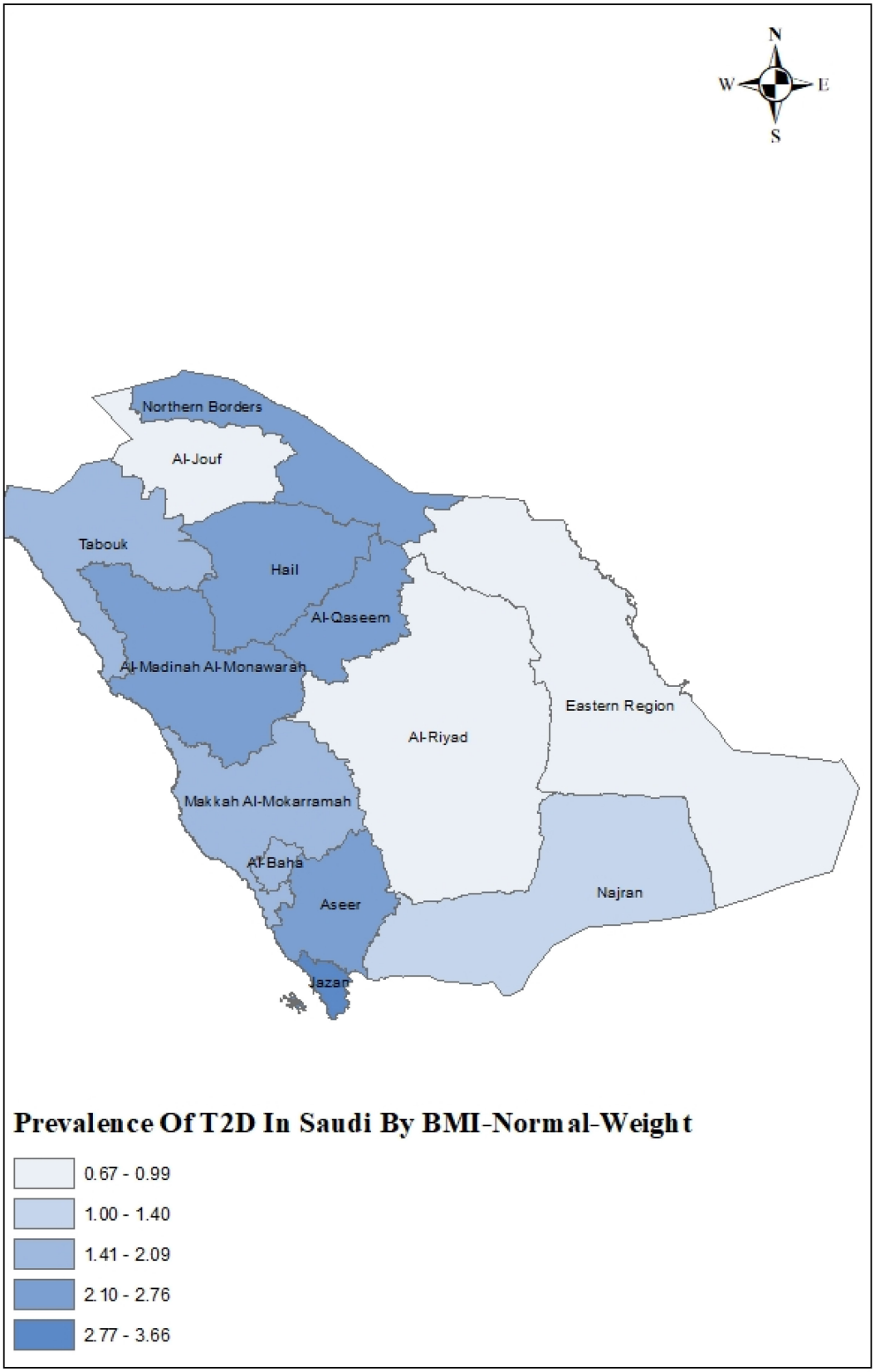


Figure 12: Prevalence of T2D by BMI--Normal Weight

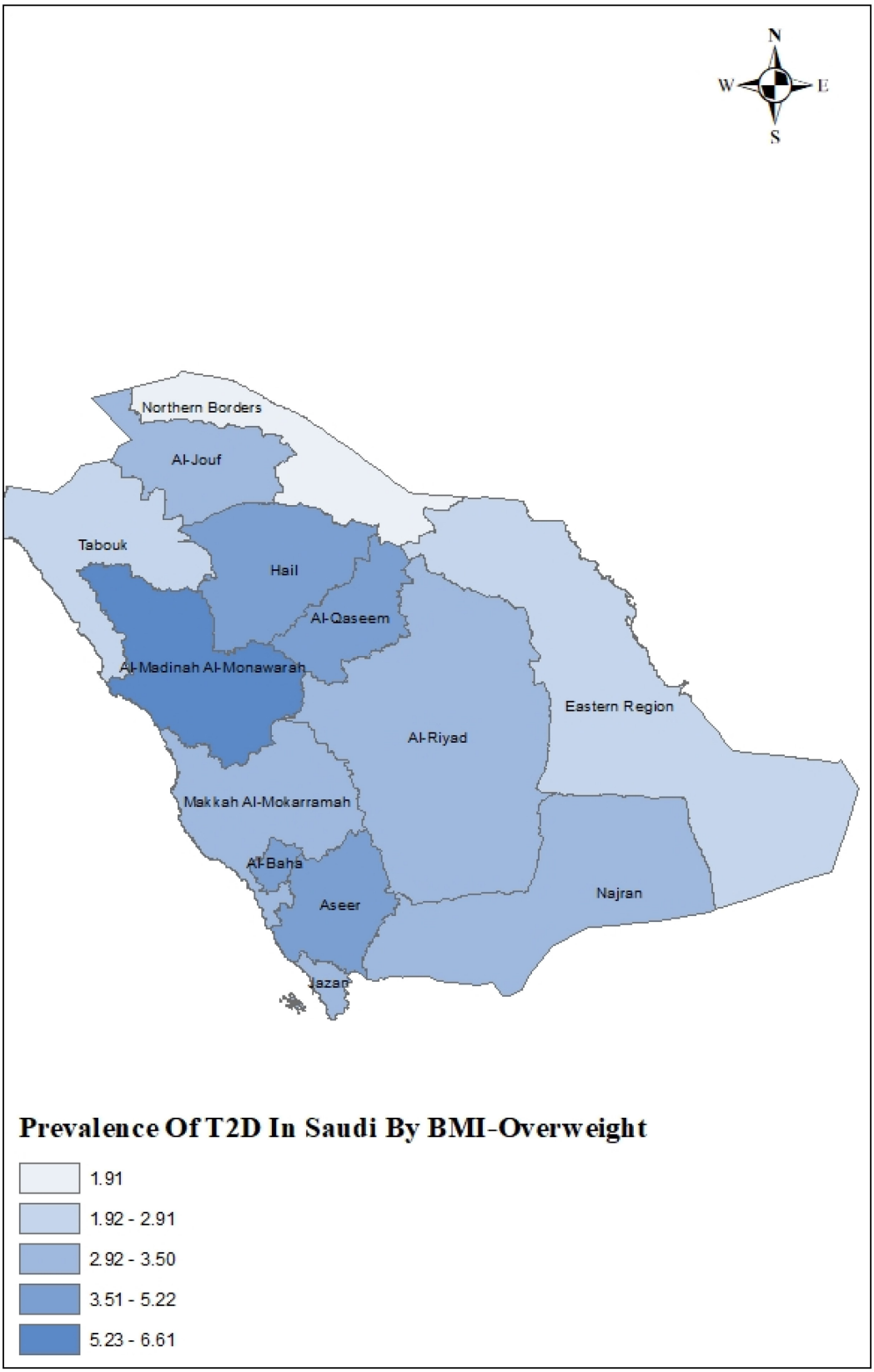


Figure 13: Prevalence of T2D by BMI—Overweight

For BMI, the most affected group was typically the obese group had the highest percentage of T2D diagnoses. This is not true in every region, though: in Al-Madinah, Northern Borders, Al-Jouf, Hail, Aseer, and Jizan, the men who were overweight made up the highest percentage of diagnoses in their respective regions.

In Northern Borders, the men of normal weight actually had the highest percentage of T2D at 21.15% of total cases in that region. This is the highest for both men and women in that region and also the highest percentage of normal-weight T2D cases in all of Saudi Arabia. Similarly, in Jizan, men of normal weight made up 20.97% of total cases in that region, which is the second highest for normal-weight men in all of Saudi Arabia. This region also had the highest percentage of normal-weight T2D diagnoses in women, at 16.13% of total cases in that region.

In Al-Jouf, obese women had the highest percentage of T2D cases at 44.44% of total diabetes cases in Al-Jouf. This is a pattern that is true in other northern regions as well; in Northern Borders, obese women made up 44.23% of T2D cases in that region. Tabuk, another northern region, showed a similar pattern. In that region, obese women made up 24% of T2D cases in that region, which is much higher than the percentages for overweight and normal weight women in that region, which were 6% and 4% of total cases in that region, respectively.

In the south, Al-Baha and Aseer showed similar data patterns as the northern regions. In each of these regions, respectively, obese women made up 35.63% and 32.86% of T2D cases in their respective regions. In Jizan, 19.35% of T2D cases in

the region were obese women, compared to only 8.06% of cases diagnosed in obese men in that region.

In central Saudi Arabia, obese women made up 30% of T2D diagnoses in Al-Qassim. This is double the diagnoses of obese men in that same region, which were only 14% of total cases in that region. The opposite is true of the normal weight group: the normal weight men comprise 16% of T2D cases in Al-Qassim; the normal weight women make up only 4% of total cases in that region. This is true for the overweight group as well as the normal weight group. Riyadh, which is also in central Saudi Arabia, had similar data as Al-Qassim. Normal weight men made up 9.3% of that region's T2D cases while normal weight women made up only 1.16% of that region's cases.

Also, worth noting is that, in Al-Jouf, there were no women of normal weight diagnosed with T2D. This could be an indication of good lifestyle choices that can help guide other regions to better health in the future. In Riyadh, only 1.16% of T2D

cases were women of normal weight, which could indicate the same thing as this group in Al-Jouf.

In Jizan, the T2D cases for the overweight group was the same for both men and women: these groups each made up 17.74% of Jizan's total diagnoses.

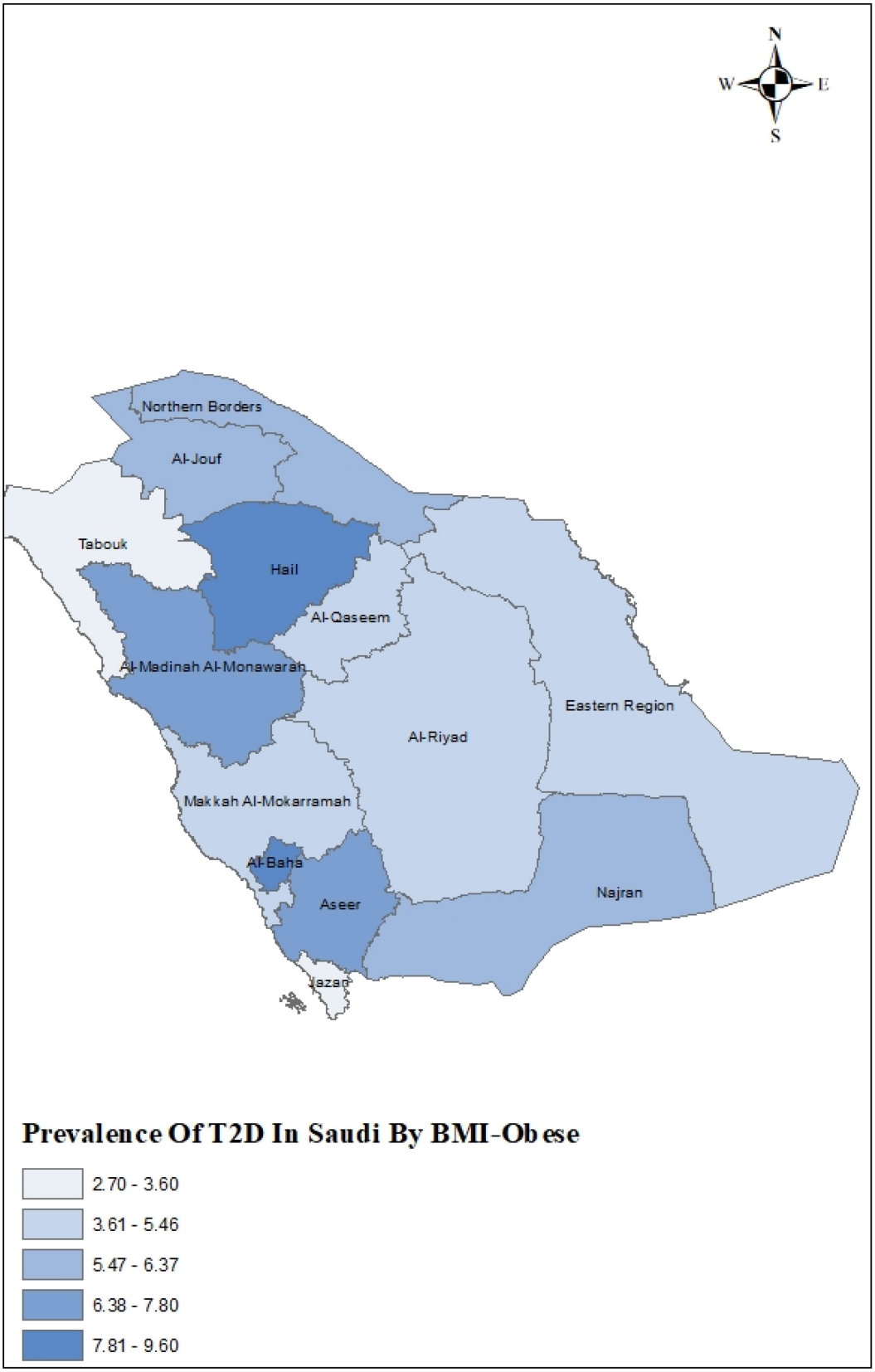


Figure 14: Prevalence of T2D by BMI—Obese

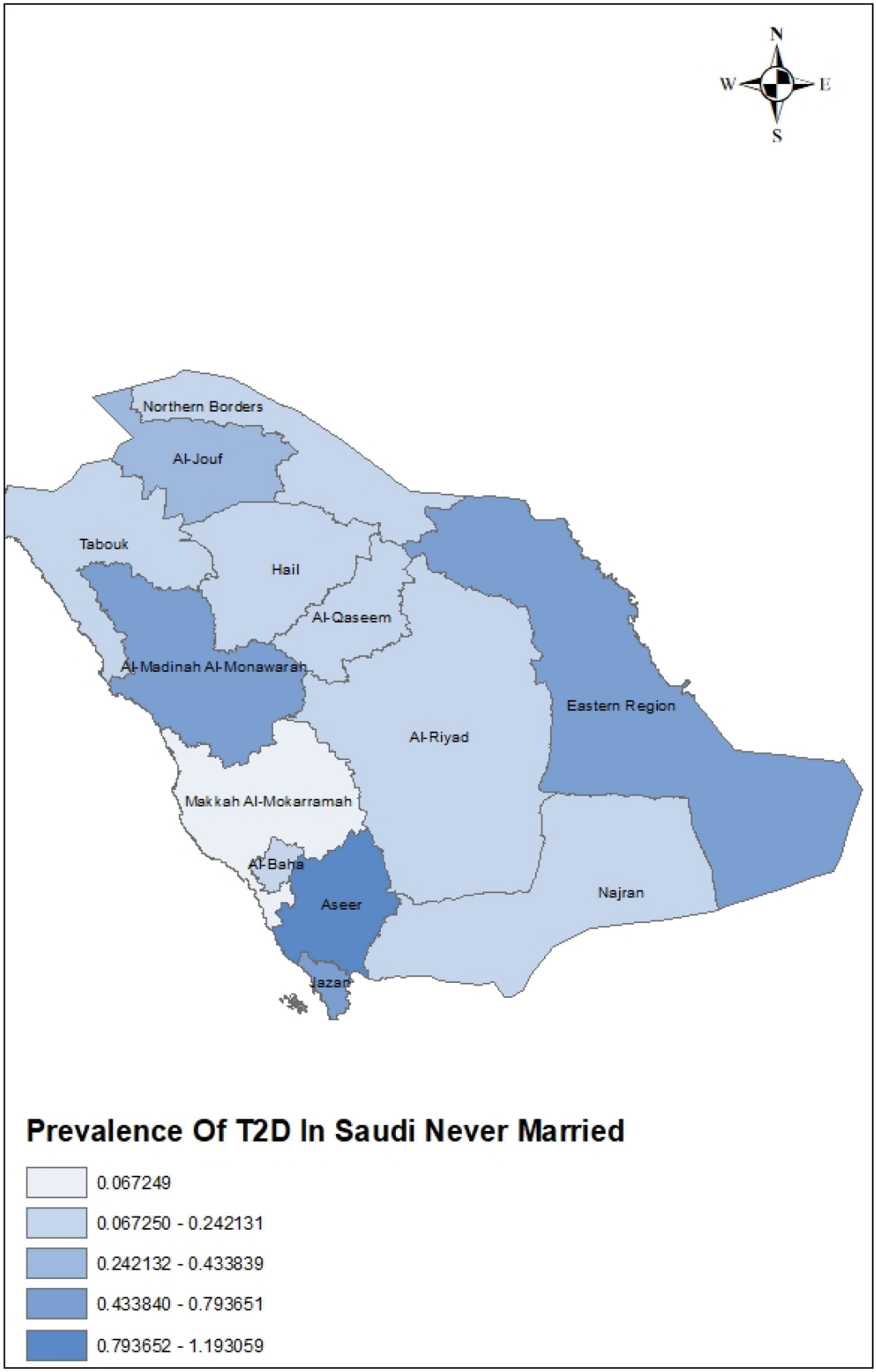


Figure 15: Prevalence of T2D by Marital Status--Never Married

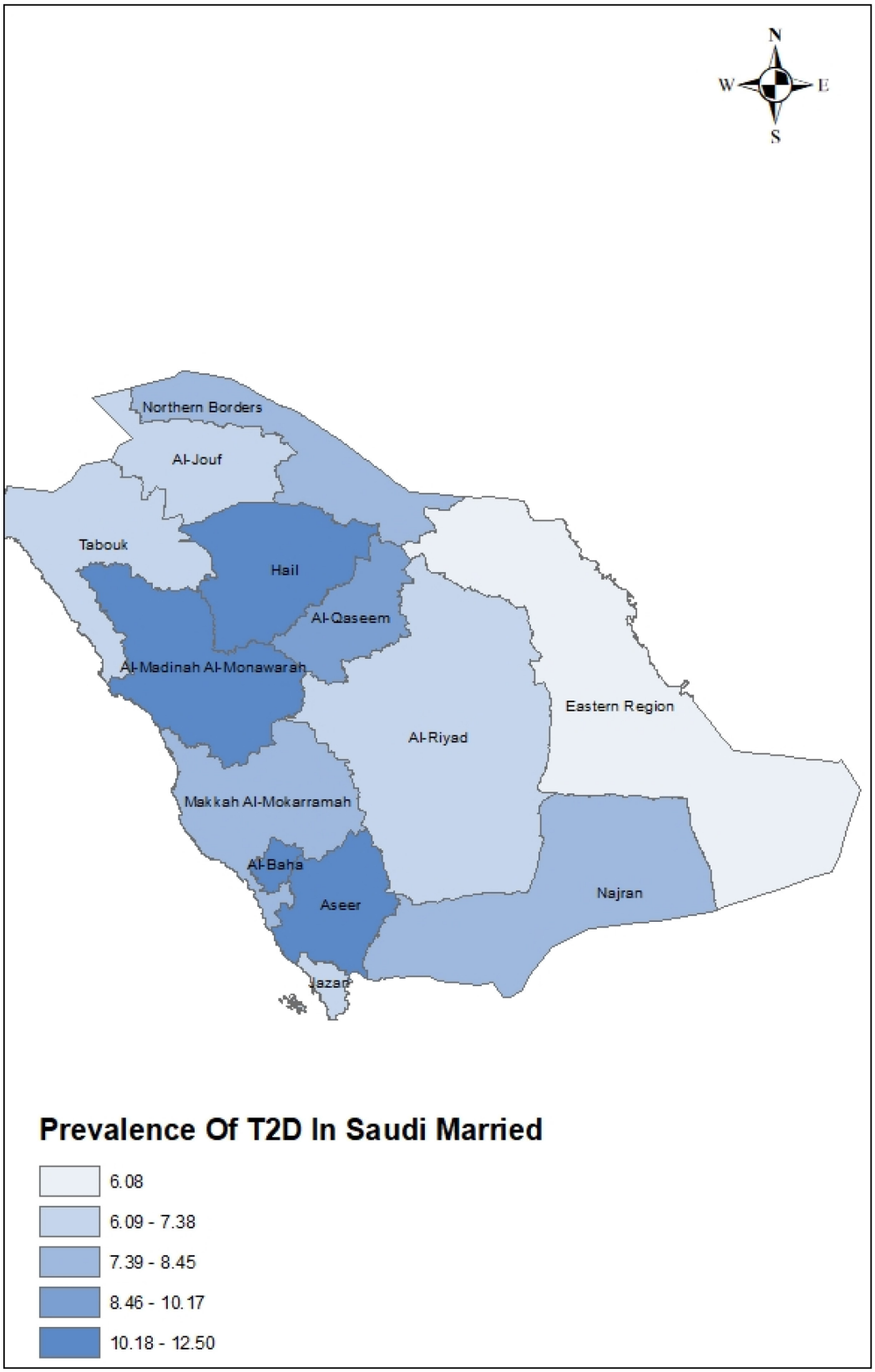


Figure 16: Prevalence of T2D by Marital Status—Married

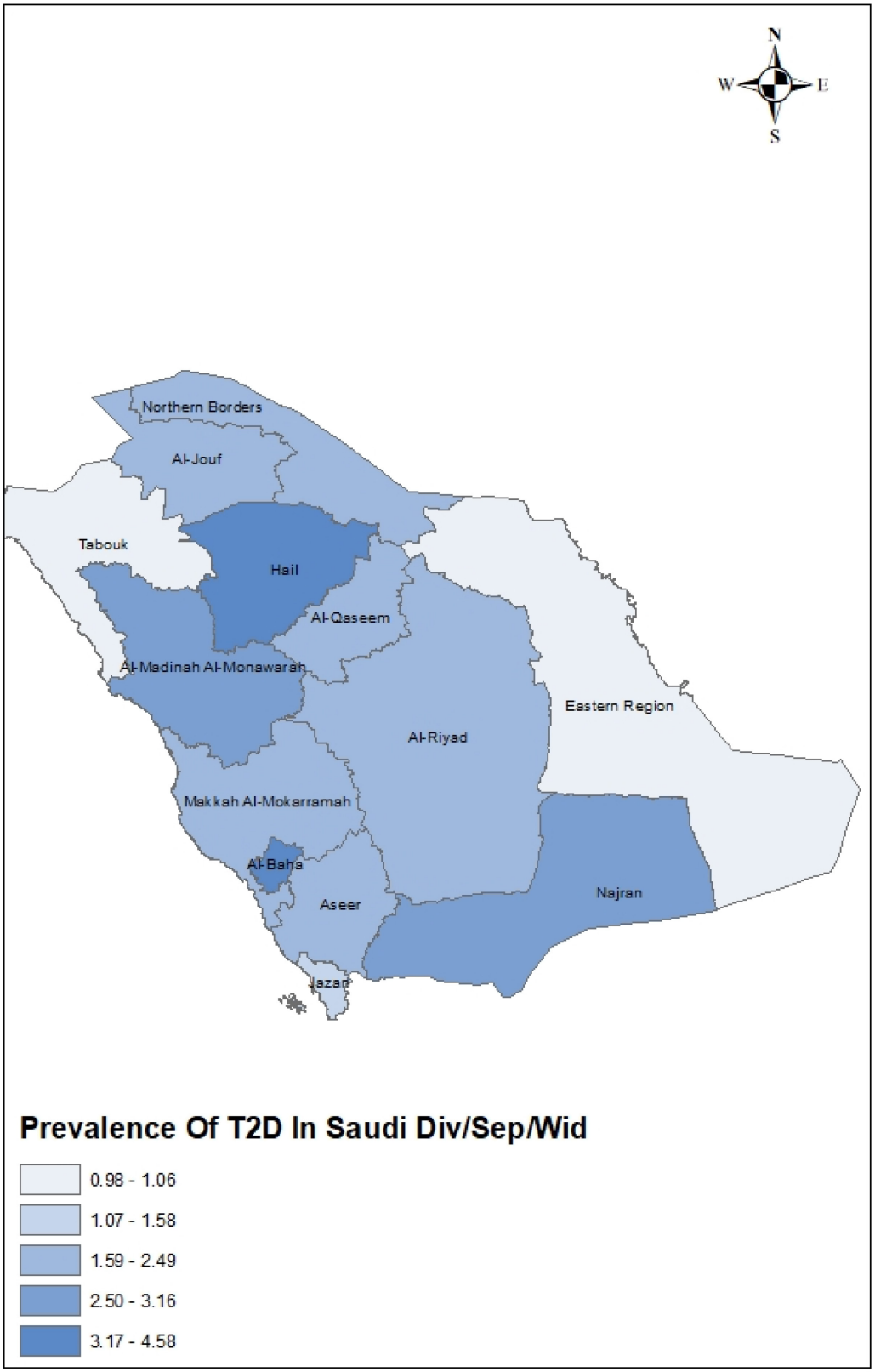


Figure 17: Prevalence of T2D by Marital Status--Divorced/Separated/Widowed

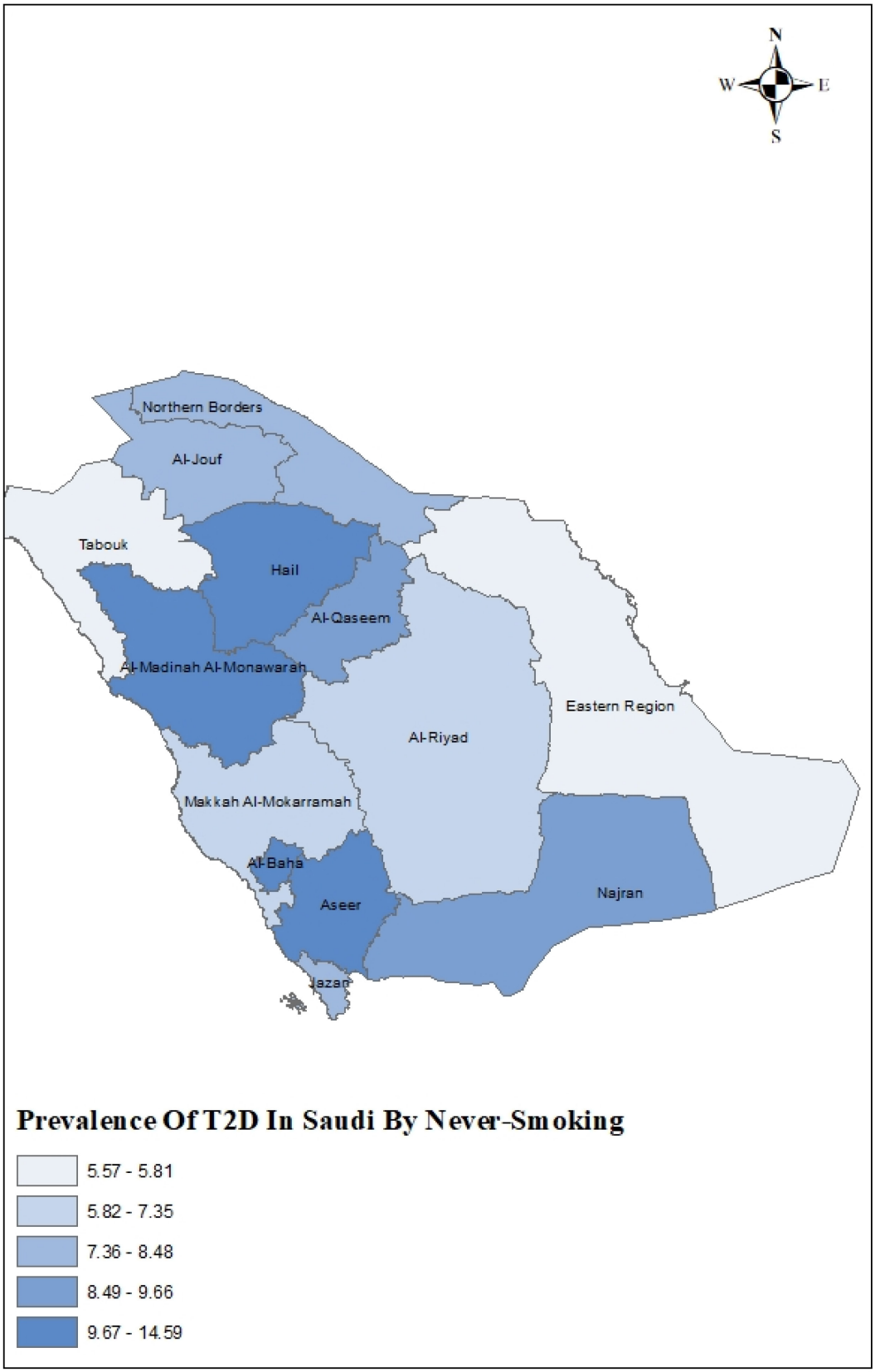


Figure 18: Prevalence of T2D by Smoking Status: Never Smoked

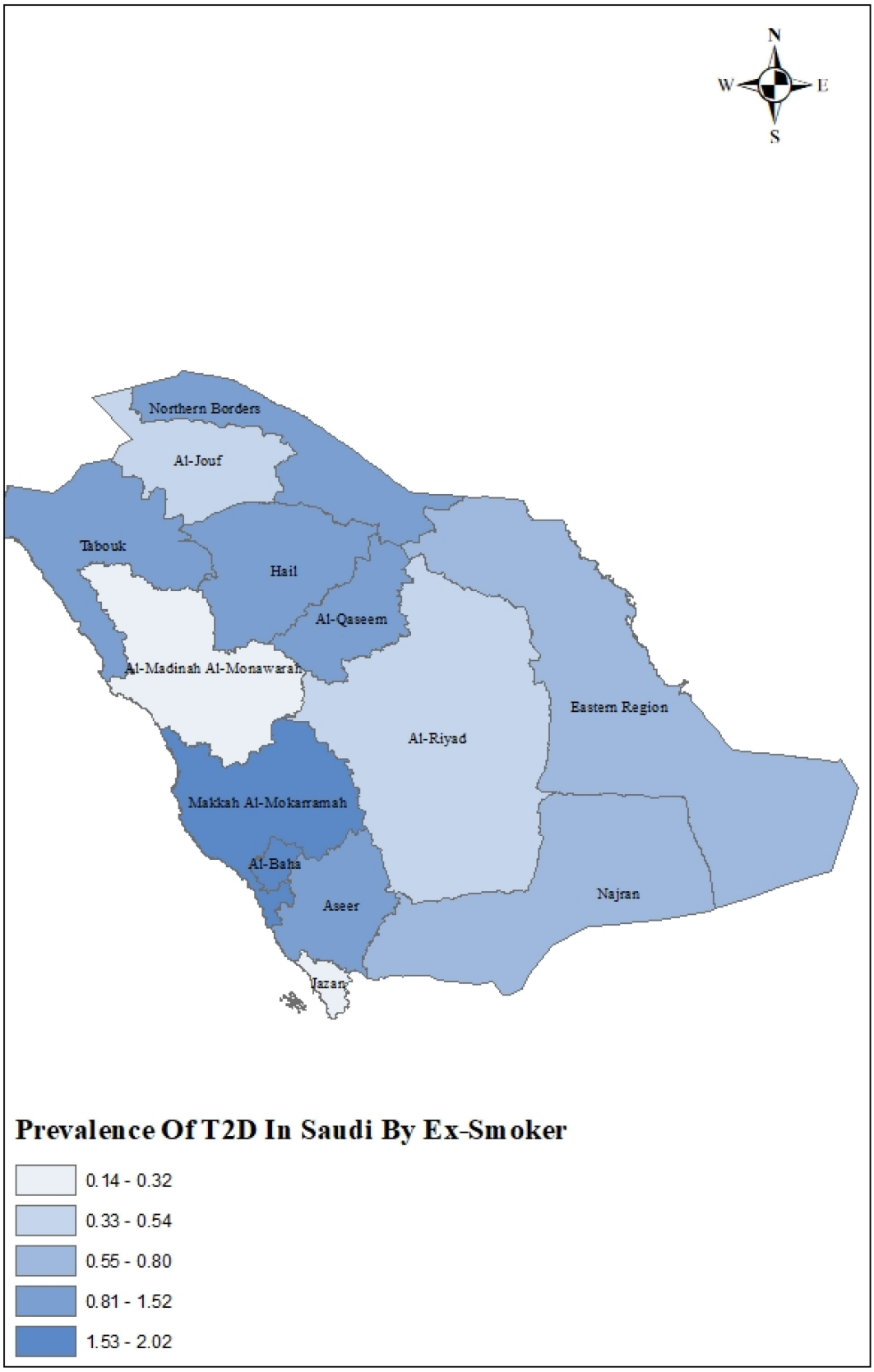


Figure 19: Prevalence of T2D by Smoking Status--Ex-Smokers

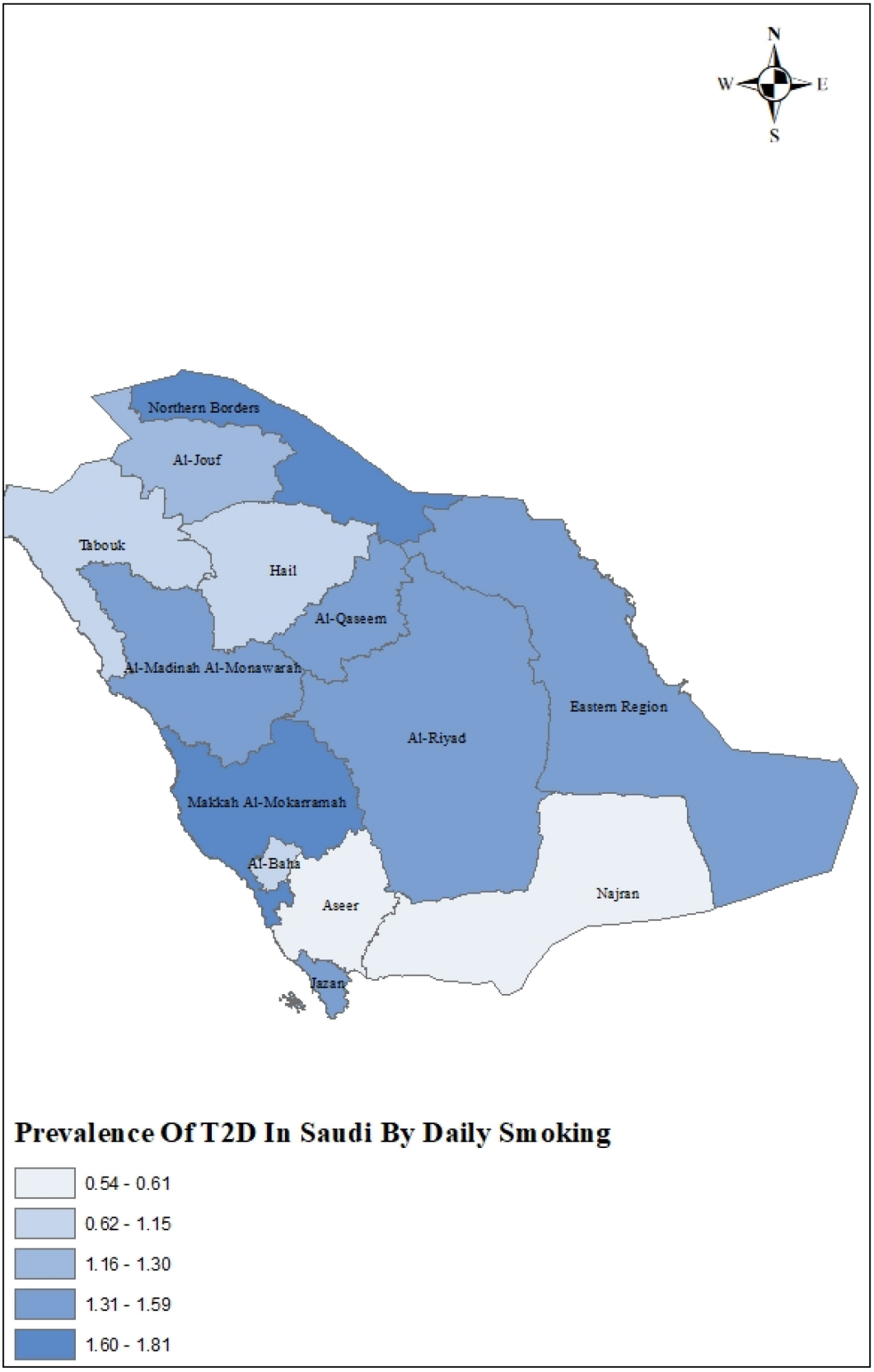


Figure 20: Prevalence of T2D by Smoking Status: Daily Smokers

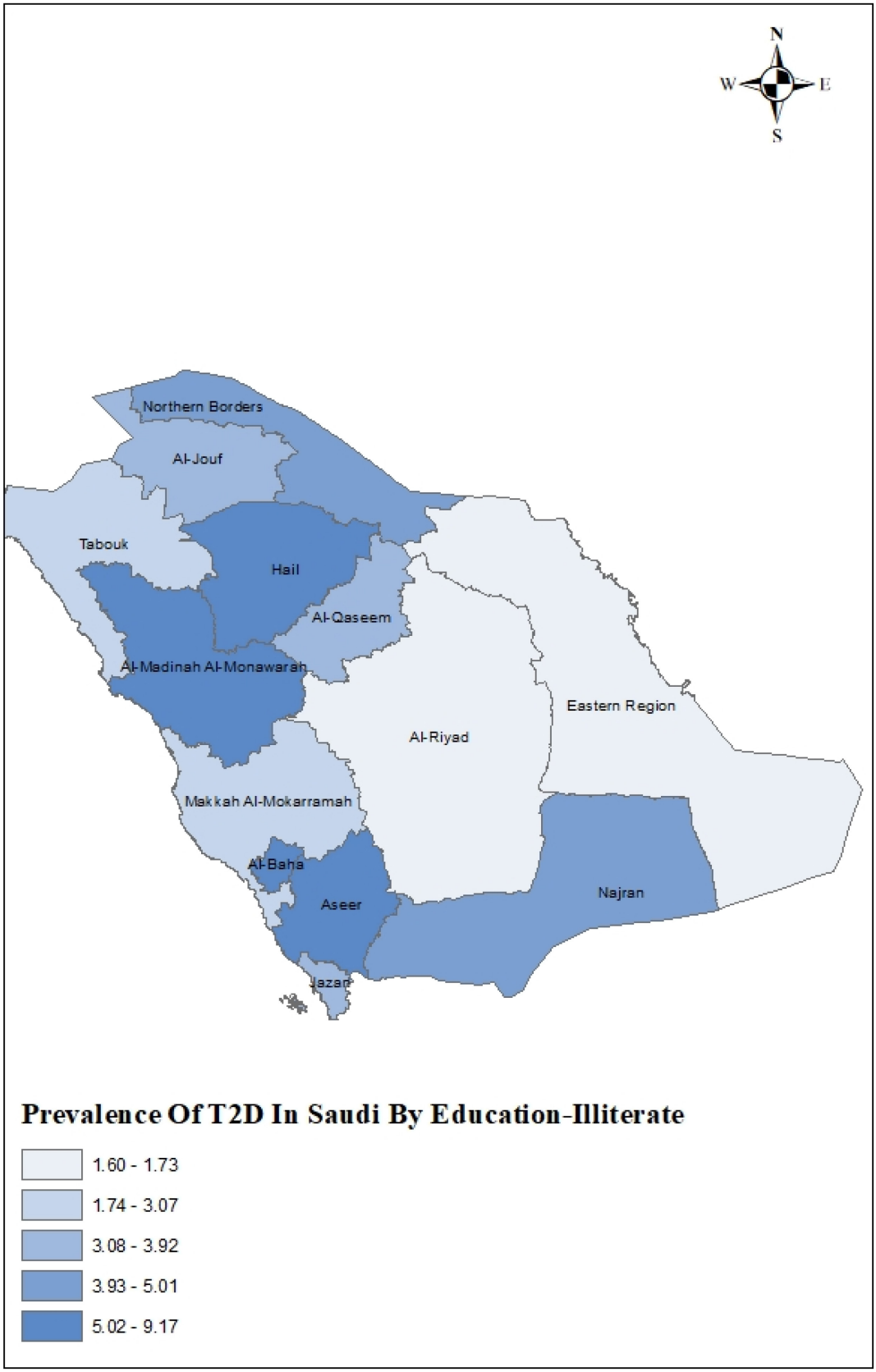


Figure 21: Prevalence of T2D by Education Level—Illiterate

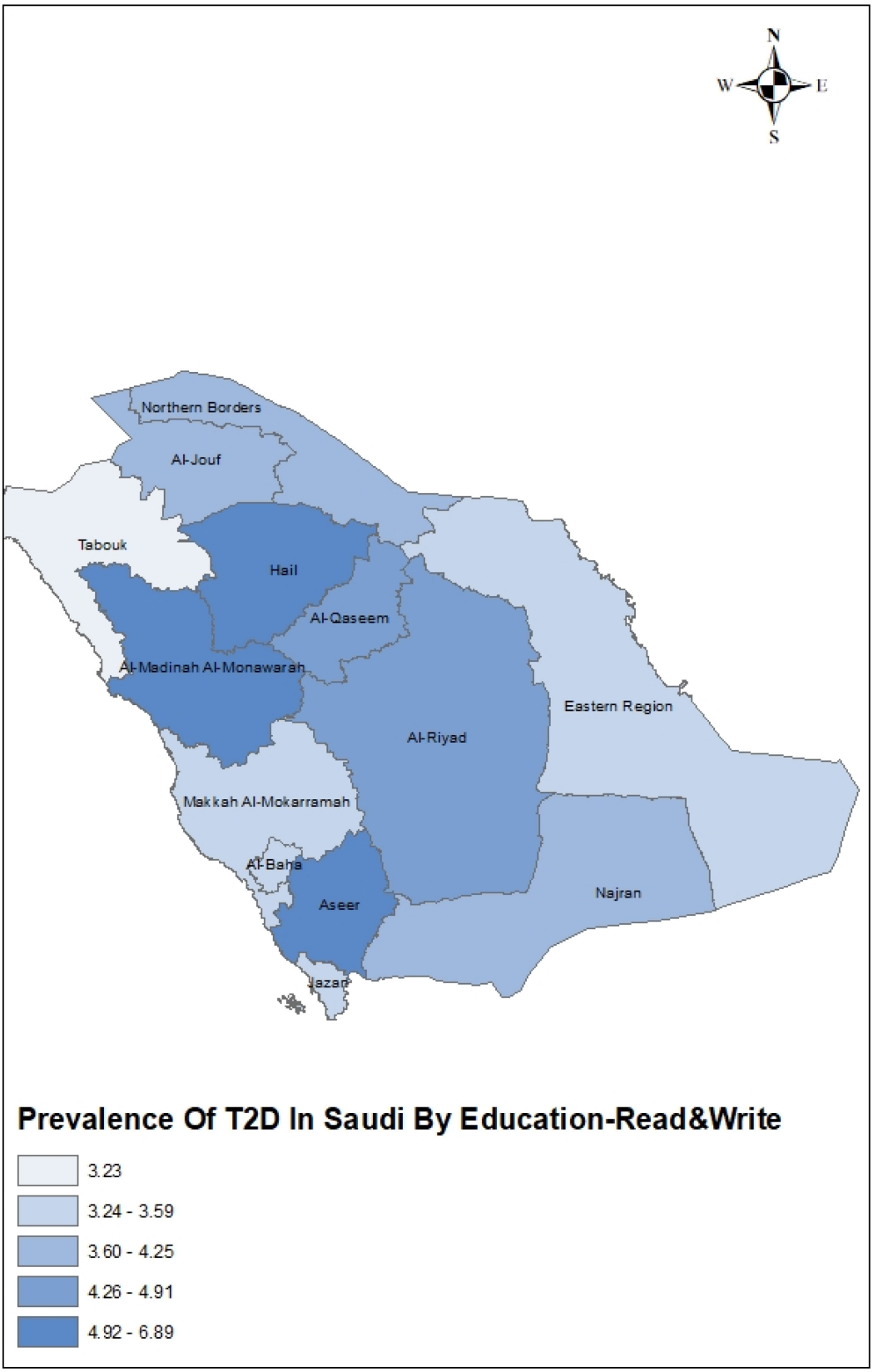


Figure 22: Prevalence of T2D by Education Level—Literate

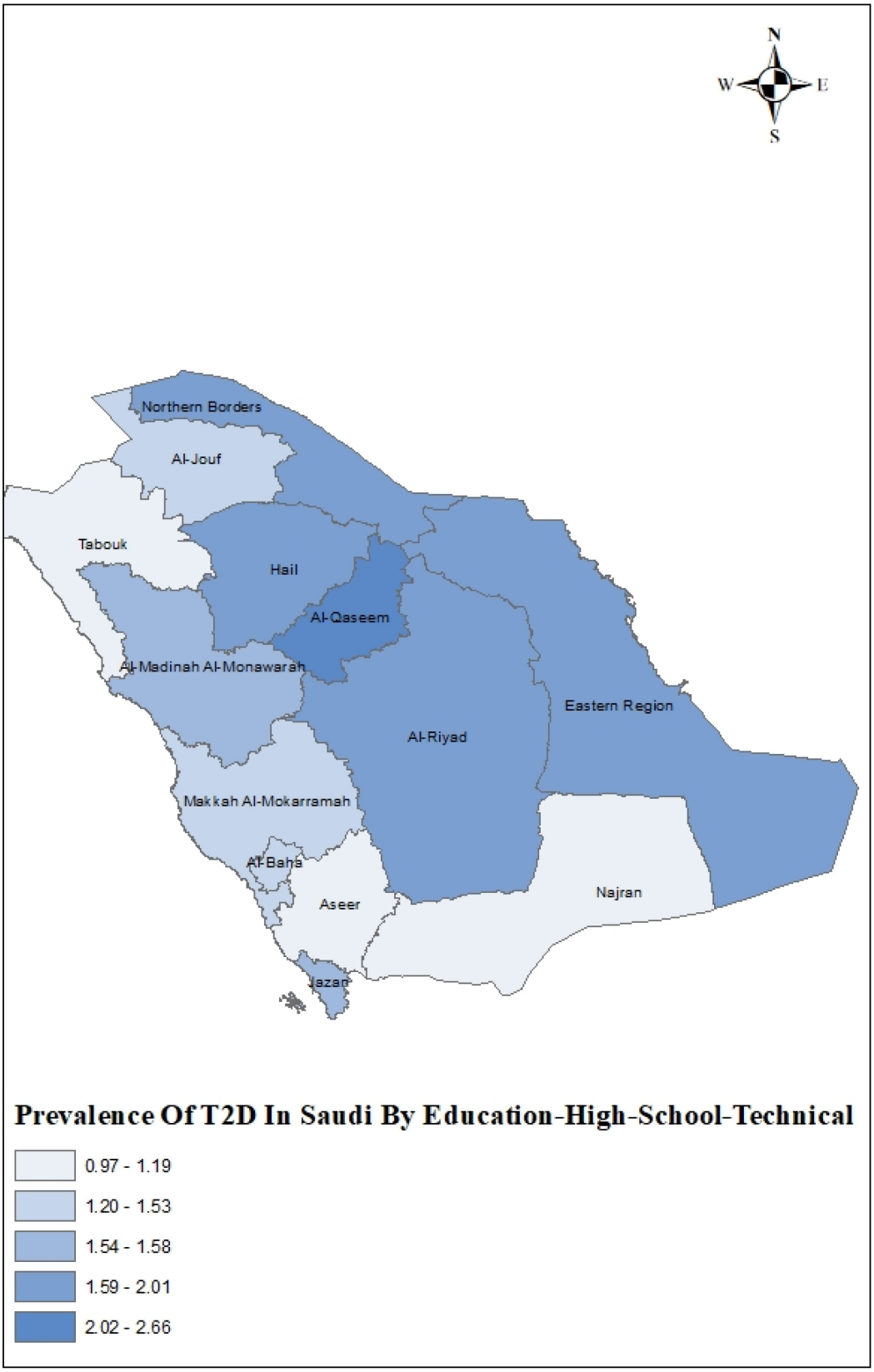


Figure 23: Prevalence of T2D by Education Level—High School/Technical School

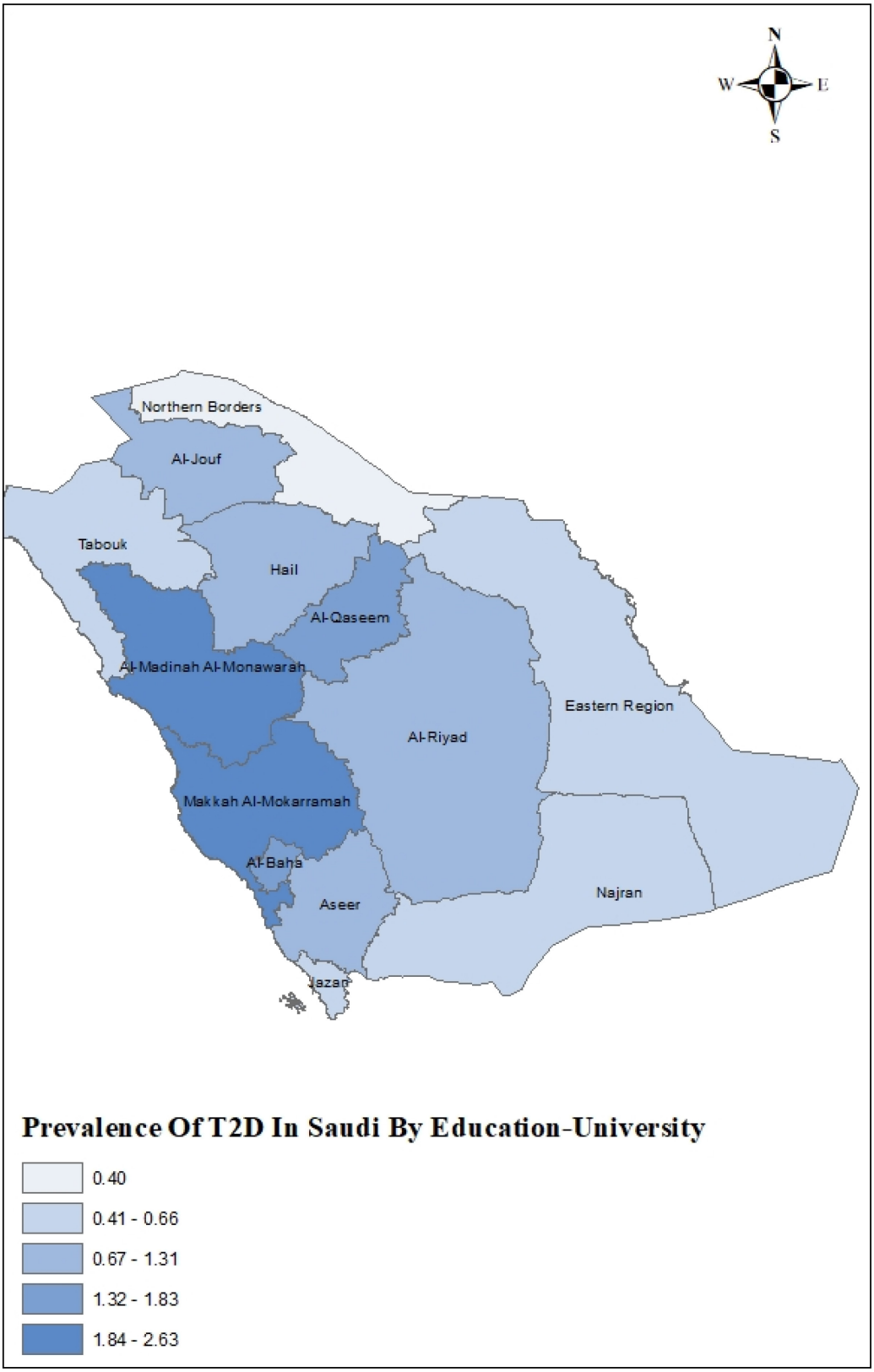


Figure 24: Prevalence of T2D by Education Level—University

4.4. Saudi Arabia's Thirteen Regions

4.4.1 Region One

Riyadh

In Riyadh, the population is 8,216,284 people over an area of 10,637,492. There are 43 sports clubs, 47 hospitals, and 424 health centers. This region has the most grade schools: 1,529 high schools, 2,073 middle schools, 3,372 elementary schools, and 838 preschools. There are also eight universities and six colleges. Riyadh has 26,081 farms.

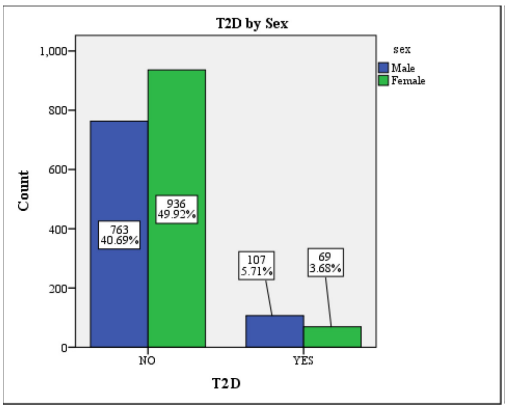


Figure 25: T2D by Sex

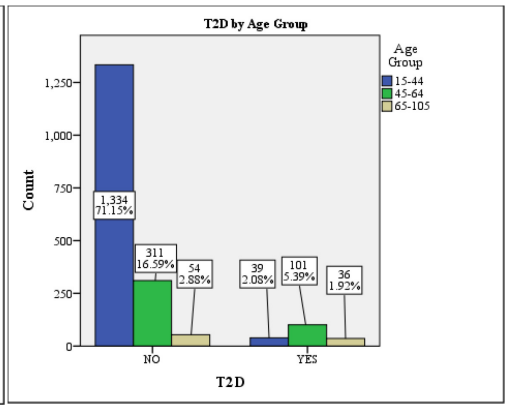


Figure 26: T2D by Sex

Figure 25 shows the T2D breakdown by sex. Of the 1,875 respondents, 763 men and 936 women did not have diabetes. 107 men and 69 women had T2D; 5.71% of the total respondents were men with T2D, and 3.68% were women affected by this disease.

Figure 26 shows the T2D breakdown by age. When split into age groups, 1,334 people aged 15- to 44-years-old did not have diabetes. 311 people aged 45- to 64-years-old did not have diabetes. 54 people aged 65+ did not have diabetes. This means that 2.08% of the total respondents were aged 15-44 and had T2D, 5.39% were aged 45-64 with T2D, and 1.92% were aged 65+ and had T2D.

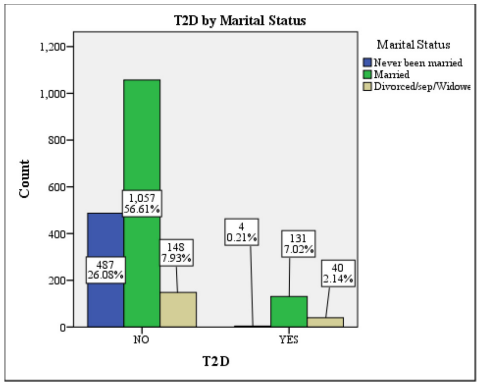


Figure 27: T2D by Marital Status

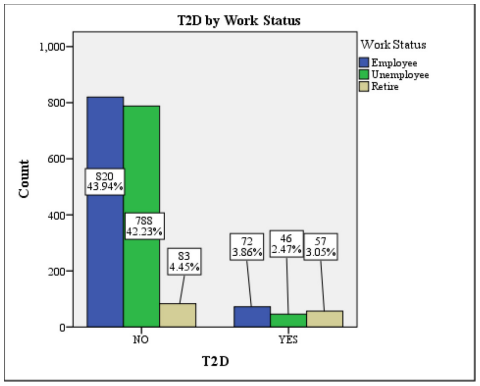


Figure 28: T2D by Work Status

Figure 27 shows the T2D breakdown by marital status. When split into groups by marital status, 487 of those who had never married, 1,057 married people, and 148 divorced/separated/widowed people did not have T2D. This means that 0.21% of total respondents had never been married and had diabetes, 7.02% were married and had T2D, and 2.14% were divorced/separated/widowed and had T2D.

Figure 28 shows the T2D breakdown by work status. When split into groups by work status, 830 employed people, 788 unemployed people, and 83 retired people did not have T2D. This means that 3.86% of total respondents were employed and had T2D, 2.47% were unemployed and had T2D, and 3.05% were retired and had T2D.

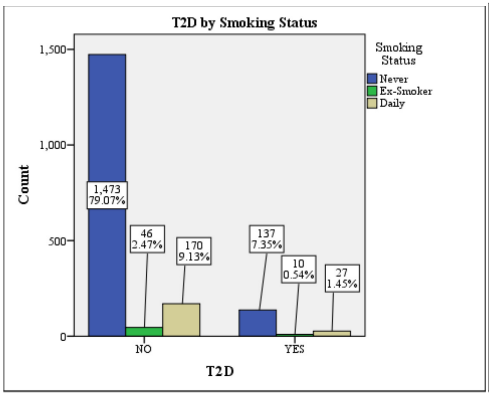


Figure 29: T2D by Smoking Status

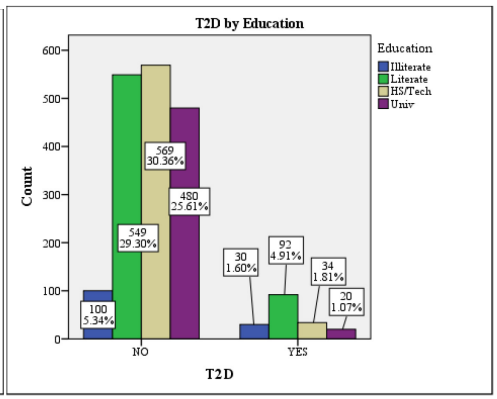


Figure 30: T2D by Education Level

Figure 29 shows the T2D breakdown by smoking status. When split into groups by smoking status, 1,473 non-smokers, 46 ex-smokers, and 170 daily smokers did not have T2D. This means that 7.35% of total respondents were non-smokers and had T2D, 0.54% were ex-smokers and had T2D, and 1.45% were daily smokers and had T2D.

Figure 30 shows the T2D breakdown by education level. When split into groups by education level, 100 illiterate people, 549 people who had completed intermediate school, 569 people who had completed high school or technical school, and 480 college, university, or postgraduates did not have T2D. This means that 1.60% of total respondents were illiterate and had T2D, 4.91% had graduated intermediate school and had T2D, 1.81% had completed technical or high school and had T2D, and 1.07% were college, university, or postgraduates and had T2D.

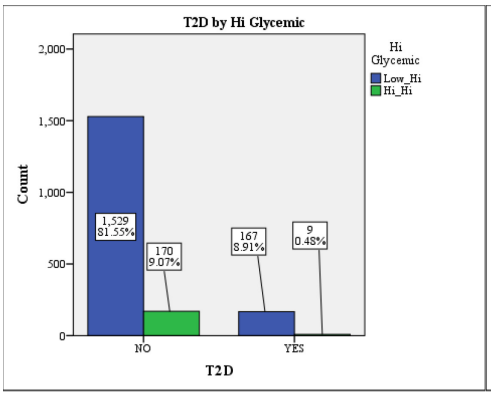


Figure 31: T2D by Diet

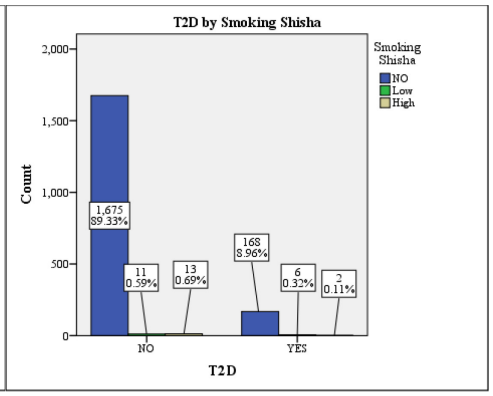


Figure 32: T2D by Shisha Use

Figure 31 shows the T2D breakdown by diet. When split into groups by high glycemic diet, 1,529 people who ate low-hi glycemic diets and 170 people who ate hi-hi glycemic diets did not have T2D. This means that 8.91% of total respondents ate low-hi glycemic diets and had T2D, and 0.48% ate hi-hi glycemic diets and had T2D.

Figure 32 shows the T2D breakdown by shisha use. When split into groups by shisha use, 1,674 people who had never smoked shisha, 14 people who smoked

small amounts of shisha, and 11 people who smoked large amounts of shisha did not have T2D. This means that 9.12% of total respondents who had never smoked shisha had T2D, 0.21% of those who smoked small amounts of shisha had T2D, and 0.05% smoked large amounts of shisha and had T2D.

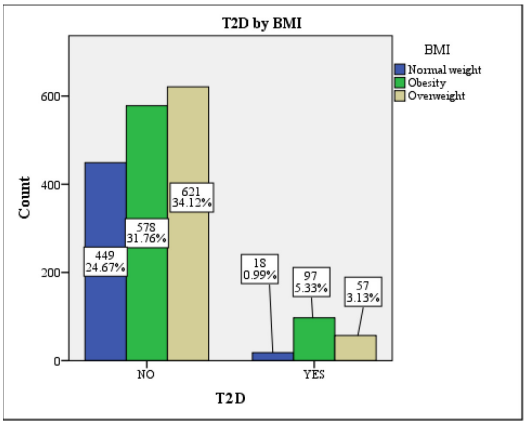


Figure 33: T2D by BMI

Figure 33 shows the T2D breakdown by BMI. When split into groups by BMI, 449 people of normal weight, 578 people who were obese, and 621 people who were overweight did not have T2D. This means that 0.99% of total respondents were of normal weight and had T2D, 5.33% were obese and had T2D, and 3.13% were overweight and had T2D.

Table 3: Riyadh Chi-Square Results Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	1875	16.18	1	$p<.001$***
Age	1875	279.19	2	$p<.001$***
Marital Status	1867	77.52	2	$p<.001$***
Education	1874	74.21	3	$p<.001$***
Work Status	1863	10.54	2	$p=.005$**
Smoke Status	1863	10.54	2	$p=.005$**
Smoke Cigarettes	1875	4.09	3	$p=.251$
Smoke Shish	1875	3.53	2	$p=.171$
Smoke Hookah	1875	13.84	2	$p<.001$***
Diet – Hi Gl	1875	4.42	1	$p=.036$*
Diet – Low Gl	1875	2.67	1	$p=.102$
Body Mass Index	1820	37.04	2	$p<.001$***

A chi-square test for association and independence was conducted for the sample from Riyadh. All expected cell frequencies were greater than five. There was a statistically significant association between sex and diabetes type 2: χ^2 (1) = 16.18, $p = p<.001$. Men were more likely to have T2D than women, at 12.3% and 6.9%, respectively.

There was a statistically significant association between age and diabetes type 2: χ^2 (2) = 279.19, $p < .001$. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, 40.0%, 2.8%, and 24.5%, respectively.

There was a statistically significant association between marital status and diabetes type 2: χ^2 (2) = 77.52, $p < .001$.The divorced/separated/widowed group was more likely to have T2D than those who had never been married or married people, at 21.3%, 0.8%, and 11.0%, respectively.

There was a statistically significant association between education and diabetes type 2: χ^2 (3) = 74.21, $p < .001$. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 23.1%, 14.4%, 5.6% and 4.0%, respectively.

There was a statistically significant association between working status and diabetes type 2: χ^2 (2) = 10.54, $p= .005$. Retired people were more likely to have T2D than those who were employed or currently unemployed, at 40.7%, 8.1%, and 5.5%, respectively.

There was a statistically significant association between smoking status and diabetes type 2: χ^2 (2) = 10.54, $p=.005$. Ex-smokers were more likely to have T2D than those who had never smoked and daily smokers, at 17.9%, 8.5, and 13.7%, respectively.

There was not a statistically significant association between smoking cigarettes and diabetes type 2: χ^2 (3) = 4.09, $p =.251$.

There was not a statistically significant association between smoking shisha and diabetes type 2: χ^2 (2) = 3.53, $p = .171$.

There was a statistically significant association between smoking hookah and diabetes type 2: χ^2 (2) = 13.84, $p<.001$. People who smoke a small amount of hookah were more likely to have T2D than non-smokers and those who smoked hookah often at 35.3%, 9.1%, and 13.3%, respectively.

There was a statistically significant association between high-glycemic diet and diabetes type 2: χ^2 (1) = 4.42, p = .036. People who consumed low glycemic food were more likely to have T2D than those who consumed hi glycemic food, at 9.8% and 5.0%, respectively.

There was not a statistically significant association between low-glycemic diet and diabetes type 2: χ^2 (1) = 2.76, p = .102.

There was a statistically significant association between Body Mass Index (BMI) and diabetes type 2: χ^2 (2) = 37.04, p<.001. The obese group was more likely to have T2D than both the normal and overweight groups, at 14.4%, 3.9%, and 8.4%, respectively.

After knowing the predictor variables that are statistically associated with diabetes type 2, we can enter them in a logistic model to figure out how strong the association is and to predict the likelihood of diabetes type 2 for participants and for new cases.

Table 4: Riyadh Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	5.813	3.767	8.970
	65-105	1	.000	13.104	7.006	24.512
Marital Status	Never been married	2	.019			
	Married	1	.006	4.360	1.528	12.439
	Div/sep/Wid	1	.006	4.917	1.587	15.237
Education	College/Univ/PG	3	.007			
	Read-Inte-School	1	.001	2.516	1.426	4.439
BMI	Normal weight	2	.001			
	Obesity	1	.000	3.046	1.697	5.467
	Overweight	1	.013	2.153	1.172	3.953
	NO	2	.018			
Hookah	Low	1	.006	6.021	1.670	21.713
Smoking Status	Never	2	.028			
	Ex-smoker	1	.038	2.334	1.049	5.194
	Constant	1	.000	.002		

a. Variable(s) entered on step 1: age group, marital status, education, BMI, hookah use, and smoking status.

A binomial logistic regression was performed to ascertain the effects of sex, age, marital status, education, working status, smoking status, smoking hookah, high-glycemic diet and body mass index on the likelihood that participants from Riyadh would have diabetes type 2. The logistic regression model was statistically significant, χ^2 (18) = 291.652, $p < .0005$. The model explained 32.4%

(Nagelkerke R^2) of the variance in diabetes type 2 and correctly classified 91.1% of cases. Sensitivity was 16.7%, specificity was 98.8%, positive predictive value was 58.3%, and negative predictive value was 92.0%.

Of the nine predictors variables, only six were statistically significant: age, marital status, education, BMI, sex, smoking hookah (as shown in the Table above). Participants at age group 45-64 had 4.72 times higher odds of suffering from diabetes type 2 than those in the reference category, the 15-44 age group. Participants at age group 65-105 had 6.58 times higher odds of suffering from diabetes type 2 than those in the reference category. It appears that increasing age is associated with an increasing likelihood of diabetes type 2.

Married participants had 4.16 times higher odds of suffering from diabetes type 2 than those in the reference group, the never-been-married participants. Divorced, separated, or widowed participants had 4.94 times higher odds of suffering from diabetes type 2 than those in the reference group.

Participants who cannot read or write had 2.98 times higher odds of suffering from diabetes type 2 than those in the reference category, the College/University/Postgraduate participants. Participants who read and write and had an intermediate school diploma had 2.89 times higher odds of suffering from diabetes type 2 than those in the reference category.

Obese participants had 3.61 times higher odds of suffering from diabetes type 2 than those in the reference group, the normal-weight participants. Overweight participants had 2.27 times higher odds to suffer from diabetes type 2 than those in the reference category. It appears that increasing weight is associated with an increased likelihood of diabetes type 2.

Males had 1.79 times higher odds of suffering from diabetes type 2 than females.

Not-current smokers of hookah had 7.17 times higher odds of suffering from diabetes type 2 than those in the reference category, those who had never smoked hookah.

4.4.2 Region Two

Makkah

The population of Makkah is 8.557,766 people, the highest of any of the regions in Saudi Arabia, in an area of 1,160,507. They have 12 sports clubs, 40 hospitals, and 331 health centers. This region has the second-highest number of grade schools, with 1,374 high schools, 1,857 middle schools, 2,929 elementary schools, and 594 preschools. There are also three universities. Makkah has 61,407 farms.

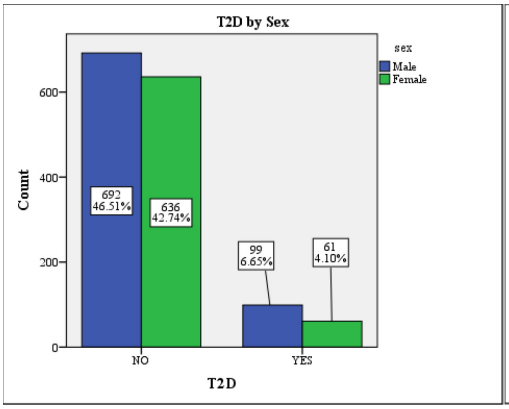


Figure 34: T2D by Sex

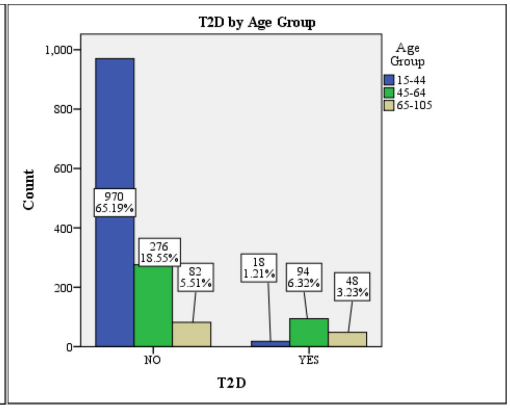


Figure 35: T2D by Age

Figure 34 shows the T2D breakdown by sex. Of the 1,488 respondents, 692 men and 636 women did not have diabetes. 99 men and 61 women did have T2D; 6.65% of the total respondents were men with T2D, and 4.10% were women affected by this disease.

Figure 35 shows the T2D breakdown by Age Group. When split into age groups, 970 people aged 15- to 44-years-old did not have diabetes. 276 people aged 45- to 64-years-old did not have diabetes. 82 people aged 65+ did not have diabetes. This means that 1.21% of the total respondents were aged 15-44 and had T2D, 6.32% were aged 45-64 with T2D, and 3.23% were aged 65+ and had T2D.

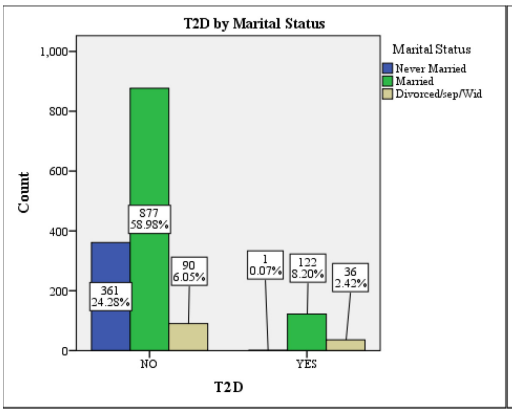


Figure 36: by Marital Status

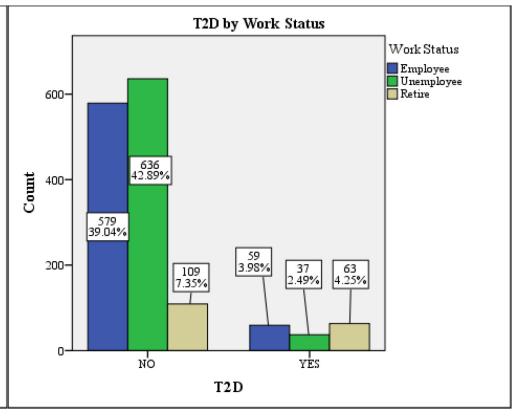


Figure 37: T2D by Work Status

Figure 36 shows the T2D breakdown by marital status. When split into groups by marital status, 361 of those who had never been married, 877 married people, and 90 divorced/separated/widowed people did not have T2D. This means that 0.07% of total respondents had never been married and had diabetes, 8.20% were married and had T2D, and 2.42% were divorced/separated/widowed and had T2D.

Figure 37 shows the T2D breakdown by work status. When split into groups by work status, 579 employed people, 636 unemployed people, and 109 retired people did not have T2D. This means that 3.98% of total respondents were employed and had T2D, 2.49% were unemployed and had T2D, and 4.25% were retired and had T2D.

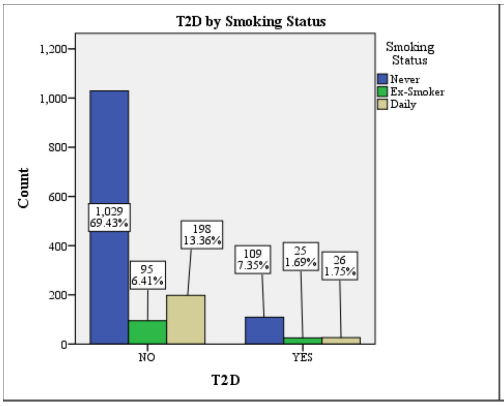


Figure 38: T2D by Smoking Status

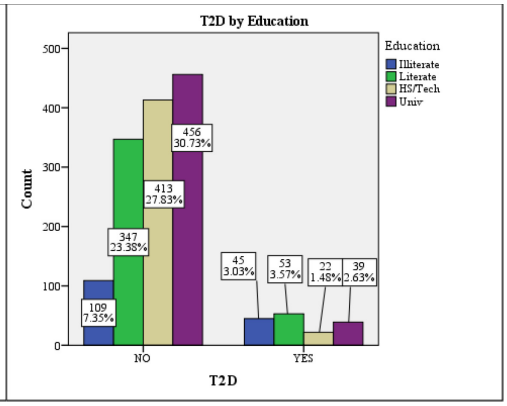


Figure 39: T2D by Education Level

Figure 38 shows the T2D breakdown by smoking status. When split into groups by smoking status, 1,029 non-smokers, 95 ex-smokers, and 198 daily smokers did not have T2D. This means that 7.35% of total respondents were non-smokers and had T2D, 1.69% were ex-smokers and had T2D, and 1.75% were daily smokers and had T2D.

Figure 39 shows the T2D breakdown by education. When split into groups by education level, 109 illiterate people, 347 people who had completed intermediate school, 413 people who had completed high school or technical school, and 456 college, university, or postgraduates did not have T2D. This means that 3.03% of total respondents were illiterate and had T2D, 3.57% had graduated intermediate school and had T2D, 1.48% had completed technical or high school and had T2D, and 2.63% were college, university, or postgraduates and had T2D.

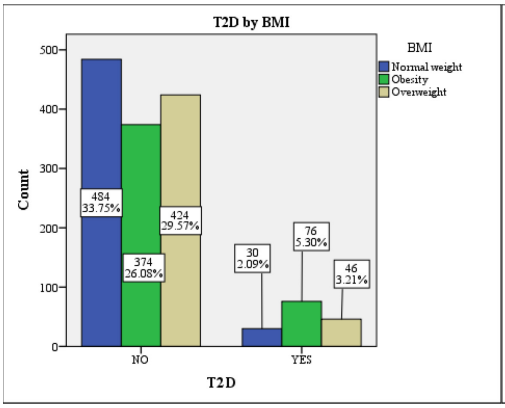


Figure 40: T2D by BMI

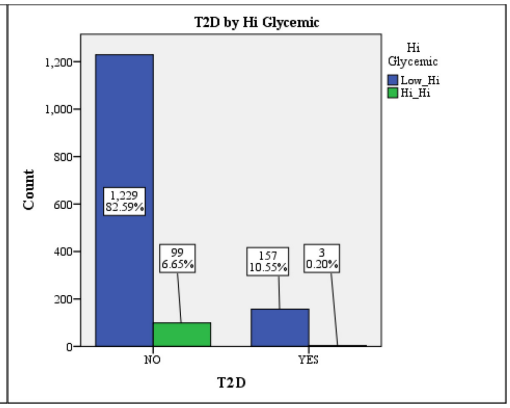


Figure 41: T2D by High Glycemic Diet

Figure 40 shows the T2D breakdown by BMI. When split into groups by BMI, 484 people of normal weight, 374 people who were obese, and 424 people who were overweight did not have T2D. This means that 2.09% of total respondents were of normal weight and had T2D, 5.30% were obese and had T2D, and 3.21% were overweight and had T2D.

Figure 41 shows the T2D breakdown by Diet. When split into groups by high glycemic diet, 1,229 people who ate low-hi glycemic diets and 99 people who ate hi-hi glycemic diets did not have T2D. This means that 10.55% of total respondents ate low-hi glycemic diets and had T2D, and 0.20% ate hi-hi glycemic diets and had T2D.

Table 5: Makkah Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Sex	1488	5.47	1	p=.019*
Age	1488	257.67	2	p<.001***
Marital Status	1487	85.72	2	p<.001***
Education	1484	76.53	3	p<.001***
Work Status	1483	141.23	2	p<.001***
Smoke Status	1482	14.45	2	p=.001**
Smoke Cigarettes	1488	6.54	3	p=.088
Smoke Shish	1488	5.30	2	p=.071
Smoke Hookah	1488	1.15	2	p=.561
Diet – Hi Gl	1488	6.96	1	p=.008**
Diet – Low Gl	1488	1.11	1	p=.290
Body Mass Index	1434	31.41	2	p<.001***

The chi-square of Makkah shows there is a significant relationship between sex and diabetes type 2: (χ^2,1, N=1488) = 5.47, p = .019. Men were more likely to have T2D than women, at 12.5% and 8.8%, respectively.

There is a significant relationship between age and diabetes type 2: (χ^2,2, N=1488) = 257.67, p = .000. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 36.9%, 1.8%, and 25.4%, respectively.

There is a significant relationship between marital status and diabetes type 2: (χ^2,2, N=1487) = 85.72, p = .000. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 28.6%, 0.3%, and 12.20%, respectively.

There is a significant relationship between smoking status and diabetes type 2: (χ^2, 2, N=1482) = 14.45, p = .001. Ex-smokers were more likely to have T2D than those who had never smoked and the daily smokers group, at 20.8%, 9.6%, and 11.6%, respectively.

There is a significant relationship between working status and diabetes type 2: (χ^2, 2, N=1483) = 141.23, p = .000. Retired people were more likely to have T2D than those who were employee or currently unemployed people, at 36.6%, 9.2%, and 5.5%, respectively.

There is a significant relationship between education and diabetes type 2: (χ^2,3, N=1484) = 76.53, p = .000. Those who were illiterate were more likely to have T2D than were those who had completed intermediate school, high school, or post-graduate work, at 29.2%, 13.3%, 5.1%, and 7.9%, respectively.

There is a significant relationship between a high-glycemic diet and diabetes type 2: (χ^2, 1, N=1488) = 6.96, p = .008. People who consumed low-hi glycemic

food were more likely to have T2D than who consumed hi-hi glycemic food, at 11.3% and 2.9%, respectively.

There is no significant relationship between a low-glycemic diet and diabetes type 2: (χ^2, 1, N=1488) = 1.11, p = .290.

There is no significant relationship between smoking shisha and diabetes type 2: (χ^2, 2, N=1488) = 5.30, p = .071.

There is no significant relationship between smoking hookah and diabetes type 2: (χ^2, 2, N=1488) = 1.15, p = .561.

There is no significant relationship between smoking cigarettes and diabetes type 2: (χ^2, 3, N=1488) = 6.54, p = .088.

There is a significant relationship between body mass index (BMI) and diabetes type 2: (χ^2, 2, N=1434) = 31.41, p = .000. Those in the obese group were more likely to have T2D than those in the normal and overweight groups, at 16.9%, 5.8%, and 9.8%, respectively.

Table 6: Makkah Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	11.307	6.495	19.684
	65-105	1	.000	21.908	11.640	41.234
Marital Status	Never married	2	.019			
	Married	1	.020	10.819	1.452	80.592
	Divorced/sep/Wi d	1	.008	16.067	2.057	125.503
	Normal weight	2	.001			
BMI	Obesity	1	.001	2.476	1.486	4.128
	Never	2	.002			
Smoking Status	Ex-Smoker	1	.001	2.631	1.460	4.742
	Constant	1	.000	.001	-6.664	1.028

a. Variable(s) entered on step 1: Age Group, marital Status BMI, Smoking Status,

The logistic model for Makkah shows that there are, in general, significant independent relationships between age and diabetes type 2, BMI (Body Mass Index) and diabetes type 2, marital status and diabetes type 2, and smoking and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 11.3, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and older is 22, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For BMI, the reference category was normal weight (BMI: 18.5 – 24.9). The odds ratio for obese people is 2.5, indicating that obesity carries a higher risk of T2D than normal weight. The odds ratio for overweight people was 1.3 (p-value = 0.35, not significant), indicating that the overweight group has the same risk of T2D as those who have normal weight (6%).

For smoking status, the reference category was non-smokers. The odds ratio for ex-smokers was 2.6, indicating that ex-smokers have a higher risk of T2D than those who have never smoked. The odds ratio for daily smokers is 1.7, (p-value=0.061, not significant), indicating that the daily smoker has the same risk of T2D as a non-smoker (10%).

For marital status, the reference category was the never married group. The odds ratio for the married group is 10.8, indicating that married people have a higher risk of T2D than those who have never been married. The odds ratio for the divorced, widowed and separated group is 16, indicating that this group has a higher risk of T2D than those who never married.

4.4.3 Region Three

Al-Madinah

In Al-Madinah, the population is 2,132,679 people over an area of 839,992. This region has 9 sports clubs, 20 hospitals, and 162 health centers. There are 448 high schools, 700 middle schools, 1,084 elementary schools, and 180 preschools. This region has the most higher education institutions, with 14 universities and nine colleges. Al-Madinah has 17,665 farms.

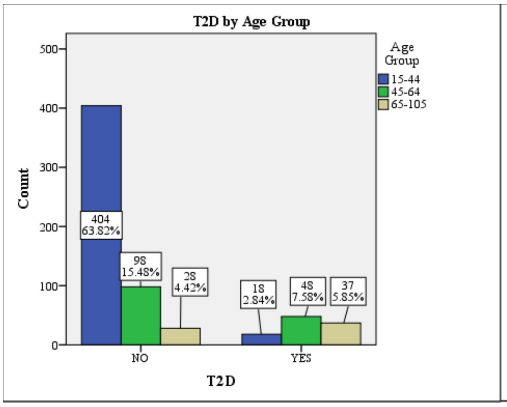


Figure 42: T2D by Age

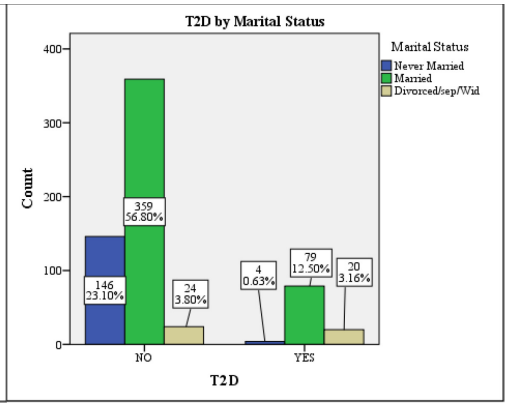


Figure 43: T2D by Marital Status

Figure 42 shows the T2D breakdown by age. When split into age groups, 404 people aged 15- to 44-years-old did not have diabetes. 96 people aged 45- to 64-years-old did not have diabetes. 28 people aged 65+ did not have diabetes. This means that 2.84% of the total respondents were aged 15-44 and had T2D, 7.58% were aged 45-64 with T2D, and 5.85% were aged 65+ and had T2D.

Figure 43 shows the T2D breakdown by marital status. When split into groups by marital status, 146 of those who had never married, 359 married people, and 24 divorced/separated/widowed people did not have T2D. This means that 0.63% of total respondents had never been married and had diabetes, 12.50% were married and had T2D, and 3.16% were divorced/separated/widowed and had T2D.

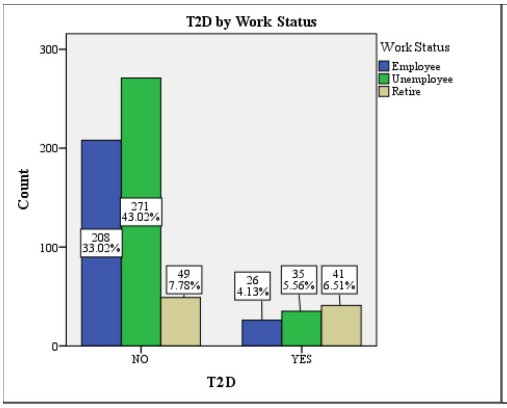


Figure 44: T2D by Work Status

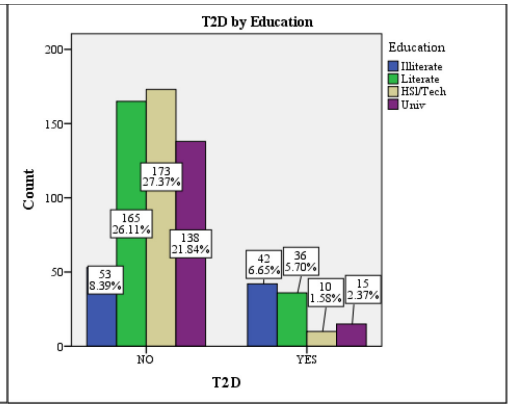


Figure 45: T2D by Education Level

Figure 44 shows the T2D breakdown by work status. When split into groups by work status, 208 employed people, 271 unemployed people, and 49 retired

people did not have T2D. This means that 4.13% of total respondents were employed and had T2D, 5.56% were unemployed and had T2D, and 6.51% were retired and had T2D.

Figure 45 shows the T2D breakdown by education. When split into groups by education level, 53 illiterate people, 165 people who had completed intermediate school, 173 people who had completed high school or technical school, and 138 college, university, or postgraduates did not have T2D. This means that 6.65% of total respondents were illiterate and had T2D, 5.70% had graduated intermediate school and had T2D, 1.58% had completed technical or high school and had T2D, and 2.37% were college, university, or postgraduates and had T2D.

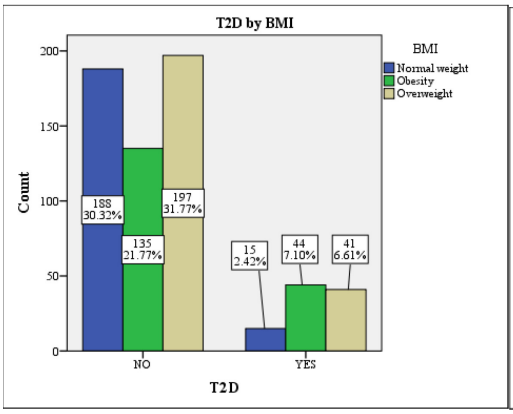


Figure 46: T2D by BMI

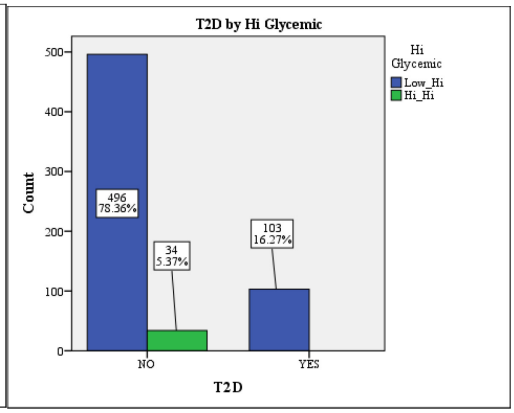


Figure 47: T2D by High Glycemic Diet

Figure 46 shows the T2D breakdown by BMI. When split into groups by BMI, 188 people of normal weight, 135 people who were obese, and 197 people who were overweight did not have T2D. This means that 2.42% of total respondents were of normal weight and had T2D, 7.10% were obese and had T2D, and 6.61% were overweight and had T2D.

Figure 47 shows the T2D breakdown by diet When split into groups by high glycemic diet, 496 people who ate low-hi glycemic diets and 34 people who ate hi-hi glycemic diets did not have T2D. This means that 16.27% of total respondents

ate low-hi glycemic diets and had T2D, and 0% ate hi-hi glycemic diets and had T2D.

Table 7: Al-Madinah Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	633	.564	1	p=.452
Age	633	153.04	2	p<.001***
Marital Status	632	48.82	2	p<.001***
Education	632	75.11	3	p<.001***
Work Status	630	66.73	2	p<.001***
Smoke Status	632	4.01	2	p=.134
Smoke Cigarettes	633	5.73	3	p=.125
Smoke Shish	633	.054	2	p=.973
Smoke Hookah	633	1.77	2	p=.412
Diet – Hi Gl	633	6.98	1	p=.008**
Diet – Low Gl	633	3.48	1	p=.062
Body Mass Index	620	21.12	2	p<.001***

There is no significant relationship between sex and diabetes type 2: (χ^2, 1, N=633) = .564, p = .452.

There is a significant relationship between age and diabetes type 2: (χ^2, 2, N=633) = 153.04, p = .000. People 65 years old and over were more likely to have

T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 56.9%, 4.3%, and 32.9%, respectively.

There is a significant relationship between marital status and diabetes type 2: (χ^2, 2, N=632) = 48.82, p = .000. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 45.5%, 2.7%, and 18.0%, respectively.

There is no significant relationship between smoking status and diabetes type 2: (χ^2, 2, N=632) = 4.01, p = .134.

There is a significant relationship between working status and diabetes type 2: (χ^2, 2, N=630) = 66.73, p = .000. Retired people were more likely to have T2D than those who were employed and currently unemployed, at45.6%, 11.1%, and 11.4%, respectively.

There is a significant relationship between education and diabetes type 2: (χ^2, 3, N=632) = 75.11, p = .000. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, High school, or post-graduate work, at 44.2%, 17.9%, 5.5%, and 9.8%, respectively.

There is a significant relationship between a high-glycemic diet and diabetes type 2: (χ^2, 1, N=633) = 6.98, p = .008. People who consumed low-hi glycemic food were more likely to have T2D than who consumed hi-hi glycemic food, at 17.2% and 0%, respectively.

There is no significant relationship between a low-glycemic diet and diabetes type 2: (χ^2, 1, N=633) = 3.48, p = .62.

There is no significant relationship between smoking shisha and diabetes type 2: (χ^2, 2, N=633) = .054, p = .973.

There is no significant relationship between smoking hookah and diabetes type 2: (χ^2, 2, N=633) = 1.77, p = .412.

There is no significant relationship between smoking cigarettes and diabetes type 2: (χ^2, 3, N=633) = 5.73, p = .125.

There is a significant relationship between body mass index (BMI) and diabetes type 2: (χ^2, 2, N=620) = 21.12, p = .000. The obese group was more likely to have T2D than those in the normal and overweight groups, at 24.4%, 7.4%, and 17.2%, respectively.

Table 8: Al-Madinah Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	9.523	5.257	17.251
	65-105	1	.000	25.879	12.921	51.832
BMI	Normal weight	2	.010			
	Obesity	1	.003	2.927	1.452	5.901
	Constant	1	.000	.025		

a. Variable(s) entered on step 1: Age Group, BMI

The logistic model for Al-Madinah shows that there are, in general, significant independent relationships between age and diabetes type 2, and BMI (Body Mass Index) and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 9.5, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and

older is 25.88, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For BMI, the reference category was people of normal weight (BMI: 18.5 – 24.9). The odds ratio for the obese group is 2.9, indicating that obesity carries a higher risk of T2D than normal weight. The odds ratio for the overweight group is 1.9 (p-value = 0.071, not significant), which indicates that overweight people have the same risk of T2D as those who have normal weight (7%).

4.4.4 Region Four

Eastern

In the Eastern region, the population is 4,900,325 over an area of 3,980,031. There are 36 sports clubs, 35 hospitals, and 250 health centers. There are also 801 high schools, 996 middle schools, 1,520 elementary schools, and 386 preschools. The Eastern region has four universities and five colleges. Eastern has 28,543 farms.

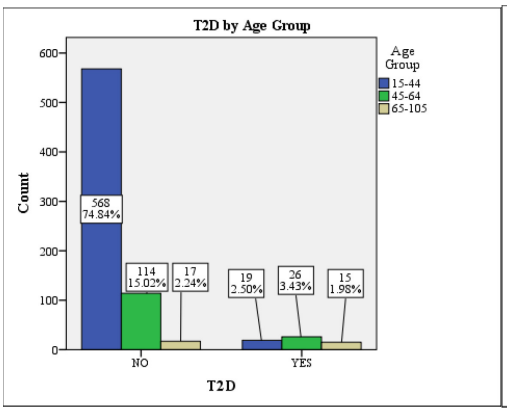


Figure 48: T2D by Age

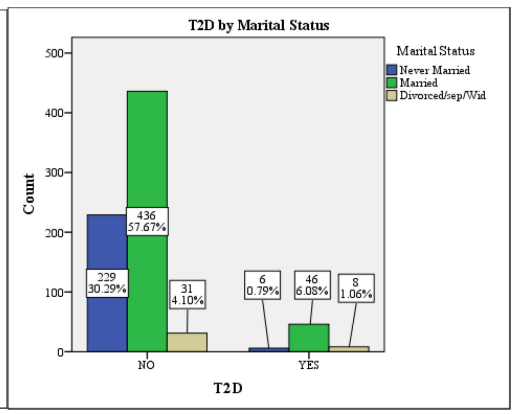


Figure 49: T2D by Marital Status

Figure 48 shows the T2D breakdown by age. When split into age groups, 568 people aged 15- to 44-years-old did not have diabetes. 114 people aged 45- to 64-years-old did not have diabetes. 17 people aged 65+ did not have diabetes. This

means that 2.50% of the total respondents were aged 15-44 and had T2D, 3.43% were aged 45-64 with T2D, and 1.98% were aged 65+ and had T2D.

Figure 49 shows the T2D breakdown by marital status. When split into groups by marital status, 229 of those who had never married, 436 married people, and 31 divorced/separated/widowed people did not have T2D. This means that 0.79% of total respondents had never been married and had diabetes, 6.08% were married and had T2D, and 1.06% were divorced/separated/widowed and had T2D.

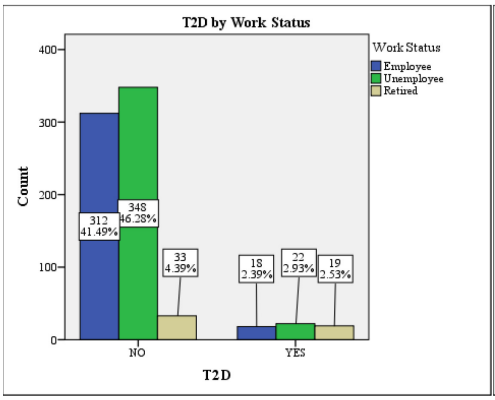


Figure 50:T2D by Work Status

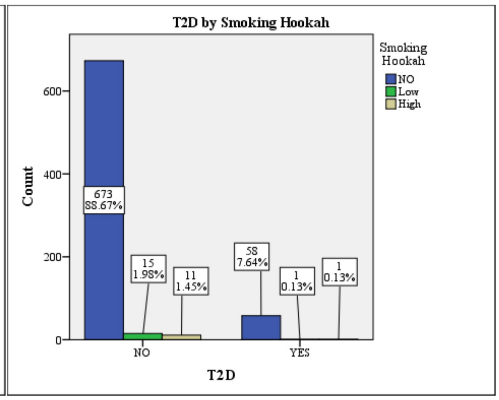


Figure 51: T2D by Hookah Use

Figure 50 shows the T2D breakdown by work status. When split into groups by work status, 312 employed people, 348 unemployed people, and 33 retired people did not have T2D. This means that 2.39% of total respondents were employed and had T2D, 2.93% were unemployed and had T2D, and 2.53% were retired and had T2D.

Figure 51 shows the T2D breakdown by hookah use. When split into groups by hookah use, 673 people who had never smoked hookah, 15 people who smoked small amounts of hookah, and 11 people who smoked large amounts of hookah did not have T2D. This means that 7.64% of total respondents who had never smoked hookah had T2D, 0.13% of those who smoked small amounts of hookah had T2D, and 0.13% smoked large amounts of hookah and had T2D.

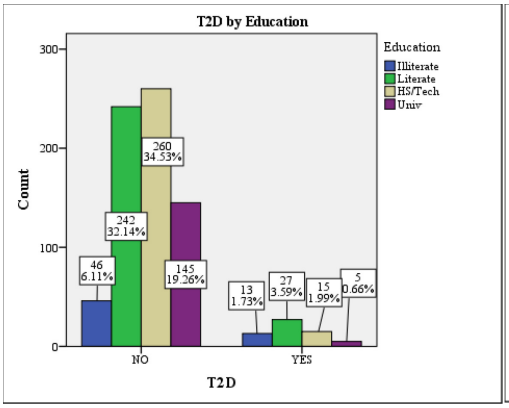


Figure 52: T2D by Education Level

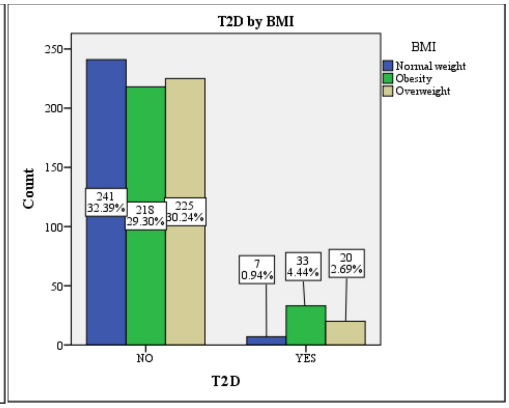


Figure 53: T2D by BMI

Figure 52 shows the T2D breakdown by education. When split into groups by education level, 46 illiterate people, 242 people who had completed intermediate school, 260 people who had completed high school or technical school, and 145 college, university, or postgraduates did not have T2D. This means that 1.73% of total respondents were illiterate and had T2D, 3.59% had graduated intermediate school and had T2D, 1.99% had completed technical or high school and had T2D, and 0.66% were college, university, or postgraduates and had T2D.

Figure 53 shows the T2D breakdown by BMI. When split into groups by BMI, 241 people of normal weight, 218 people who were obese, and 225 people who were overweight did not have T2D. This means that 0.94% of total respondents were of normal weight and had T2D, 4.44% were obese and had T2D, and 2.69% were overweight and had T2D.

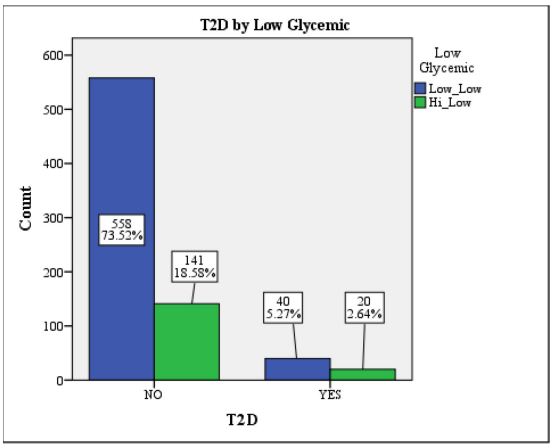


Figure 54: T2D by Low Glycemic Diet

Figure 54 shows the T2D breakdown by diet. When split into groups by low glycemic diet, 558 people who ate low-low glycemic diets and 141 people who ate hi-low glycemic diets did not have T2D. This means that 5.27% of total respondents ate low-low glycemic diets and had T2D, and 2.64% ate hi-low glycemic diets and had T2D.

Table 9: Eastern Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	759	.858	1	p=.354
Age	759	109.20	2	p<.001***
Marital Status	756	19.46	2	p<.001***
Education	753	24.25	3	p<.001***
Work Status	752	39.33	2	p<.001***
Smoke Status	754	3.21	2	p=.200
Smoke Cigarettes	759	5.93	3	p=.115
Smoke Shish	759	10.61	2	p=.006**
Smoke Hookah	759	.064	2	p=.968
Diet – Hi Gl	759	1.74	1	p=.187
Diet – Low Gl	759	5.72	1	p=.017*
Body Mass Index	744	17.94	2	p<.001***

There is no significant relationship between sex and diabetes type 2: (χ^2,1, N=759) = .858, p = .354.

There is a significant relationship between age and diabetes type 2: (χ^2,2, N=759) = 109.20, p = .000. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 49.9%, 3.2%, and 18.6%, respectively.

There is a significant relationship between marital status and diabetes type 2: (χ^2,2, N=756) = 19.46, p = .000. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 20.5%, 2.6%, and 9.5%, respectively.

There is no significant relationship between smoking status and diabetes type 2: (χ^2,2, N=754) = 3.21, p = .200.

There is a significant relationship between working status and diabetes type 2: (χ^2,2, N=752) = 39.33, p = .000. Fisher's. Retired people were more likely to have T2D than those who were employed or currently unemployed, at 36.5%, 5.5%, and 5.9%, respectively.

There is a significant relationship between education level and diabetes type 2: (χ^2,3, N=753) = 24.25, p = .000. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 22.0%, 10.0%, 5.5%, and 3.3%, respectively.

There is no significant relationship between a high-glycemic diet and diabetes type 2: (χ^2,1, N=759) = 1.74, p = .187.

There is a significant relationship between a low-glycemic diet and diabetes type 2: (χ^2,1, N=759) = 5.72, p = .017. People who consumed hi-low glycemic food

were more likely to have T2D than who consumed low-low glycemic food, at 12.4% and 6.7%, respectively.

There is a significant relationship between smoking shisha and diabetes type 2: (χ^2,2, N=759) = 10.61, p = .006. Fisher's. People who smoked shisha more often were more likely to have T2D than nonsmokers and those who smoked small amounts of shisha, at 60.0%, 7.6%, and 0%, respectively.

There is no significant relationship between smoking hookah and diabetes type 2: (χ^2,2, N=759) = .064, p = .968.

There is no significant relationship between smoking cigarettes and diabetes type 2: (χ^2,3, N=759) = 5.93, p = .115.

There is a significant relationship between body mass index (BMI) and diabetes type 2: (χ^2,2, N=744) = 17.94, p = .000. Those in the obese group were more likely to have T2D than both the normal and overweight groups, at 13.1%, 2.8%, and 8.2%, respectively.

Table 10: Eastern Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	4.792	2.390	9.609
	65-105	1	.000	18.017	6.698	48.463
Work Status	Employee	2	.044			
	Retired	1	.014	2.997	1.246	7.209
BMI	Normal weight	2	.006			
	Obesity	1	.002	4.277	1.706	10.723
	Constant	1	.000	.012		

a. Variable(s) entered on step 1: Age Group, Work Status, BMI.

The logistic model for Eastern shows that there are, in general, significant independent relationships between age and diabetes type 2, BMI (Body Mass Index) and diabetes type 2, and work status and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 4.8, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and older is 18, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For BMI, the reference category was normal weight people (BMI: 18.5 – 24.9). The odds ratio for the obese group was 4.3, indicating that obese people have a higher risk of T2D than people of normal weight.

For work status, the reference category was employed people. The odds ratio for the retired group is 3, indicating that those who are retired have a higher risk of T2D than the employed group.

4.4.5 Region Five

Northern Borders

Northern Borders is the least populated region, with only 365,231 people, over an area of 27,839. There are three sports clubs, nine hospitals, and 47 health centers. There are 128 high schools, 151 middle schools, 235 elementary schools, and 36 preschools. Northern Borders has only one university. There are only 213 farms in Northern Borders.

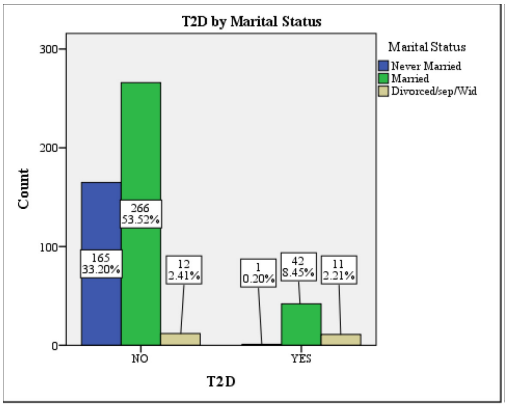


Figure 55: T2D by Age

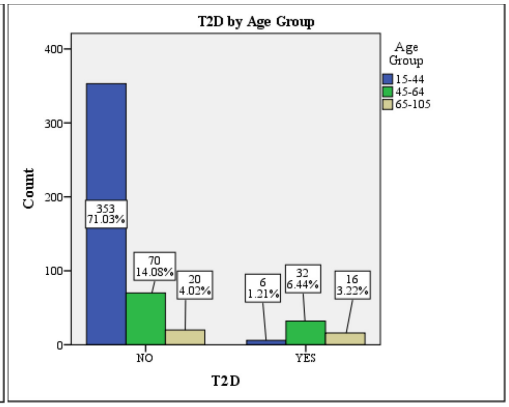


Figure 56: T2D by Marital Status

Figure 55 shows the T2D breakdown by age. When split into age groups, 353 people aged 15- to 44-years-old did not have diabetes. 70 people aged 45- to 64-years-old did not have diabetes. 20 people aged 65+ did not have diabetes. This means that 1.21% of the total respondents were aged 15-44 and had T2D, 6.44% were aged 45-64 with T2D, and 3.22% were aged 65+ and had T2D.

Figure 56 shows the T2D breakdown by marital status. When split into groups by marital status, 165 of those never married, 266 married people, and 12 divorced/separated/widowed people did not have T2D. This means that 0.20% of total respondents had never been married and had diabetes, 8.45% were married and had T2D, and 2.21% were divorced/separated/widowed and had T2D.

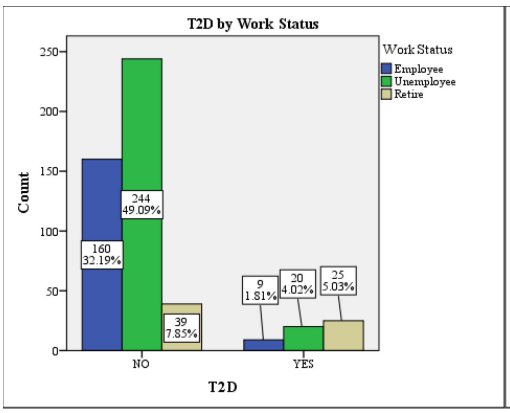


Figure 57: T2D by Work Status

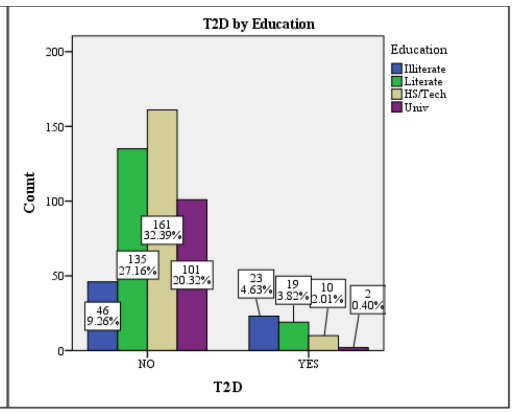


Figure 58: T2D by Education Level

Figure 57 shows the T2D breakdown by work status. When split into groups by work status, 160 employed people, 244 unemployed people, and 39 retired

people did not have T2D. This means that 1.81% of total respondents were employed and had T2D, 4.02% were unemployed and had T2D, and 5.03% were retired and had T2D.

Figure 58 shows the T2D breakdown by education. When split into groups by education level, 46 illiterate people, 135 people who had completed intermediate school, 161 people who had completed high school or technical school, and 101 college, university, or postgraduates did not have T2D. This means that 4.63% of total respondents were illiterate and had T2D, 3.82% had graduated intermediate school and had T2D, 2.01% had completed technical or high school and had T2D, and 0.40% were college, university, or postgraduates and had T2D.

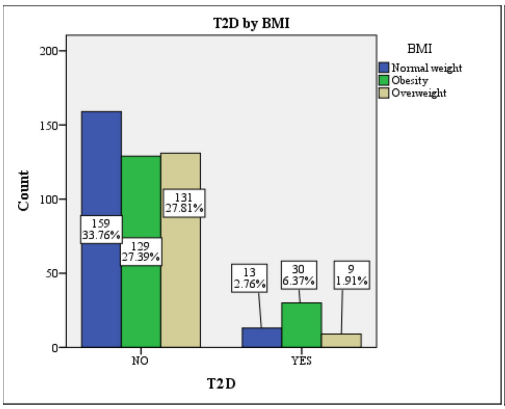


Figure 59: T2D by BMI

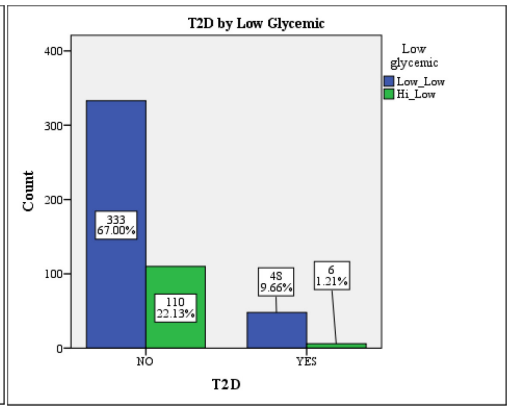


Figure 60: T2D by Low Glycemic Diet

Figure 59 shows the T2D breakdown by BMI. When split into groups by BMI, 159 people of normal weight, 129 people who were obese, and 131 people who were overweight did not have T2D. This means that 2.76% of total respondents were of normal weight and had T2D, 6.37% were obese and had T2D, and 1.91% were overweight and had T2D.

Figure 60 shows the T2D breakdown by diet. When split into groups by low glycemic diet, 333 people who ate low-low glycemic diets and 110 people who ate hi-low glycemic diets did not have T2D. This means that 9.66% of total respondents

ate low-low glycemic diets and had T2D, and 1.21% ate hi-low glycemic diets and had T2D.

Table 11: Northern Borders Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	497	.089	1	p=.766
Age	497	117.54	2	p<.001***
Marital Status	497	52.93	2	p<.001***
Education	497	49.22	3	p<.001***
Work Status	497	60.84	2	p<.001***
Smoke Status	497	1.63	2	p=.441
Smoke Cigarettes	497	6.84	3	p=.077
Smoke Shish	497	.512	2	p=.774
Smoke Hookah	497	1.75	2	p=.416
Diet – Hi Gl	497	3.08	1	p=.079
Diet – Low Gl	497	5.06	1	p=.024*
Body Mass Index	471	15.07	2	p=.001**

There is no significant relationship between sex and diabetes type 2: (χ^2,1, N=497) = .089, p = .766.

There is a significant relationship between age and diabetes type 2: (χ^2,2, N=497) = 117.54, p = .000. People 65 years old and over were more likely to have

T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 44.4%, 1.7%, and 31.4%, respectively.

There is a significant relationship between marital status and diabetes type 2: (χ^2,2, N=497) = 52.93, p = .000. The divorced/separated/widowed group was more likely to have T2D than those who were never been married and married people, at 47.8%, 0.6%, and 13.6%, respectively.

There is no significant relationship between smoking status and diabetes type 2: (χ^2,2, N=497) = 1.63, p = .441.

There is a significant relationship between working status and diabetes type 2: (χ^2,2, N=497) = 60.84, p = .000. Retired people were more likely to have T2D than those who were employed or currently unemployed, at 39.1%, 5.3%, and 7.6%, respectively.

There is a significant relationship between education and diabetes type 2: (χ^2,3, N=497) = 49.22, p = .000. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 33.3%, 12.3%, 5.8%, and 1.9%, respectively.

There is no significant relationship between a high-glycemic diet and diabetes type 2: (χ^2,1, N=497) = 3.08, p = .079.

There is a significant relationship between a low-glycemic diet and diabetes type 2: (χ^2,1, N=497) = 5.06, p = .024. People who consumed low-low glycemic food were more likely to have T2D than who consumed hi-low glycemic food, at 12.6% and 5.2%, respectively.

There is no significant relationship between smoking shisha and diabetes type 2: (χ^2,2, N=497) = .512, p = .774.

There is no significant relationship between smoking hookah and diabetes type 2: (χ^2,2, N=497) = 1.75, p = .416.

There is no significant relationship between smoking cigarettes and diabetes type 2: (χ^2,3, N=497) = 6.84, p = .077.

There is a significant relationship between body mass index (BMI) and diabetes type 2: (χ^2,2, N=471) = 15,07 p = .001. Those in the obese group were more likely to have T2D than those in both the normal and overweight groups, at 18.9%, 7.6%, and 6.4%, respectively.

Table 12: Northern Borders Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	29.692	10.838	81.343
	65-105	1	.000	59.150	19.159	182.615
	Normal weight	2	.034			
BMI	Overweight	1	.009	3.223	1.332	7.794

a. Variable(s) entered on step 1: Age Group, BMI

The logistic model for Northern Borders shows that there are, in general, significant independent relationships between age and diabetes type 2, and BMI (Body Mass Index) and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 29.7, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and older is 59.15, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For BMI, the reference category was people of normal weight (BMI: 18.5 – 24.9). The odds ratio for the overweight group is 3.22, indicating that overweight people have a higher risk of T2D than people of normal weight.

4.4.6 Region Six

Al-Jouf

The population of Al-Jouf is 508,475 people. There are six sports clubs, 13 hospitals, and 61 health centers. This region has 178 high schools, 235 middle schools, 361 elementary schools, and 60 preschools. Al-Jouf also has two universities and one college.

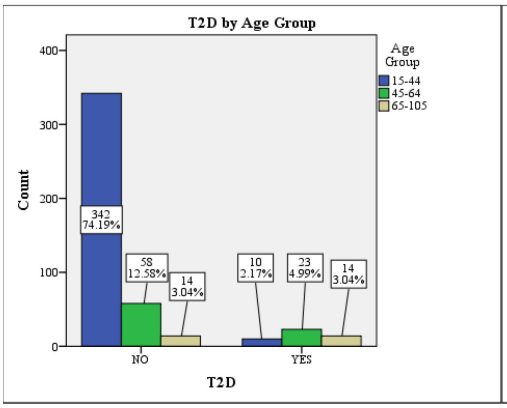


Figure 61: T2D by Age

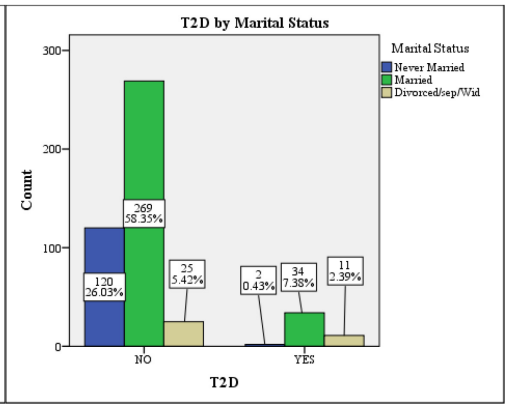


Figure 62: T2D by Marital Status

Figure 61 shows the T2D breakdown by age. When split into age groups, 342 people aged 15- to 44-years-old did not have diabetes. 58 people aged 45- to 64-years-old did not have diabetes. 14 people aged 65+ did not have diabetes. This means that 2.17% of the total respondents were aged 15-44 and had T2D, 4.99% were aged 45-64 with T2D, and 3.04% were aged 65+ and had T2D.

Figure 62 shows the T2D breakdown by marital status. When split into groups by marital status, 120 of those who had never married, 269 married people, and 25 divorced/separated/widowed people did not have T2D. This means that 0.43% of

total respondents had never been married and had diabetes, 7.38% were married and had T2D, and 2.39% were divorced/separated/widowed and had T2D.

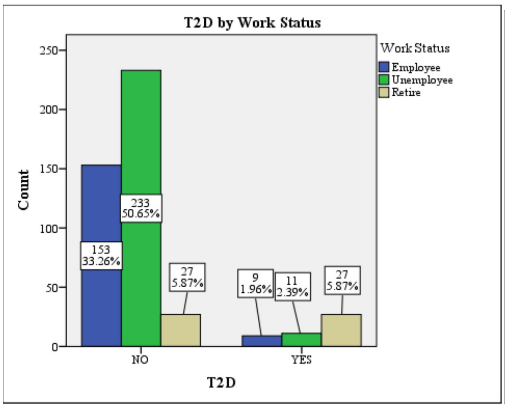


Figure 63: T2D by Work Status

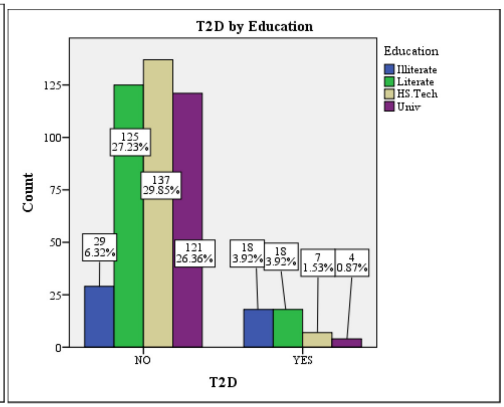


Figure 64: T2D by Education Level

Figure 63 shows the T2D breakdown by work status. When split into groups by work status, 153 employed people, 233 unemployed people, and 27 retired people did not have T2D. This means that 1.96% of total respondents were employed and had T2D, 2.39% were unemployed and had T2D, and 5.87% were retired and had T2D.

Figure 64 shows the T2D breakdown by education. When split into groups by education level, 29 illiterate people, 125 people who had completed intermediate school, 137 people who had completed high school or technical school, and 121 college, university, or postgraduates did not have T2D. This means that 3.92% of total respondents were illiterate and had T2D, 3.92% had graduated intermediate school and had T2D, 1.53% had completed technical or high school and had T2D, and 0.87% were college, university, or postgraduates and had T2D.

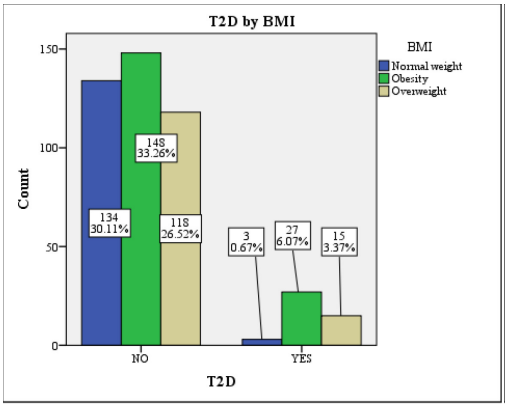


Figure 65: T2D by BMI

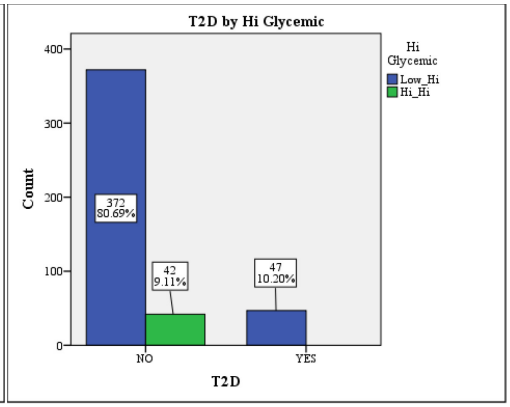


Figure 66: T2D by High Glycemic Diet

Figure 65 shows the T2D breakdown by BMI. When split into groups by BMI, 134 people of normal weight, 148 people who were obese, and 118 people who were overweight did not have T2D. This means that 0.67% of total respondents were of normal weight and had T2D, 6.07% were obese and had T2D, and 3.37% were overweight and had T2D.

Figure 66 shows the T2D breakdown by diet. When split into groups by high glycemic diet, 372 people who ate low-hi glycemic diets and 42 people who ate hi-hi glycemic diets did not have T2D. This means that 10.20% of total respondents ate low-hi glycemic diets and had T2D, and 0% ate hi-hi glycemic diets and had T2D.

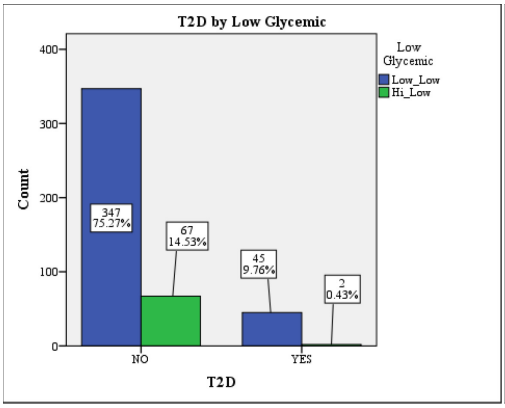


Figure 67: T2D by Low Glycemic Diet

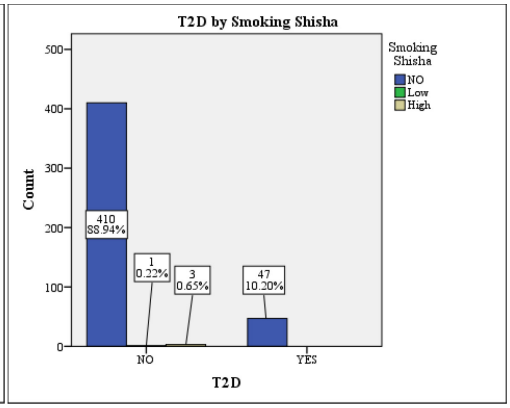


Figure 68: T2D by Shisha Use

Figure 67 shows the T2D breakdown by diet. When split into groups by low glycemic diet, 347 people who ate low-low glycemic diets and 67 people who ate

hi-low glycemic diets did not have T2D. This means that 9.78 % of total respondents ate low-low glycemic diets and had T2D, and 0.43% ate hi-low glycemic diets and had T2D.

Figure 68 shows the T2D breakdown by shisha use. When split into groups by shisha use, 410 people who had never smoked shisha, 1 people who smoked small amounts of shisha, and 3 people who smoked large amounts of shisha did not have T2D. This means that 10.20% of total respondents who had never smoked shisha had T2D, 0% of those who smoked small amounts of shisha had T2D, and 0% smoked large amounts of shisha and had T2D.

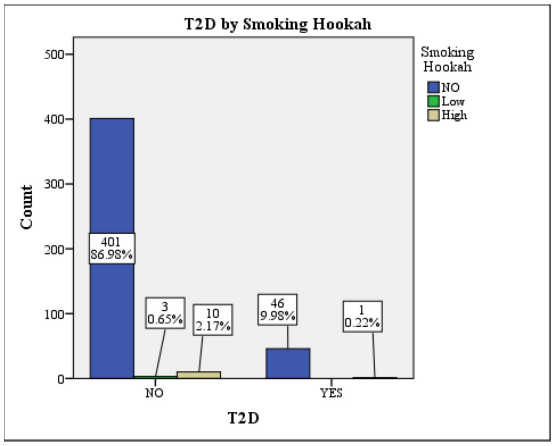


Figure 69: T2D by Hookah Use

Figure 69shows the T2D breakdown by hookah use. When split into groups by hookah use, 401 people who had never smoked hookah, 3 people who smoked small amounts of hookah, and 10 people who smoked large amounts of hookah did not have T2D. 9.98 % of total respondents who had never smoked hookah had T2D, and 0.22% smoked large amounts of hookah and had T2D.

Table 13: Al-Jouf Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	461	.211	1	p=.646
Age	461	77.89	2	p<.001***
Marital Status	461	25.45	2	p<.001***
Education	459	40.46	3	p<.001***
Work Status	460	105.67	2	p<.001***
Smoke Status	460	.898	2	p=.638
Smoke Cigarettes	461	.344	3	p=.952
Smoke Shish	461	.458	2	p=.795
Smoke Hookah	461	.360	2	p=.952
Diet – Hi Gl	461	5.24	1	p=.022*
Diet – Low Gl	461	4.71	1	p=.030*
Body Mass Index	445	15.10	2	p=.001**

There is no significant relationship between sex and diabetes type 2: (χ^2,1, N=461) = .211, p = .646.

There is a significant relationship between age and diabetes type 2: (χ^2,2, N=461) = 77.89, p = .000. Fisher's. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 50.0%, 2.8%, and 28.4%, respectively.

There is a significant relationship between marital status and diabetes type 2: (χ^2,2, N=461) = 25.45, p = .000. Fisher's. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 30.6%, 1.6%, and 11.2%, respectively.

There is no significant relationship between smoking status and diabetes type 2: (χ^2,2, N=460) = .898, p = .638.

There is a significant relationship between working status and diabetes type 2: (χ^2,2, N=460) = 105.67, p = .000. Retired people were more likely to have T2D than those who were employed or currently unemployed, at 50.0%, 5.6%, and 4.5%, respectively.

There is a significant relationship between education and diabetes type 2: (χ^2,3, N=459) = 40.46, p = .000. Fisher's. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at (38.3%, 12.6%, 4.9%, 3.2%) respectively.

There is a significant relationship between a high-glycemic diet and diabetes type 2: (χ^2,1, N=461) = 5.24, p = .022. People who consumed low-hi glycemic food were more likely to have T2D than those who consumed hi-hi glycemic food, at 11.2% and 0%, respectively.

There is a significant relationship between a low-glycemic diet and diabetes type 2: (χ^2,1, N=461) = 4.71, p = .030. People who consumed low-low glycemic food were more likely to have T2D than those who consumed hi-low glycemic food, at 11.5% and 2.9%, respectively.

There is no significant relationship between smoking shisha and diabetes type 2: (χ^2,2, N=461) = .458, p = .795.

There is no significant relationship between smoking hookah and diabetes type 2: (χ^2,2, N=461) = .360, p = .835.

There is no significant relationship between smoking cigarettes and diabetes type 2: (χ^2,3, N=461) = .344, p = .952.

There is a significant relationship between body mass index (BMI) and diabetes type 2: (χ^2,2, N=445) = 15.10, p = .001. Those in the obese group were more likely to have T2D than those in both the normal and overweight groups, at 15.4%, 2.2 %, and 11.3%, respectively.

Table 14: Al-Jouf Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	6.736	2.668	17.010
	65-105	1	.002	7.763	2.160	27.891
Work Status	Employee	2	.001			
	Retired	1	.006	4.606	1.561	13.589
	Normal weight	2	.037			
BMI	Obesity	1	.013	5.315	1.421	19.879
	Overweight	1	.016	5.515	1.381	22.032
	Constant	1	.000	.008		

a. Variable(s) entered on step 1: Age_Group, Work.St, BMI.

The logistic model for Al-Jouf shows that there are, in general, significant independent relationships between age and diabetes type 2, work status and diabetes type 2, and BMI (Body Mass Index) and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 6.7, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and older is 7.8, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For work status, the reference category was employed people. The odds ratio for the retired is 4.6, indicating that those who have retired have a higher risk of T2D than the employed group.

For BMI, the reference category was people of normal weight (BMI: 18.5 – 24.9). The odds ratio for the obese group is 5.3, indicating that obese people have a higher risk of T2D than people of normal weight. The odds ratio for overweight people is 5.5, indicating that overweight people have a higher risk of T2D than people of normal weight.

4.4.7 Region Seven

Tabuk

In Tabuk, the population is 910,030 people. This region has seven sports clubs, 11 hospitals, and 83 health centers. There are 136 high schools, 334 middle schools, 513 elementary schools, and 86 preschools. Tabuk also has one university and one college.

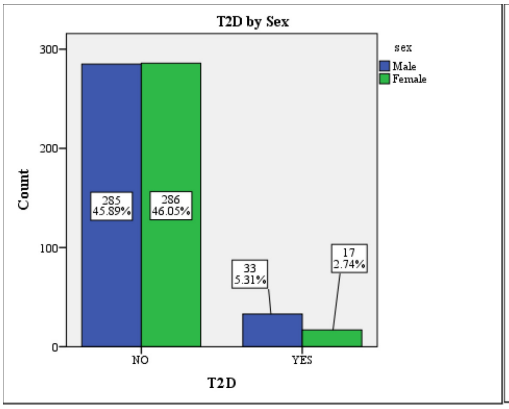


Figure 70: T2D by Sex

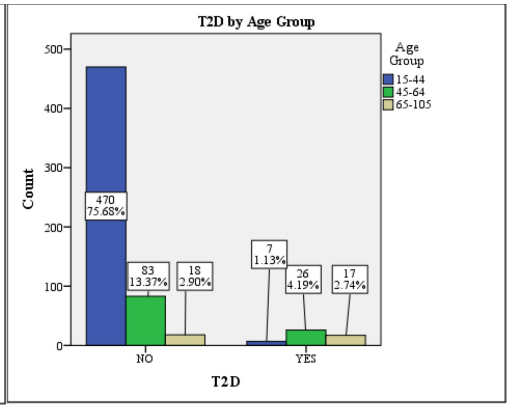


Figure 71: T2D by Age

Figure 70 shows the T2D breakdown by sex. Of the 571 respondents, 285 men and 286 women did not have diabetes. 33 men and 17 women did have T2D; 5.31 % of the total respondents were men with T2D, and 2.74 % were women affected by this disease.

Figure 71 shows the T2D breakdown by age. When split into age groups, 470 people aged 15- to 44-years-old did not have diabetes. 83 people aged 45- to 64-years-old did not have diabetes. 18 people aged 65+ did not have diabetes. This means that 1.13 % of the total respondents were aged 15-44 and had T2D, 4.19 % were aged 45-64 with T2D, and 2.74 % were aged 65+ and had T2D.

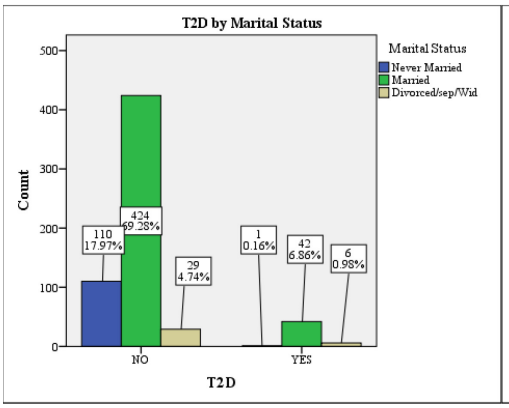


Figure 72: T2D by Marital Status

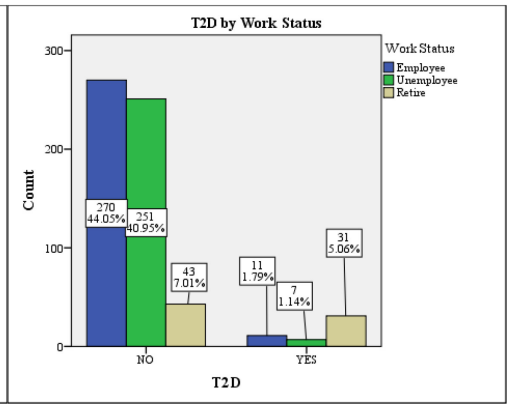


Figure 73: T2D by Work Status

Figure 72 shows the T2D breakdown by marital status. When split into groups by marital status, 110 never married people, 424 married people, and 29 divorced/separated/widowed people did not have T2D. This means that 0.16% of

total respondents had never been married and had diabetes, 6.86 % were married and had T2D, and 0.98 % were divorced/separated/widowed and had T2D.

Figure 73 shows the T2D breakdown by work status. When split into groups by work status, 270 employed people, 251 unemployed people, and 43 retired people did not have T2D. This means that 1.79 % of total respondents were employed and had T2D, 1.14 % were unemployed and had T2D, and 5.06 % were retired and had T2D.

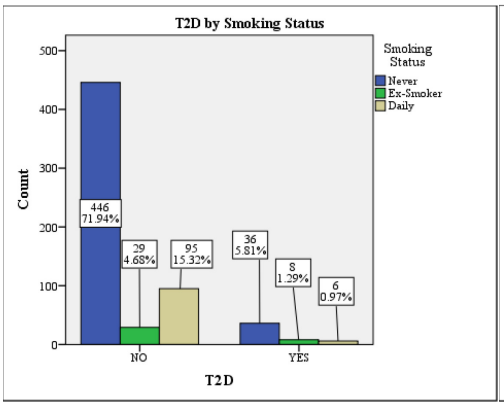


Figure 74: T2D by Smoking Status

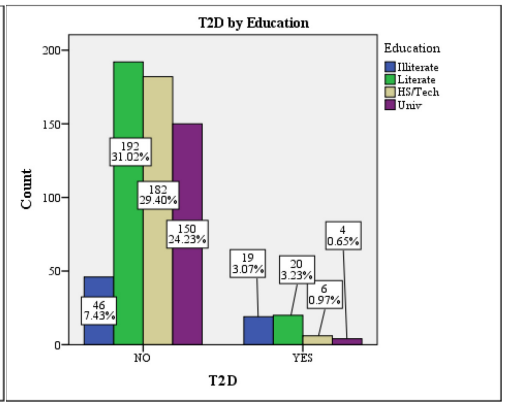


Figure 75: T2D by Education Level

Figure 74 shows the T2D breakdown by smoking. When split into groups by smoking status, 446 non-smokers, 29 ex-smokers, and 95 daily smokers did not have T2D. This means that 5.81 % of total respondents were non-smokers and had T2D, 1.29 % were ex-smokers and had T2D, and 0.97 % were daily smokers and had T2D.

Figure 75 shows the T2D breakdown by education. When split into groups by education level, 46 illiterate people, 192 people who completed intermediate school, 182 people who had completed high school or technical school, and 150 college, university, or postgraduates did not have T2D. This means that 3.07 % of total respondents were illiterate and had T2D, 3.23 % had graduated intermediate school and had T2D, 0.97 % had completed technical or high school and had T2D, and 0.65 % were college, university, or postgraduates and had T2D.

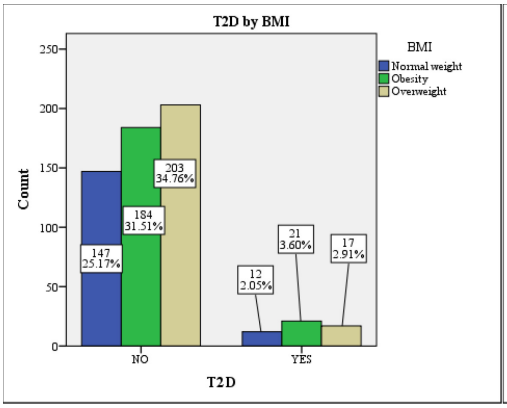


Figure 76: T2D by BMI

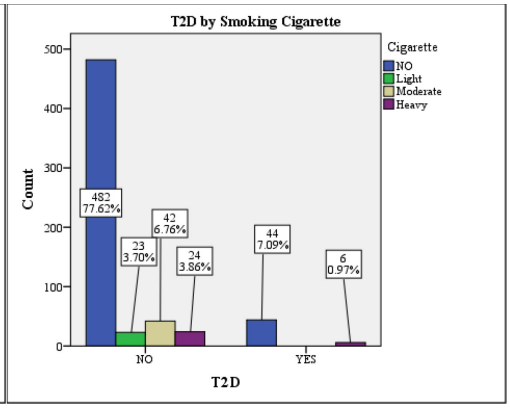


Figure 77: T2D by Cigarette Use

Figure 76 shows the T2D breakdown by BMI. When split into groups by BMI, 147 people of normal weight, 184 people who were obese, and 203 people who were overweight did not have T2D. This means that 2.05% of total respondents were of normal weight and had T2D, 3.60% were obese and had T2D, and 2.91 % were overweight and had T2D.

Figure 77 shows the T2D breakdown by cigarette. When split into groups by cigarette use, 482 people who had never smoked cigarettes, 23 people who lightly smoked cigarettes, 42 people who moderately smoked cigarettes, and 24 people who smoked cigarettes heavily did not have T2D. This means that 7.09 % of total respondents who had never smoked cigarettes had T2D, 0% of moderate cigarette smokers had T2D, and 0.97% of heavy cigarette smokers had T2D.

Table 15: Tabuk Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	621	4.76	1	p=.029*
Age	621	107.05	2	p<.001***
Marital Status	612	14.53	2	p=.001**
Education	619	52.91	3	p<.001***
Work Status	613	131.75	2	p<.001***
Smoke Status	620	7.95	2	p=.015*
Smoke Cigarettes	621	10.71	3	p=.008**
Smoke Shish	621	1.80	2	p=.406
Smoke Hookah	621	1.25	2	p=.534
Diet – Hi Gl	621	2.05	1	p=.152
Diet – Low Gl	621	.227	1	p=.634
Body Mass Index	584	1.14	2	p=.564

There is a significant relationship between sex and diabetes type 2: (χ^2,1, N=621) = 4.76, p = .029. Men were more likely to have T2D than women, at 10.4% and 5.6%, respectively.

There is a significant relationship between age and diabetes type 2: (χ^2,2, N=621) = 107.05, p = .000. Fisher's. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 48.6%, 1.5%, and 23.9%, respectively.

There is a significant relationship between marital status and diabetes type 2: (χ^2,2, N=612) = 14.53, p = .001. Fisher's. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 17.1%, 0.9%, and 9.0%, respectively.

There is a significant relationship between smoking status and diabetes type 2: (χ^2,2, N=620) = 7.95, p = .015. Fisher's. Ex-smokers were more likely to have T2D than those who had never smoked and the daily smoker group, at 21.6%, 7.5, and 5.9%, respectively.

There is a significant relationship between working status and diabetes type 2: (χ^2,2, N=613) = 131.75, p = .000. Retired people were more likely to have T2D than those who were employed or currently unemployed, at 41.9%, 3.9%, and 2.7%, respectively.

There is a significant relationship between education and diabetes type 2: (χ^2,3, N=619) = 52.91, p = .000. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 29.2%, 9.4%, 3.2%, and 2.6%, respectively.

There is no significant relationship between a high-glycemic diet and diabetes type 2: (χ^2,1, N=621) = 2.05, p = .152.

There is no significant relationship between a low-glycemic diet and diabetes type 2: (χ^2,1, N= 621) = .227, p = .634.

There is no significant relationship between smoking shisha and diabetes type 2: (χ^2,2, N=621) = 1.80, p = .406.

There is no significant relationship between smoking hookah and diabetes type 2: (χ^2,2, N= 621) = 1.25, p = .534.

People who smoked hookah occasionally were more likely to have T2D than nonsmoking and those who smoked hookah often, at 35.3%, 9.1%, and 13.3%, respectively.

There is a significant relationship between smoking cigarettes and diabetes type 2: (χ^2,3, N=621) = 10.71, p = .008. Fisher's. Heavy smoking was more likely to have T2D than who never smoked, light smokers, and moderate smokers, at 20.0%, 8.4%, 0%, and 0%, respectively.

There is no significant relationship between body mass index (BMI) and diabetes type 2: (χ^2,2, N=584) = 1.14, p = .564.

Table 16: Tabuk Logistic Regression Table

					95% C.I.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	12.173	4.669	31.739
	65-105	1	.000	20.301	6.056	68.057
Work	Employee	2	.003			
Status	Retired	1	.008	3.449	1.388	8.570

a. Variable(s) entered on step 1: Age Group, Work Status.

The logistic model for Tabuk shows that there are, in general, significant independent relationships between age and diabetes type 2, and work status and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 12.17, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and older is 20.30, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For work status, the reference category was employed people. The odds ratio for the retired is 3.45, indicating that those who have retired have a higher risk of T2D than the employed group.

4.4.8 Region Eight

Hail

The population of Hail is 699,774 people. There are 10 sports clubs, 12 hospitals, and 105 health centers. There are also 248 high schools, 351 middle schools, 656 elementary schools, and 75 preschools. They have only one university.

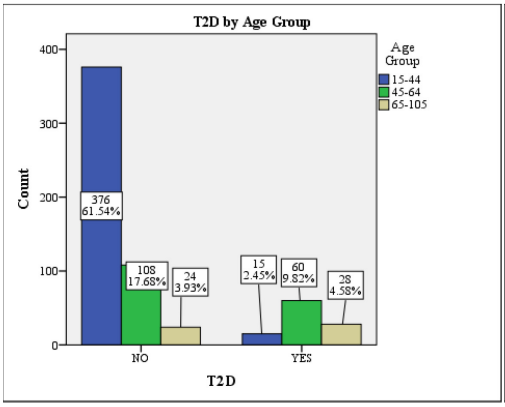


Figure 78: T2D by Age

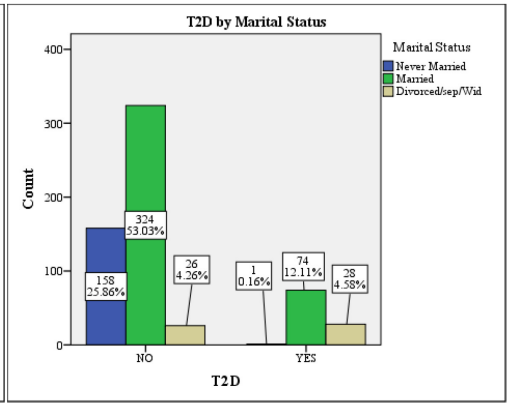


Figure 79: T2D by Marital Status

Figure 78 shows the T2D breakdown by age. When split into age groups, 376 people aged 15- to 44-years-old did not have diabetes. 108 people aged 45- to 64-years-old did not have diabetes. 24 people aged 65+ did not have diabetes. This means that 2.45% of the total respondents were aged 15-44 and had T2D, 9.82% were aged 45-64 with T2D, and 4.58% were aged 65+ and had T2D.

Figure 79 shows the T2D breakdown by marital status. When split into groups by marital status, 158 of those never married, 324 married, and 26 divorced/separated/widowed people did not have T2D. This means that 0.16% of

total respondents had never been married and had diabetes, 12.11% were married and had T2D, and 4.58% were divorced/separated/widowed and had T2D.

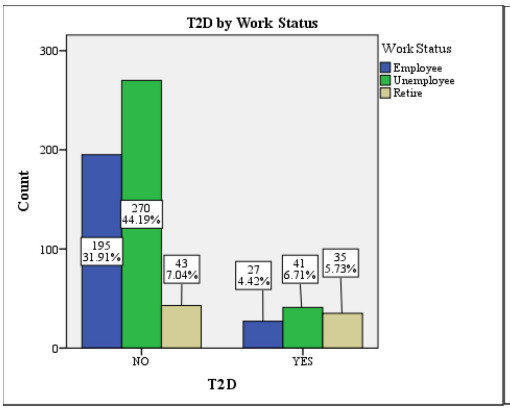


Figure 80: T2D by Work Status

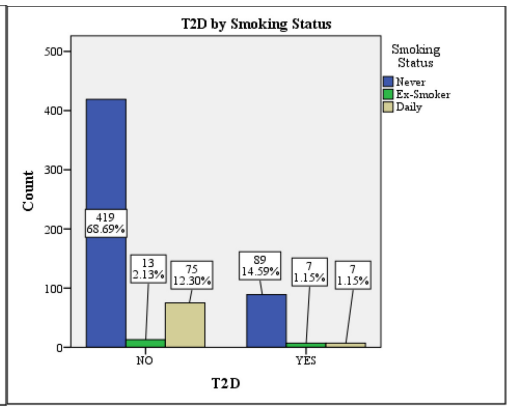


Figure 81: T2D by Smoking Status

Figure 80 shows the T2D breakdown by work status. When split into groups by work status, 195 employed people, 270 unemployed people, and 43 retired people did not have T2D. This means that 4.42% of total respondents were employed and had T2D, 6.71% were unemployed and had T2D, and 5.73% were retired and had T2D.

Figure 81 shows the T2D breakdown by smoking. When split into groups by smoking status, 419 non-smokers, 13 ex-smokers, and 75 daily smokers did not have T2D. This means that 14.59% of total respondents were non-smokers and had T2D, 1.15% were ex-smokers and had T2D, and 1.15% were daily smokers and had T2D.

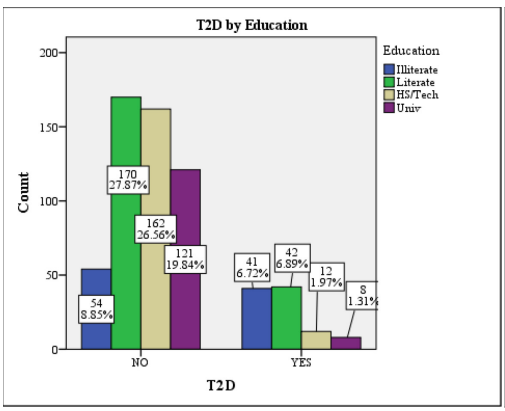


Figure 82: T2D by Education Level

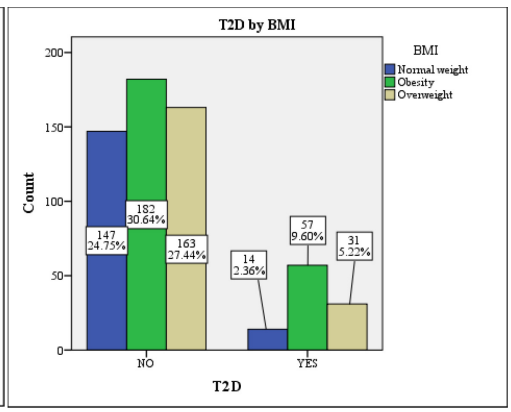


Figure 83: T2D by BMI

Figure 82 shows the T2D breakdown by education. When split into groups by education level, 54 illiterate people, 170 people who had completed intermediate school, 162 people who had completed high school or technical school, and 121 college, university, or postgraduates did not have T2D. This means that 6.72% of total respondents were illiterate and had T2D, 6.89% had graduated intermediate school and had T2D, 1.97% had completed technical or high school and had T2D, and 1.31% were college, university, or postgraduates and had T2D.

Figure 83 shows the T2D breakdown by BMI. When split into groups by BMI, 147 people of normal weight, 182 people who were obese, and 163 people who were overweight did not have T2D. This means that 2.36% of total respondents were of normal weight and had T2D, 9.60% were obese and had T2D, and 5.22% were overweight and had T2D.

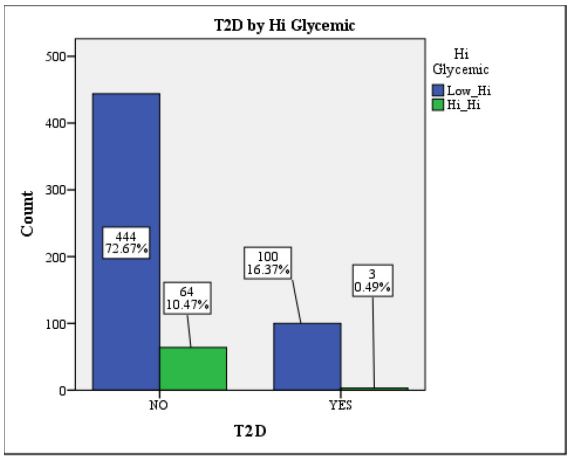


Figure 84: T2D by High Glycemic Diet

Figure 84 shows the T2D breakdown by diet. When split into groups by high glycemic diet, 444 people who ate low-hi glycemic diets and 64 people who ate hi-hi glycemic diets did not have T2D. This means that 16.37% of total respondents ate low-hi glycemic diets and had T2D, and 0.49% ate hi-hi glycemic diets and had T2D.

Table 17: Hail Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	611	.410	1	p=.522
Age	611	140.68	2	p<.001***
Marital Status	611	77.91	2	p<.001***
Education	610	70.88	3	p<.001***
Work Status	611	50.16	2	p<.001***
Smoke Status	610	8.89	2	p=.012*
Smoke Cigarettes	611	2.73	3	p=.434
Smoke Shish	611	.612	2	p=.736
Smoke Hookah	611	.612	2	p=.737
Diet – Hi Gl	611	8.22	1	p=.004**
Diet – Low Gl	611	.030	1	p=.862
Body Mass Index	594	15.81	2	p<.001***

There is no significant relationship between sex and diabetes type 2: (χ^2,1, N=611) = .410, p = .522.

There is a significant relationship between age and diabetes type 2: (χ^2,2, N=611) = 140.68, p = .000. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 53.8%, 3.8%, and 35.7%, respectively.

There is a significant relationship between marital status and diabetes type 2: (χ^2,2, N=611) = 77.91, p = .000. The divorced/separated/widowed group was more

likely to have T2D than those who had never been married and married people, at 51.9%, 0.6%, and 18.6%, respectively.

There is a significant relationship between smoking status and diabetes type 2: (χ^2,2, N=610) = 8.89, p = .012. Ex-smokers were more likely to have T2D than those who had never smoked and daily smokers, at 35.0%, 17.5, and 8.5%, respectively.

There is a significant relationship between working status and diabetes type 2: (χ^2,2, N=611) = 50.16, p = .000. Retired people were more likely to have T2D than both the employed and unemployed groups, at 44.9%, 12.2%, and 13.2%, respectively.

There is a significant relationship between education and diabetes type 2: (χ^2,3, N=610) = 70.88, p = .000. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 43.2%, 19.8%, 6.9%, and 6.2%, respectively.

There is a significant relationship between a high-glycemic diet and diabetes type 2: (χ^2,1, N=611) = 8.22, p = .004. People who consumed low-hi glycemic food were more likely to have T2D than those who were consumed hi-hi glycemic food, at 18.4% and 4.5%, respectively.

There is no significant relationship between a low-glycemic diet and diabetes type 2: (χ^2,1, N=611) = .030, p = .862.

There is no significant relationship between smoking shisha and diabetes type 2: (χ^2,2, N=611) = .612, p = .736.

There is no significant relationship between smoking hookah and diabetes type 2: (χ^2,2, N= 611) = .612, p = .737.

There is no significant relationship between smoking cigarettes and diabetes type 2: (χ^2,3, N=611) = 2.73, p = .434.

There is a significant relationship between body mass index (BMI) and diabetes type 2: (χ^2,2, N=594) = 15.81, p = .000. Those in the obese group were more likely to have T2D than those in both the normal and overweight groups, at 23.8%, 8.7%, and 16.0%, respectively.

Table 18: Hail Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	8.483	4.495	16.009
	65-105	1	.000	14.684	6.621	32.568
Marital Status	Never	2	.000			
	Married	1	.023	10.474	1.378	79.606
	Div/sep/Wi d	1	.001	32.397	3.950	265.707
Smoking Status	Never	2	.043			
	Ex-Smoker	1	.032	3.482	1.110	10.918

a. Variable(s) entered on step 1: Age Group, marital Status, Smoking Status.

The logistic model for Hail shows that there are, in general, significant independent relationships between age and diabetes type 2, marital status and diabetes type 2, and smoking and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 8.5, indicating that this group has a higher

risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and older is 14.7, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For marital status, the reference category was the never married group. The odds ratio for the married group is 10.5, indicating that married people have a higher risk of T2D than those who have never been married. The odds ratio for the divorced, widowed and separated group is 32.4, indicating that this group has a higher risk of T2D than those who never married.

For smoking status, the reference category was non-smokers. The odds ratio for ex-smokers was 3.5, indicating that ex-smokers have a higher risk of T2D than those who never smoked.

4.4.9 Region Nine

Al-Qassim

In the region of Al-Qassim, the population is 1,423,935 people. There are 15 spots clubs, 18 hospitals, and 177 health centers. There are also 461 high schools, 645 middle schools, 1,094 elementary schools, and 159 preschools. Al-Qassim also has one university and ten colleges, which is the highest number of colleges of any region.

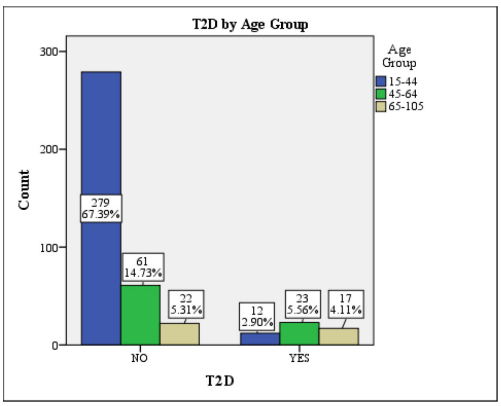


Figure 85: T2D by Age

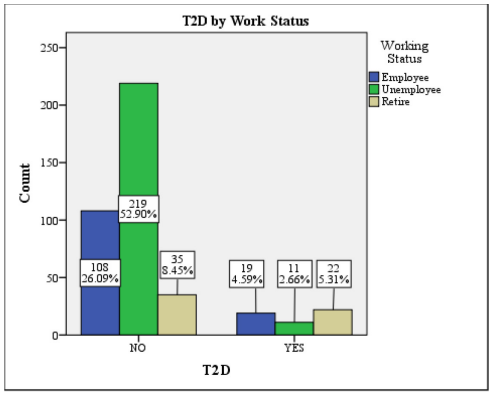


Figure 86: T2D by Work Status

Figure 85 shows the T2D breakdown by age. When split into age groups, 279 people aged 15- to 44-years-old did not have diabetes. 61 people aged 45- to 64-years-old did not have diabetes. 22 people aged 65+ did not have diabetes. This means that 2.90% of the total respondents were aged 15-44 and had T2D, 5.56% were aged 45-64 with T2D, and 4.11% were aged 65+ and had T2D.

Figure 86 shows the T2D breakdown by work status. When split into groups by work status, 108 employed people, 219 unemployed people, and 35 retired people did not have T2D. This means that 4.59% of total respondents were employed and had T2D, 2.66% were unemployed and had T2D, and 5.31% were retired and had T2D.

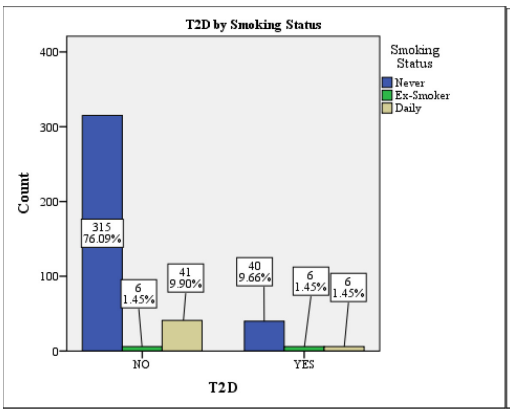


Figure 87: T2D by Smoking Status

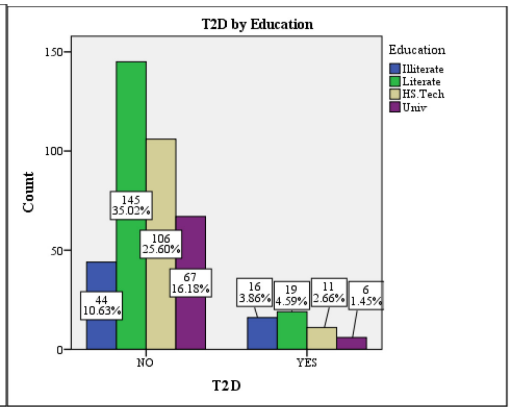


Figure 88: T2D by Education Level

Figure 87 shows the T2D breakdown by smoking status. When split into groups by smoking status, 315 non-smokers, 6 ex-smokers, and 41 daily smokers

did not have T2D. This means that 9.66% of total respondents were non-smokers and had T2D, 1.45% were ex-smokers and had T2D, and 1.45% were daily smokers and had T2D.

Figure 88 shows the T2D breakdown by education. When split into groups by education level, 44 illiterate people, 145 people who had completed intermediate school, 106 people who had completed high school or technical school, and 67 college, university, or postgraduates did not have T2D. This means that 3.86% of total respondents were illiterate and had T2D, 4.59% had graduated intermediate school and had T2D, 2.66% had completed technical or high school and had T2D, and 1.45% were college, university, or postgraduates and had T2D.

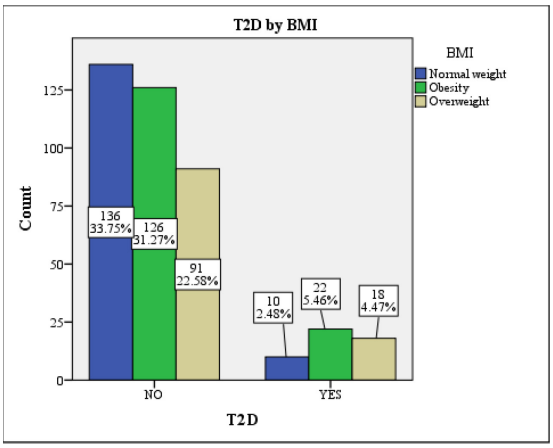


Figure 89: T2D by BMI

Figure 89 shows the T2D breakdown by BMI. When split into groups by BMI, 136 people of normal weight, 126 people who were obese, and 91 people who were overweight did not have T2D. This means that 2.48% of total respondents were of normal weight and had T2D, 5.46% were obese and had T2D, and 4.47% were overweight and had T2D.

Table 19: Al-Qassim Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	414	1.32	1	p=.250
Age	414	61.28	2	p<.001***
Marital Status	413	42.14	2	p<.001***
Education	414	13.32	3	p=.004**
Work Status	414	48.51	2	p<.001***
Smoke Status	414	11.24	2	p=.003**
Smoke Cigarettes	414	2.43	3	p=.466
Smoke Shish	414	1.24	2	p=.612
Smoke Hookah	414	1.45	2	p=.544
Diet – Hi Gl	414	.622	1	p=.430
Diet – Low Gl	414	.464	1	p=.496
Body Mass Index	403	6.66	2	p=.036*

There is no significant relationship between sex and diabetes type 2: (χ^2,1, N=414) = 1.32, p = .250.

There is a significant relationship between age and diabetes type 2: (χ^2,2, N=414) = 61,28 p = .000. Fisher's. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 43.6%, 4.1%, and 27.4%, respectively.

There is a significant relationship between marital status and diabetes type 2: (χ^2,2, N=413) = 42.14, p = .000. Fisher's. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 29.0%, 0.7%, and 18.1%, respectively.

There is a significant relationship between smoking status and diabetes type 2: (χ^2,2, N=414) = 11.24, p = .003. Fisher's. Ex-smokers were more likely to have T2D than those who had never smoked and the daily smokers' group, at 50.0%, 11.3, and 12.8%, respectively.

There is a significant relationship between working status and diabetes type 2: (χ^2,2, N=414) = 48.51, p = .000. Retired people were more likely to have T2D than those who were employed or currently unemployed, at 38.6%, 15.0%, and 4.8%, respectively.

There is a significant relationship between education and diabetes type 2: (χ^2,3, N=414) = 13.32, p = .004. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 26.7%, 11.6%, 9.4%, and 8.2%, respectively.

There is no significant relationship between a high-glycemic diet and diabetes type 2: (χ^2,1, N=414) = .622, p = .430.

There is no significant relationship between a low-glycemic diet and diabetes type 2: (χ^2,1, N=414) = .464, p = .496.

There is no significant relationship between smoking shisha and diabetes type 2: (χ^2,2, N=414) = 1.24, p = .612. Fisher's

There is no significant relationship between smoking hookah and diabetes type 2: (χ^2,2, N=414) = 1.45, p = .544. Fisher's

There is no significant relationship between smoking cigarettes and diabetes type 2: (χ^2,3, N=414) = 2.43, p = .466. Fisher's

There is a significant relationship between body mass index (BMI) and diabetes type 2: (χ^2,2, N=403) = 6.66, p = .036. Those in the overweight group were

more likely to have T2D than those in the normal and obese groups, at 16.5%, 6.8%, and 14.9%, respectively.

Table 20: Al-Qassim Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	4.600	2.083	10.157
	65-105	1	.000	8.879	3.469	22.727
Marital Status	Never married	2	.046			
	Married	1	.015	12.851	1.656	99.720
	Divorced sep/Wid	1	.016	15.291	1.652	141.483
Smoking Status	Never	2	.041			
	Ex-Smoker	1	.013	5.983	1.451	24.677
	Constant	1	.436	1.496	.543	4.121

a. Variable(s) entered on step 1: Age Group, Marital Status, Smoking Status.

The logistic model for Al-Qassim shows that there are, in general, significant independent relationships between age and diabetes type 2, marital status and diabetes type 2, and smoking and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 4.60, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and older is 8.9, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For marital status, the reference category was the never married group. The odds ratio for the married group is 12.85, indicating that married people have a

higher risk of T2D than those who have never been married. The odds ratio for the divorced, widowed and separated group is 15.3, indicating that this group has a higher risk of T2D than those who never married.

For smoking status, the reference category was non-smokers. The odds ratio for ex-smokers was 6, indicating that ex-smokers have a higher risk of T2D than those who never smoked.

4.4.10 Region Ten

Aseer

In the region of Aseer, the population is 2,211,875 people. There are 12 sports clubs, 27 hospitals, and 334 health centers. There are also 665 high schools, 1,025 middle schools, 1,741 elementary schools, and 258 preschools. This region has only one university.

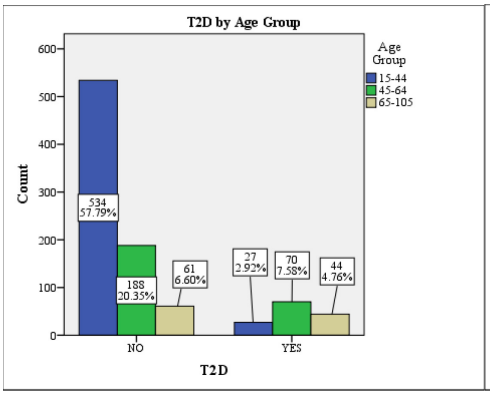


Figure 90: T2D by Age

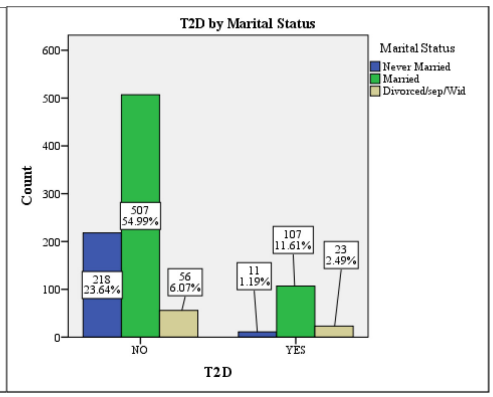


Figure 91: T2D by Marital Status

Figure 90 shows the T2D breakdown by age. When split into age groups, 534 people aged 15- to 44-years-old did not have diabetes. 188 people aged 45- to 64-years-old did not have diabetes. 61 people aged 65+ did not have diabetes. This means that 2.92% of the total respondents were aged 15-44 and had T2D, 7.58% were aged 45-64 with T2D, and 4.76% were aged 65+ and had T2D.

Figure 91 shows the T2D breakdown by marital status. When split into groups by marital status, 218 of those who had never married, 507 married people, and 56 divorced/separated/widowed people did not have T2D. This means that 1.19% of total respondents had never been married and had diabetes, 11.61% were married and had T2D, and 2.49% were divorced/separated/widowed and had T2D.

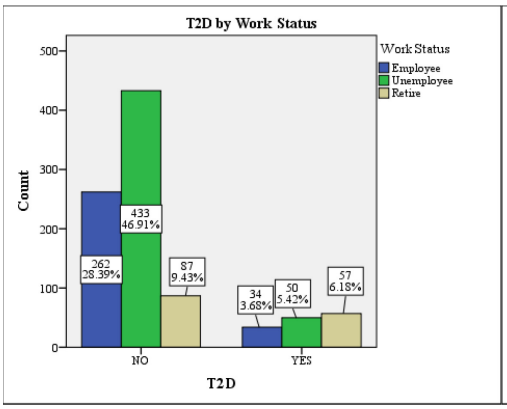


Figure 92: T2D by Work Status

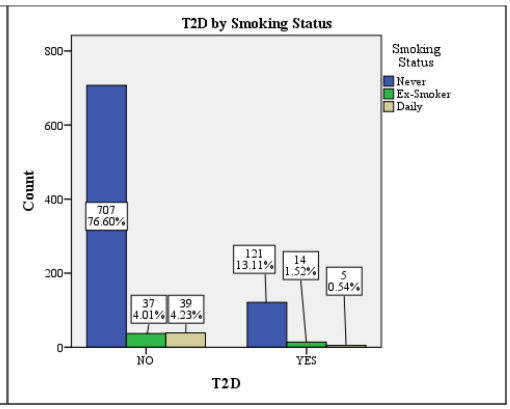


Figure 93: T2D by Smoking Status

Figure 92 shows the T2D breakdown by work status. When split into groups by work status, 262 employed people, 433 unemployed people, and 87 retired people did not have T2D. This means that 3.68% of total respondents were employed and had T2D, 5.42% were unemployed and had T2D, and 6.18% were retired and had T2D.

Figure 93 shows the T2D breakdown by smoking. When split into groups by smoking status, 707 non-smokers, 37 ex-smokers, and 39 daily smokers did not have T2D. This means that 13.11% of total respondents were non-smokers and had T2D, 1.52% were ex-smokers and had T2D, and 0.54% were daily smokers and had T2D.

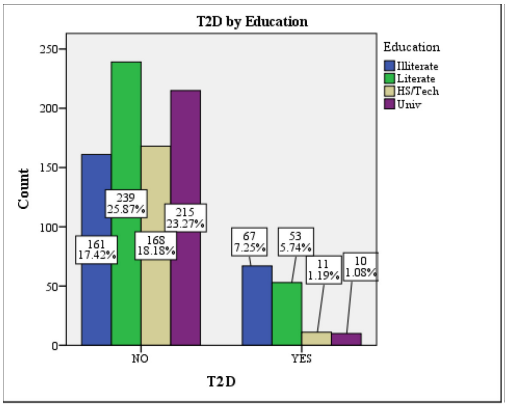


Figure 94: T2D by Education Level

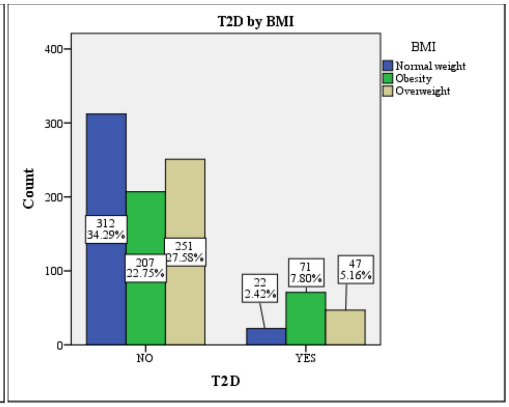


Figure 95: T2D by BMI

Figure 94 shows the T2D breakdown by education. When split into groups by education level, 161 illiterate people, 239 people who had completed intermediate school, 168 people who had completed high school or technical school, and 215 college, university, or postgraduates did not have T2D. This means that 7.25% of total respondents were illiterate and had T2D, 5.74% had graduated intermediate school and had T2D, 1.19% had completed technical or high school and had T2D, and 1.08% were college, university, or postgraduates and had T2D.

Figure 95 shows the T2D breakdown by BMI. When split into groups by BMI, 312 people of normal weight, 207 people who were obese, and 251 people who were overweight did not have T2D. This means that 2.42% of total respondents were of normal weight and had T2D, 7.80% were obese and had T2D, and 5.16% were overweight and had T2D.

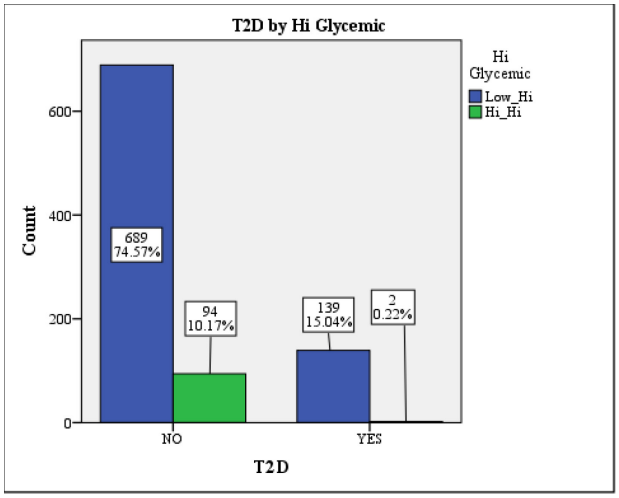


Figure 96: T2D by High Glycemic Diet

Figure 96 shows the T2D breakdown by diet. When split into groups by high glycemic diet, 689 people who ate low-hi glycemic diets and 94 people who ate hi-hi glycemic diets did not have T2D. This means that 15.04% of total respondents ate low-hi glycemic diets and had T2D, and 0.22% ate hi-hi glycemic diets and had T2D.

Table 21: Aseer Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	924	.231	1	p=.631
Age	924	133.11	2	p<.001***
Marital Status	922	33.25	2	p<.001***
Education	924	68.92	3	p<.001***
Work Status	923	78.07	2	p<.001***
Smoke Status	923	6.67	2	p=.036*
Smoke Cigarettes	924	4.74	3	p=.192
Smoke Shisha	924	.941	2	p=.625
Smoke Hookah	924	.905	2	p=.636
Diet – Hi Gl	924	14.38	1	p<.001***
Diet – Low Gl	924	.676	1	p=.411
Body Mass Index	910	41.91	2	p<.001***

A chi-square test for association and independence was conducted for the sample from Aseer. All expected cell frequencies were greater than five. There was not a statistically significant association between sex and Diabetes type 2, χ^2 (1) = .231, p = .631.

There was a statistically significant association between age and diabetes type 2, χ^2 (2) = 133.11, p < .001. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 41.9%, 4.8%, and 27.1%, respectively.

There was a statistically significant association between marital status and diabetes type 2, χ^2 (2) = 33.25, p < .001. The divorced/separated/widowed group

was more likely to have T2D than those who had never been married and married people, at 29.1%, 4.8%, and 17.4%, respectively.

There was a statistically significant association between education and diabetes type 2, χ^2 (3) = 68.92, $p < .001$. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 29.4%, 18.2%, 6.1%, and 4.4%, respectively.

There was a statistically significant association between working status and diabetes type 2, χ^2 (2) = 78.07, $p < .001$. Retired people were more likely to have T2D than those who were employed and currently unemployed, at 39.6%, 11.5%, and 10.4%, respectively.

There was a statistically significant association between smoking status and diabetes type 2, χ^2 (2) = 6.67, $p = .036$. Ex-smokers were more likely to have T2D than those who had never smoked and daily smokers, at 27.5%, 14.6, and 15.2%, respectively.

There was not a statistically significant association between smoking cigarettes and diabetes type 2, χ^2 (3) = 4.74, $p = .192$.

There was not a statistically significant association between smoking shisha and diabetes type 2, χ^2 (2) = .941, $p = .625$.

There was not a statistically significant association between smoking hookah and diabetes type 2, χ^2 (2) = .905, $p = .636$.

There was a statistically significant association between high-glycemic diet and diabetes type 2, χ^2 (1) = 14.38, $p<.001$. People who consumed low-hi glycemic food were more likely to have T2D than those who were consumed hi-hi glycemic food, at 16.8% and 2.1%, respectively.

There was not a statistically significant association between low-glycemic diet and diabetes type 2, χ^2 (1) = .676, p = .411.

There was a statistically significant association between Body Mass Index (BMI) and diabetes type 2, χ^2 (2) = 41.91, p<.001. Those in the obese group were more likely to have T2D than those in both the normal and overweight groups, at 25.5%, 6.6%, and 15.8%, respectively.

After knowing the predictor variables that are statistically associated with diabetes type 2, we can enter them in a logistic model to figure out how strong the association is and to predict the likelihood of diabetes type 2 for participants and for new cases.

Table 22: Aseer Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	3.378	1.901	6.004
	65-105	1	.000	5.828	2.588	13.126
Work Status	Employee	2	.019			
	Unemployed	1	.025	.511	.285	.919
Education	College/Uni/PG	3	.005			
	Cant R or W	1	.001	4.320	1.768	10.551
	R-W-Inter-school	1	.000	4.166	1.867	9.297
BMI	Normal weight	2	.000			
	Obesity	1	.000	3.947	2.233	6.974
	Overweight	1	.040	1.841	1.027	3.300
HI_Gl	NO	1	.017	5.909	1.368	25.518

a. Variable(s) entered on step 1: Age Group, Work Status, Education, BMI, High Glycemic.

A binomial logistic regression was performed to ascertain the effects of age, marital status, education, work status, smoke status, high-glycemic diet and body mass index on the likelihood that participants from Aseer have diabetes type 2. The logistic regression model was statistically significant, χ^2 (15) = 182.777, $p < .0005$. The model explained 31.7% (Nagelkerke R^2) of the variance in diabetes type 2 and correctly classified 84.1% of cases. Sensitivity was 21.6%, specificity was 95.4%, positive predictive value was 46.2% and negative predictive value was 87.1%. Of the seven predictor variables only five were statistically significant: age, work

status, education, BMI and high-glycemic diet (as shown in the Table above). Participants at age group 45-64 had 3.48 times higher odds to suffer diabetes type 2 than those at the reference category, 15-44 age group. Participants at age group 65-105 had 5.59 times higher odds to suffer diabetes type 2 than those at the reference category. It appears that increasing age is associated with an increasing likelihood of suffering diabetes type 2. Obese participants had 4.06 times higher odds to suffer diabetes type 2 than those at the reference group, normal weight participants. It appears that increasing weight is associated with an increasing likelihood of suffering diabetes type 2.

The logistic model for Aseer shows that there are, in general, significant independent relationships between age and diabetes type 2, work status and diabetes type 2, BMI (Body Mass Index) and diabetes type 2, education and diabetes type 2, and diet and diabetes type 2.

For age, the reference category was the 15- to 44-year-old group. The odds ratio for the 45- to 64-year-old group is 3.4, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group. The odds ratio for 65 years old and older is 5.83, indicating that this group has a higher risk of T2D than the 15- to 44-year-old group.

For work status, the reference category was employed people. The odds ratio for the unemployed group was .511, indicating that the unemployed have a lower risk of T2D than those who are employed.

For education level, the reference category was the college and post-graduate group. The odds ratio for the illiterate group is 4.32, indicating that this group has a higher risk of T2D than the college and post-graduate group. The odds ratio for the

elementary and intermediate educated group is 4.2, indicating that this group has a higher risk of T2D than the highly educated reference group.

For BMI, the reference category was people of normal weight (BMI: 18.5 – 24.9). The odds ratio for the obese group is 3.95, indicating that obese people have a higher risk of T2D than people of normal weight. The odds ratio for overweight people is 1.85, indicating that overweight people have a higher risk of T2D than people of normal weight.

For diet, the reference category was low-hi glycemic. The odds ratio for low-hi is 5.91, indicating that those who consume low-hi glycemic food have a higher risk of T2D than those consuming hi-hi glycemic foods.

4.4.11 Region Eleven

Al-Baha

The population of Al-Baha is 476,172 people. There are five sports clubs, ten hospitals, and 105 health centers. There are also 177 high schools, 287 middle schools, 534 elementary schools, and 80 preschools. Al-Baha also has two universities and two colleges.

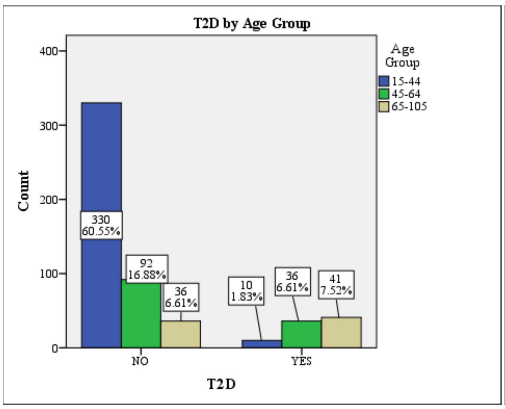


Figure 97: T2D by Age

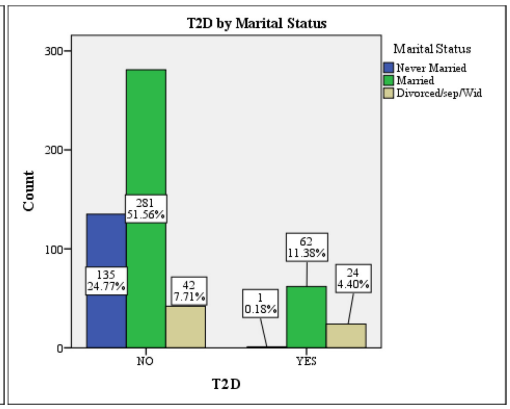


Figure 98: T2D by Marital Status

Figure 97 shows the T2D breakdown by age. When split into age groups, 330 people aged 15- to 44-years-old did not have diabetes. 92 people aged 45- to 64-years-old did not have diabetes. 36 people aged 65+ did not have diabetes. This means that 1.83% of the total respondents were aged 15-44 and had T2D, 6.61% were aged 45-64 with T2D, and 7.52% were aged 65+ and had T2D.

Figure 98 shows the T2D breakdown by marital status. When split into groups by marital status, 135 of those never married, 281 married, and 42 divorced/separated/widowed people did not have T2D. This means that 0.18% of total respondents had never been married and had diabetes, 11.38% were married and had T2D, and 4.40% were divorced/separated/widowed and had T2D.

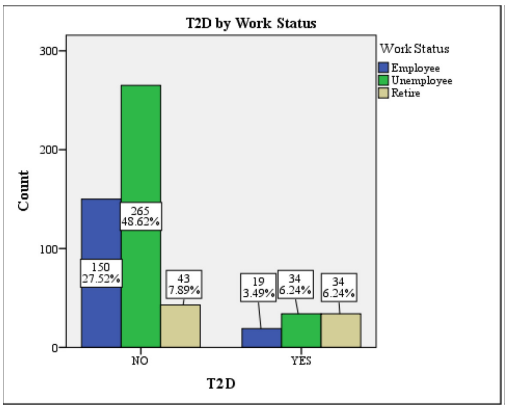


Figure 99: T2D by Work Status

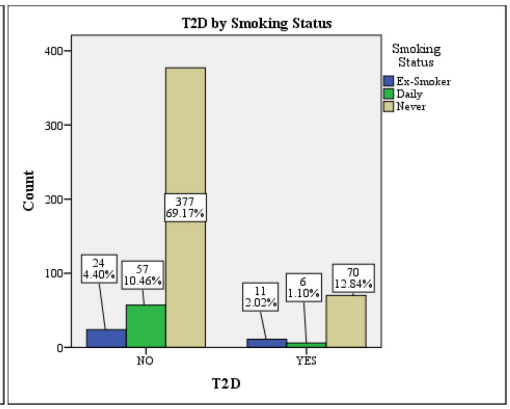


Figure 100: T2D by Smoking Status

Figure 99 shows the T2D breakdown by work status. When split into groups by work status, 150 employed people, 265 unemployed people, and 43 retired people did not have T2D. This means that 3.49% of total respondents were employed and had T2D, 6.24% were unemployed and had T2D, and 6.24% were retired and had T2D.

Figure 100 shows the T2D breakdown by smoking. When split into groups by smoking status, 24 non-smokers, 57 ex-smokers, and 377 daily smokers did not have T2D. This means that 2.02% of total respondents were non-smokers and had

T2D, 1.10% were ex-smokers and had T2D, and 12.84% were daily smokers and had T2D.

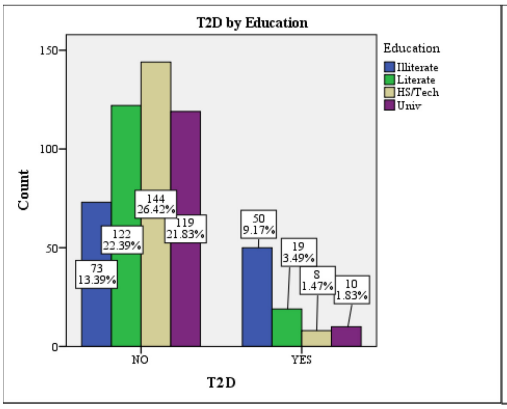


Figure 101: T2D by Education Level

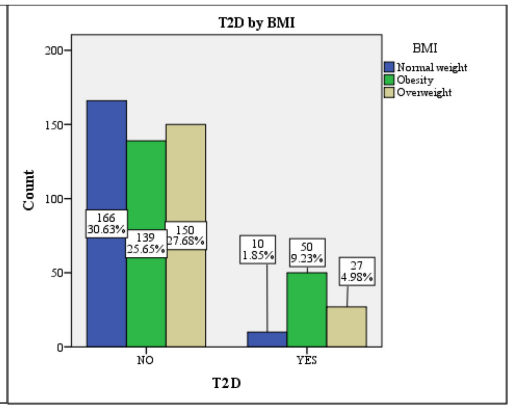


Figure 102: T2D by BMI

Figure 101 shows the T2D breakdown by education. When split into groups by education level, 73 illiterate people, 122 people who had completed intermediate school, 144 people who had completed high school or technical school, and 119 college, university, or postgraduates did not have T2D. This means that 9.17% of total respondents were illiterate and had T2D, 3.49% had graduated intermediate school and had T2D, 1.47% had completed technical or high school and had T2D, and 1.83% were college, university, or postgraduates and had T2D.

Figure 102 shows the T2D breakdown by BMI. When split into groups by BMI, 166 people of normal weight, 139 people who were obese, and 150 people who were overweight did not have T2D. This means that 1.85% of total respondents were of normal weight and had T2D, 9.23% were obese and had T2D, and 4.98% were overweight and had T2D.

Table 23: Al-Baha Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	545	.389	1	p=.533
Age	545	136.87	2	p<.001***
Marital Status	545	45.12	2	p<.001***
Education	545	75.98	33	p<.001***
Work Status	545	53.12	2	p<.001***
Smoke Status	545	8.21	2	p=.016*
Smoke Cigarettes	545	1.30	3	p=.729
Smoke Shish	545	4.22	2	p=.121
Smoke Hookah	545	.076	2	p=.963
Diet – Hi Gl	545	2.81	1	p=.094
Diet – Low Gl	545	.095	1	p=.757
Body Mass Index	542	29.30	2	p<.001***

A chi-square test for association and independence was conducted for the sample from Al-Baha. All expected cell frequencies were greater than five. There was not a statistically significant association between sex and Diabetes type 2, χ^2 (1) = .389, p = .533.

There was a statistically significant association between age and diabetes type 2, χ^2 (2) = 136.87, p < .001. People 65 years old and over were more likely to have

T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 53.2%, 2.9%, and 28.1%, respectively.

There was a statistically significant association between marital status and diabetes type 2, χ^2 (2) = 45.12, $p < .001$. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 21.3%, 0.8%, and 11.0%, respectively.

There was a statistically significant association between education and diabetes type 2, χ^2 (3) = 75.98, $p < .001$. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 40.7%, 13.5%, 5.3%, and 7.8%, respectively.

There was a statistically significant association between working status and diabetes type 2, χ^2 (2) = 53.12, $p < .001$. Retired people were more likely to have T2D than those who were employed and currently unemployed, at 44.2%, 11.2%, and 11.4%, respectively.

There was a statistically significant association between smoking status and diabetes type 2, χ^2 (2) = 8.21, $p = .016$. Ex-smokers were more likely to have T2D than those who were daily smokers and never smoked, at 31.4%, 9.5, and 15.7%, respectively.

There was not a statistically significant association between smoking cigarettes and diabetes type 2, χ^2 (3) = 1.30, $p = .729$.

There was not a statistically significant association between smoking shisha and diabetes type 2, χ^2 (2) = 4.22, $p = .121$.

There was not a statistically significant association between smoking hookah and diabetes type 2, χ^2 (2) = .076, $p = .963$.

There was not a statistically significant association between high-glycemic diet and diabetes type 2, χ^2 (1) = 2.81, p = .094.

There was not a statistically significant association between low-glycemic diet and diabetes type 2, χ^2 (1) = .095, p = .757.

There was a statistically significant association between Body Mass Index (BMI) and diabetes type 2, χ^2 (2) = 29.30, p<.001. Those in the obese group were more likely to have T2D than those in both the normal and overweight groups, at 26.5%, 5.7%, and 15.3%.

After knowing the predictor variables that are statistically associated with diabetes type 2, we can enter them in a logistic model to figure out how strong the association is and to predict the likelihood of diabetes type 2 for participants and for new cases.

Table 24: Al-Baha Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	9.248	4.340	19.705
	65-105	1	.000	35.533	16.184	78.017
BMI	Normal weight	2	.004			
	Obesity	1	.001	3.948	1.718	9.069
	Overweight	1	.047	2.392	1.011	5.661
	Constant	1	.000	.014		

a. Variable(s) entered on step 1: Age Group, BMI.

A binomial logistic regression was performed to ascertain the effects of age, marital status, education, work status, smoke status and body mass index on the likelihood that participants from Al-Baha have diabetes type 2. The logistic regression model was statistically significant, χ^2 (14) = 153.090, $p < .0005$. The model explained 42.0% (Nagelkerke R^2) of the variance in diabetes type 2 and correctly classified 84.7% of cases. Sensitivity was 27.6%, specificity was 95.6%, positive predictive value was 54.5% and negative predictive value was 87.3%. Of the six predictor variables only two were statistically significant: age and BMI (as shown in the Table above). Participants at age group 45-64 had 5.02 times higher odds to suffer diabetes type 2 than those at the reference category, 15-44 age group. Participants at age group 65-105 had 10.84 times higher odds to suffer diabetes type 2 than those at the reference category. It appears that increasing age is associated with an increasing likelihood of suffering diabetes type 2. Obese participants had 4.06 times higher odds to suffer diabetes type 2 than those at the reference group, normal weight participants. It appears that increasing weight is associated with an increasing likelihood of suffering diabetes type 2.

4.4.12 Region Twelve

Jizan

The population of Jizan is 1,567,547 people. There are eight sports clubs, 21 hospitals, and 178 health centers. There are also 382 high schools, 648 middle schools, 1,093 elementary schools, and 118 preschools. This region has only one university.

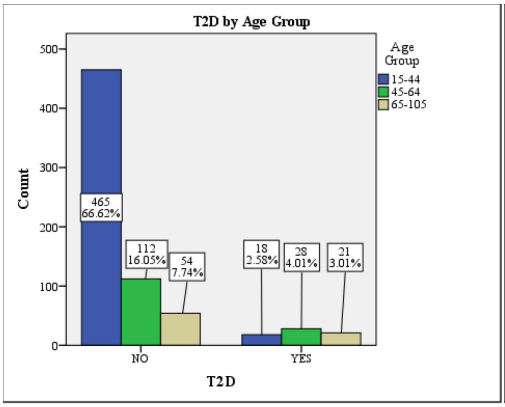


Figure 103: T2D by Age

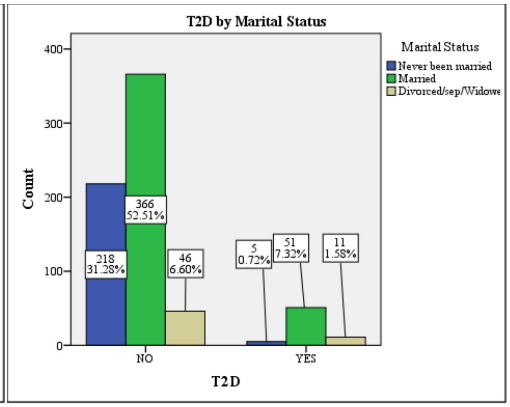


Figure 104: T2D by Marital Status

Figure 103 shows the T2D breakdown by age. When split into age groups, 465 people aged 15- to 44-years-old did not have diabetes. 112 people aged 45- to 64-years-old did not have diabetes. 54 people aged 65+ did not have diabetes. This means that 2.58% of the total respondents were aged 15-44 and had T2D, 4.01% were aged 45-64 with T2D, and 3.01% were aged 65+ and had T2D.

Figure 104 shows the T2D breakdown by marital status. When split into groups by marital status, 218 never married people, 366 married people, and 46 divorced/separated/widowed people did not have T2D. This means that 0.72% of total respondents had never been married and had diabetes, 7.32% were married and had T2D, and 1.58% were divorced/separated/widowed and had T2D.

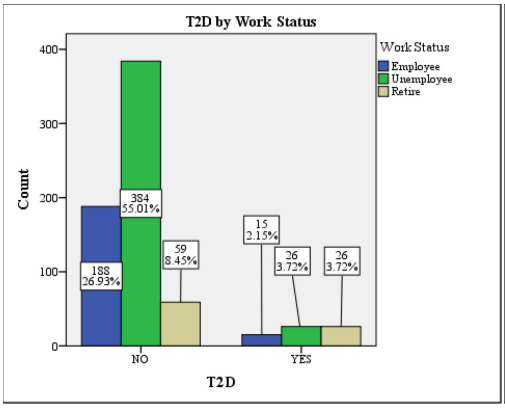


Figure 105: T2D by Work Status

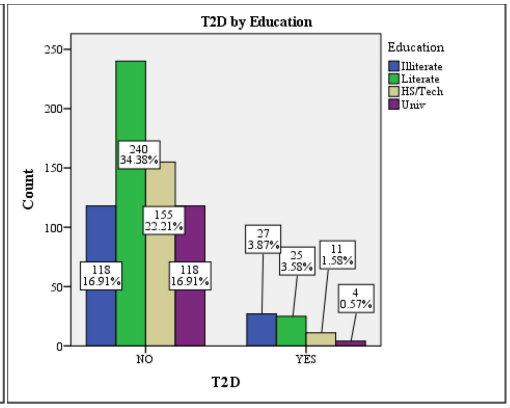


Figure 106: T2D by Education Level

Figure 105 shows the T2D breakdown by work status. When split into groups by work status, 188 employed people, 384 unemployed people, and 59 retired

people did not have T2D. This means that 2.15% of total respondents were employed and had T2D, 3.72% were unemployed and had T2D, and 3.72% were retired and had T2D.

Figure 106 shows the T2D breakdown by education. When split into groups by education level, 118 illiterate people, 240 people who had completed intermediate school, 155 people who had completed high school or technical school, and 118 college, university, or postgraduates did not have T2D. This means that 3.87% of total respondents were illiterate and had T2D, 3.58% had graduated intermediate school and had T2D, 1.58% had completed technical or high school and had T2D, and 0.57% were college, university, or postgraduates and had T2D.

Table 25: Jizan Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	698	.356	1	p=.550
Age	698	65.91	2	p<.001***
Marital Status	697	23.38	2	p<.001***
Education	698	20.91	3	p<.001***
Work Status	698	49.31	2	p<.001***
Smoke Status	698	1.90	2	p=.385
Smoke Cigarettes	698	2.17	3	p=.537
Smoke Shish	698	3.52	2	p=.171
Smoke Hookah	698	2.19	2	p=.334
Diet – Hi Gl	698	1.12	1	p=.289
Diet – Low Gl	698	.381	1	p=.537
Body Mass Index	629	1.42	2	p=.492

A chi-square test for association and independence was conducted for the sample from Jizan. All expected cell frequencies were greater than five. There was not a statistically significant association between sex and Diabetes type 2, χ^2 (1) = .356, p = .550.

There was a statistically significant association between age and diabetes type 2, χ^2 (2) = 65.91, p < .001. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 28.0%, 3.7%, and 20.0%, respectively.

There was a statistically significant association between marital status and diabetes type 2, χ^2 (2) = 23.38, $p < .001$. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 19.3%, 2.2%, and 12.2%, respectively.

There was a statistically significant association between education and diabetes type 2, χ^2 (3) = 20.91, $p < .001$. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 18.6%, 9.4%, 6.6%, and 3.3%, respectively.

There was a statistically significant association between working status and diabetes type 2, χ^2 (2) = 49.31, $p < .001$. Retired people were more likely to have T2D than those who were employed and unemployed, at 30.6%, 7.4%, and 6.3%, respectively.

There was not a statistically significant association between smoking status and diabetes type 2, χ^2 (2) = 1.90, $p = .385$.

There was not a statistically significant association between smoking cigarettes and diabetes type 2, χ^2 (3) = 2.17, $p = .537$.

There was not a statistically significant association between smoking shisha and diabetes type 2, χ^2 (2) = 3.52, $p = .171$.

There was not a statistically significant association between smoking hookah and diabetes type 2, χ^2 (2) = 2.19, $p = .334$.

There was not a statistically significant association between high-glycemic diet and diabetes type 2, χ^2 (1) = 1.12, $p = .289$.

There was not a statistically significant association between low-glycemic diet and diabetes type 2, χ^2 (1) = .381, $p = .537$.

There was not a statistically significant association between Body Mass Index (BMI) and diabetes type 2, χ^2 (2) = 1.42, $p < .492$.

After knowing the predictor variables that are statistically associated with diabetes type 2, we can enter them in a logistic model to figure out how strong the association is and to predict the likelihood of diabetes type 2 for participants and for new cases.

Table 26: Jizan Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	5.243	2.723	10.098
	65-105	1	.000	6.329	2.822	14.192

a. Variable(s) entered on step 1: Age Group.

A binomial logistic regression was performed to ascertain the effects of age, marital status, education, and work status on the likelihood that participants from Jizan have diabetes type 2. The logistic regression model was statistically significant, χ^2 (10) = 76.143, $p < .0005$. The model explained 22.1% (Nagelkerke R^2) of the variance in diabetes type 2 and correctly classified 90.4% of cases. Sensitivity was 0%, specificity was 100.0%, positive predictive value was 0% and negative predictive value was 90.4%. Of the four predictor variables only one was statistically significant: age (as shown in the Table above). Participants at age group 45-64 had 3.87 times higher odds to suffer diabetes type 2 than those at the reference category, 15-44 age group. Participants at age group 65-105 had 5.26

times higher odds to suffer diabetes type 2 than those at the reference category. It appears that increasing age is associated with an increasing likelihood of suffering diabetes type 2.

4.4.13 Region Thirteen

Najran

In the region of Najran, the population is 582,243 people. There are four sports clubs, 11 hospitals, and 68 health centers. There are also 140 high schools, 205 middle schools, 342 elementary schools, and 49 preschools. This region has one university and one college.

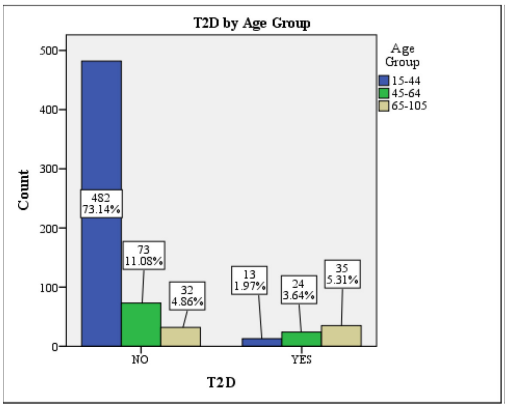


Figure 107: T2D by Age

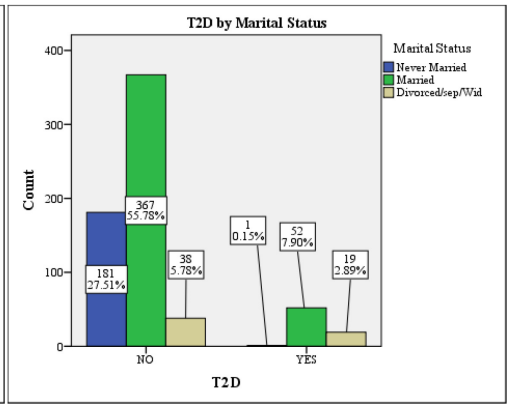


Figure 108: T2D by Marital Status

Figure 107 shows the T2D breakdown by age. When split into age groups, 482 people aged 15- to 44-years-old did not have diabetes. 73 people aged 45- to 64-years-old did not have diabetes. 32 people aged 65+ did not have diabetes. This means that 1.97% of the total respondents were aged 15-44 and had T2D, 3.64% were aged 45-64 with T2D, and 5.31% were aged 65+ and had T2D.

Figure 108 shows the T2D breakdown by marital status. When split into groups by marital status, 181 of those who had never married, 367 married, and 38 divorced/separated/widowed people did not have T2D. This means that 0.15% of

total respondents had never been married and had diabetes, 7.90% were married and had T2D, and 2.89% were divorced/separated/widowed and had T2D.

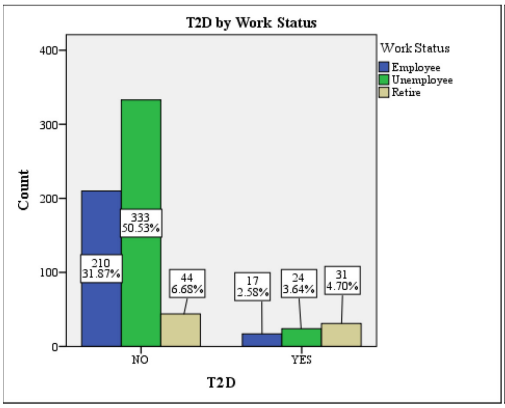


Figure 109: T2D by Work Status

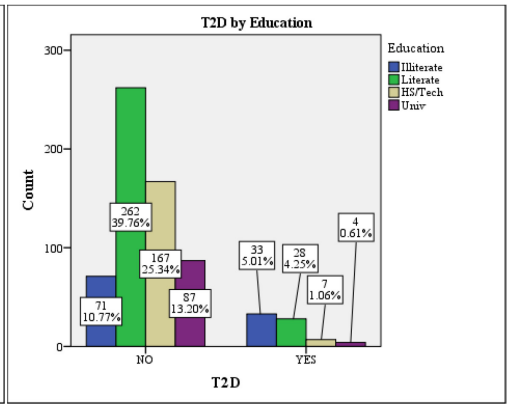


Figure 110: T2D by Education Level

Figure 109 shows the T2D breakdown by work status. When split into groups by work status, 210 employed people, 333 unemployed people, and 44 retired people did not have T2D. This means that 2.58% of total respondents were employed and had T2D, 3.64% were unemployed and had T2D, and 4.70% were retired and had T2D.

Figure 110 shows the T2D breakdown by education. When split into groups by education level, 71 illiterate people, 262 people who had completed intermediate school, 167 people who had completed high school or technical school, and 87 college, university, or postgraduates did not have T2D. This means that 5.01% of total respondents were illiterate and had T2D, 4.25% had graduated intermediate school and had T2D, 1.06% had completed technical or high school and had T2D, and 0.61% were college, university, or postgraduates and had T2D.

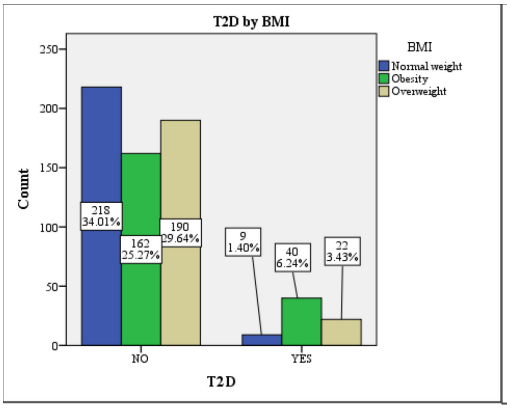


Figure 111: T2D by BMI

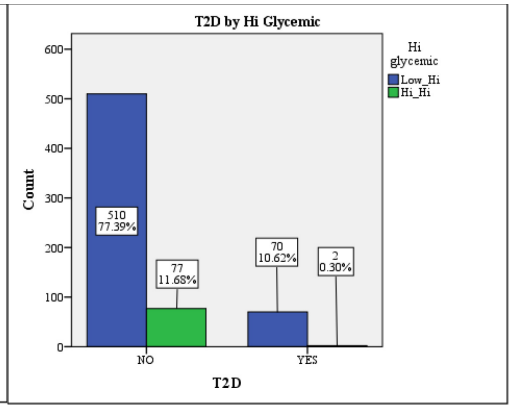


Figure 112: T2D by High Glycemic Diet

Figure 111 shows the T2D breakdown by BMI. When split into groups by BMI, 218 people of normal weight, 162 people who were obese, and 190 people who were overweight did not have T2D. This means that 1.40% of total respondents were of normal weight and had T2D, 6.24% were obese and had T2D, and 3.43% were overweight and had T2D.

Figure 112 shows the T2D breakdown by diet. When split into groups by high glycemic diet, 510 people who ate low-hi glycemic diets and 77 people who ate hi-hi glycemic diets did not have T2D. This means that 10.62% of total respondents ate low-hi glycemic diets and had T2D, and 0.30% ate hi-hi glycemic diets and had T2D.

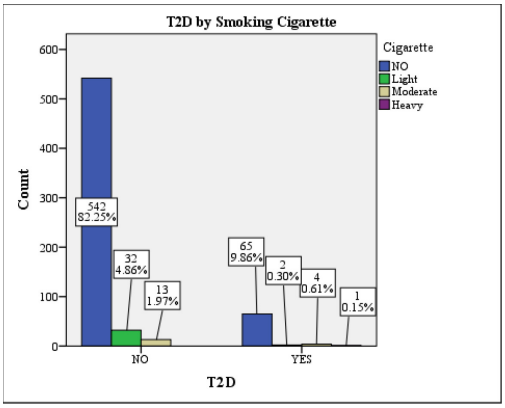


Figure 113: T2D by Cigarette Use

Figure 113 shows the T2D breakdown by cigarette. When split into groups by cigarette use, 542 people who had never smoked cigarettes, 32 people who lightly

smoked cigarettes, 13 people who moderately smoked cigarettes, and 0 people who smoked cigarettes heavily did not have T2D. This means that 9.86% of total respondents who had never smoke cigarettes had T2D, 0.30% of light cigarette smokers had T2D, 0.61% of moderate cigarette smokers had T2D, and 0.15% of heavy cigarette smokers had T2D.

Table 27: Najran Chi-Square Results, Association between predictor variables and T2D

Variables	No.	Pearson Chi-Square	df	Asymptotic Significance (2-sided)
Gander	659	1.33	1	p=.249
Age	659	171.56	2	p<.001***
Marital Status	658	50.42	2	p<.001***
Education	659	59.24	3	p<.001***
Work Status	659	80.49	2	p<.001***
Smoke Status	659	1.67	2	p=.432
Smoke Cigarettes	659	8.32	3	p=.031*
Smoke Shish	659	4.36	2	p=.070
Smoke Hookah	659	5.34	2	p=.065
Diet – Hi Gl	659	6.49	1	p=.011*
Diet – Low Gl	659	.748	1	p=.387
Body Mass Index	641	27.37	2	p<.001***

A chi-square test for association and independence was conducted for the sample from Najran. All expected cell frequencies were greater than five. There

was not a statistically significant association between sex and Diabetes type 2, χ^2 (1) = 1.33, p = .249.

There was a statistically significant association between age and diabetes type 2, χ^2 (2) = 171.56, p < .001. People 65 years old and over were more likely to have T2D than younger people 15- to 44-years old and 45- to 64-years-old, at 52.2%, 2.6%, and 24.7%, respectively.

There was a statistically significant association between marital status and diabetes type 2, χ^2 (2) = 50.42, p < .001. The divorced/separated/widowed group was more likely to have T2D than those who had never been married and married people, at 33.3%, 0.5%, and 12.4%, respectively.

There was a statistically significant association between education and diabetes type 2, χ^2 (3) = 59.24, p < .001. Those who were illiterate were more likely to have T2D than those who had completed intermediate school, high school, or post-graduate work, at 31.7%, 9.7%, 4.0%, and 4.4%, respectively.

There was a statistically significant association between working status and diabetes type 2, χ^2 (2) = 80.49, p < .001. Retired people were more likely to have T2D than those who were employed and unemployed, at 41.3%, 7.5%, and 6.7%, respectively.

There was not a statistically significant association between smoking status and Diabetes type 2, χ^2 (2) = 1.67, p = .432.

There was a statistically significant association between smoking cigarettes and Diabetes type 2, χ^2 (3) = 8.32, p = .031. People who heavy smoked of cigarettes were more likely to have T2D than non-smokers, light, and moderate of cigarettes, at 100.0%, 10.7%, 5.9%, and 23.5%, respectively.

There was not a statistically significant association between smoking shisha and Diabetes type 2, χ^2 (2) = 4.36, p = .070.

There was not a statistically significant association between smoking hookah and Diabetes type 2, χ^2 (2) = 5.34, p = .065.

There was a statistically significant association between high-glycemic diet and Diabetes type 2, χ^2 (1) = 6.49, p = .011. People who consumed low-hi glycemic food were more likely to have T2D than who consumed hi-hi glycemic food, at 12.1% and 2.5%, respectively.

There was not a statistically significant association between low-glycemic diet and Diabetes type 2, χ^2 (1) = .748, p = .387.

There was a statistically significant association between Body Mass Index (BMI) and Diabetes type 2, χ^2 (2) = 27.37, $p < .001$. Those in the obese group were more likely to have T2D than those in both the normal and overweight groups, at 19.8%, 4.0%, and 10.4%, respectively.

After knowing the predictor variables that are statistically associated with diabetes type 2, we can enter them in a logistic model to figure out how strong the association is and to predict the likelihood of diabetes type 2 for participants and for new cases.

Table 28: Najran Logistic Regression Table

					95% CI.for EXP(B)	
		df	Sig.	Exp(B)	Lower	Upper
Age Group	15-44	2	.000			
	45-64	1	.000	9.846	4.632	20.928
	65-105	1	.000	40.828	19.020	87.640
	Normal weight	2	.010			
BMI	Obesity	1	.004	3.552	1.497	8.433
	Constant	1	.000	.013		

a. Variable(s) entered on step 1: Age Group, BMI.

A binomial logistic regression was performed to ascertain the effects of age, marital status, education, work status, cigarettes smoking, high-glycemic diet, and body mass index on the likelihood that participants from Najran have diabetes type 2. The logistic regression model was statistically significant, χ^2 (13) = 153.894, $p <$ .0005. The model explained 42.6% (Nagelkerke R^2) of the variance in diabetes type 2 and correctly classified 90.2% of cases. Sensitivity was 35.2%, specificity was 97.0%, positive predictive value was 59.5% and negative predictive value was 92.3%. Of the seven predictor variables only two were statistically significant: age and body mass index (as shown in the Table above). Participants at age group 45-64 had 9.85 times higher odds to suffer diabetes type 2 than those at the reference category, 15-44 age group. Participants at age group 65-105 had 40.83 times higher odds to suffer diabetes type 2 than those at the reference category. It appears that increasing age is associated with an increasing likelihood of suffering diabetes type 2. Obese participants had 3.55 times higher odds to suffer diabetes type 2 than those at the reference group, normal weight participants. It appears that increasing weight is associated with an increasing likelihood of suffering diabetes type 2.

CHAPTER 5: DISCUSSION

5.1 Discussion

Our findings showed a high prevalence of T2D in the Kingdom of Saudi Arabia (11.5%). The percentages for each individual region are as follows: Hail, Al-Madinah and Al-Baha have the highest prevalence of T2D at 16.9%, 16.3% and 16.0%, respectively. Aseer and Al-Qassim's rates are 15.3% and 12.6%, respectively. Najran and Northern Borders's prevalence are both 10.9%, Makkah's is 10.8%, Al-Jouf's is 10.2%, and Jizan's is 9.6%. Riyadh's rate is 9.4% and Tabuk's is 8.1%. Eastern has the lowest prevalence of T2D at 7.9%.

Eastern's prevalence may be so low due to a screening campaign in that region in 2004 that raised awareness about both T2D and hypertension [122]. Awareness of the disease is important in prevention, diagnosing, and managing the long-term effects of T2D; these screenings help those suffering undiagnosed without any significant symptoms.

5.1.1 Age

Overall, according to Wild et al., the prevalence of T2D increases with the age of a population [123]. It comes as no surprise, then, that in our study, the most effective predictor of T2D in all 13 regions was age. Older patients, or those who are 65 years old or older, had a higher prevalence of T2D than their younger counterparts; this is true for every region. The odds ratios for each individual region are as follows when compared to the 15- to 44-year-old age group of the same region:
In Hail, the odds ratio for 65 years old and older is 14.7. In Almadinah, the odds ratio for 65 years old and older is 25.88. In Al-Baha, those in the 65+ age group were 9.25 times more likely to have T2D than those in the 15- to 44-year-old group. In Aseer,

the odds ratio for 65 years old and older group is 5.83. In Al-Qassim, the odds ratio for 65 years old and older is 8.9. In Najran, those in the 65+ age group where 40.828 times more likely to have T2D than those in the 15- to 44-year-old group. In Northern Borders, the odds ratio for 65 years old and older is 59.15. In Makkah, the odds ratio for 65 years old and older is 22. In Al-Jouf, the odds ratio for 65 years old and older is 7.8. In Jizan, those in the 65+ age group where 6.33 times more likely to have T2D than those in the 15- to 44-year-old group. In Riyadh, the odds ratio for 65 years old and older is 13.1. In Tabuk, the odds ratio for 65 years old and older is 20.30. In Eastern, which had the lowest prevalence of T2D, the odds ratio for 65 years old and older is 18.

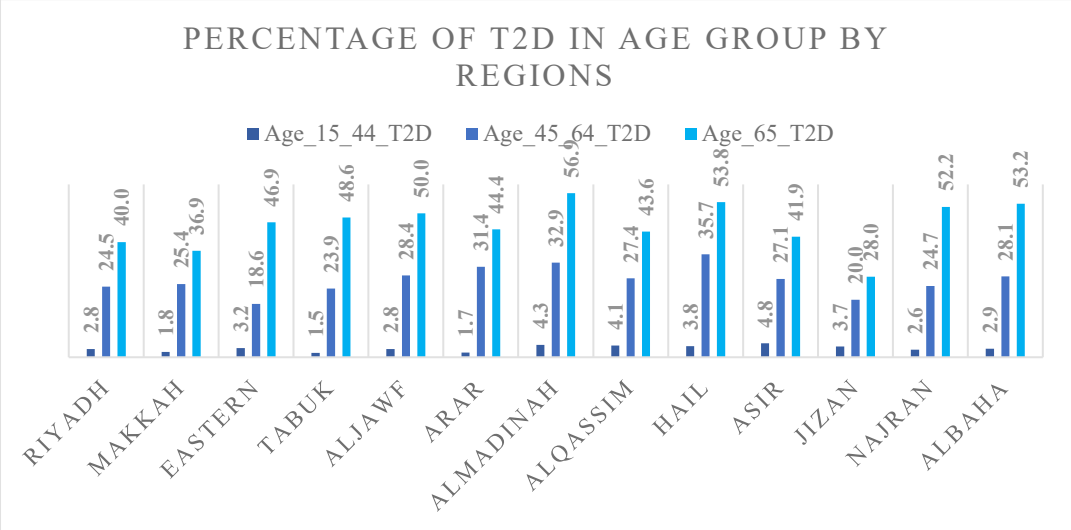


Figure 114: Percentage of T2D in age group by regions

Though the group aged 65 years and older had the highest prevalence of T2D in all regions, they had the highest incidence of the disease in Al-Madinah, with 56.9% of the population diagnosed with T2D. In Hail this percentage was 53.8%; in Al-Baha it was 53.2%.

Worth mentioning is that Aseer had the highest prevalence of T2D in the 15- to 44-year-old age group with 4.8% of the group affected. This is a large group, comprised of 1,133,131 people. [124], which accounts for a significant risk,

particularly because in Saudi Arabia, 70% of the population is under 45 years of age [124]. [125], which studied Abha City in Aseer, found that a lack of exercise among adolescents negatively affected their BMI and, therefore, their risk for T2D. The next highest T2D prevalence in this young age group is 4.3% in Al-Madinah and 4.1% in Al-Qassim. This risk may correspond with BMI in Al-Madinah—this region had the third-highest incidence of obesity accompanied by T2D at 24.6%. In Al-Qassim, this increased risk may correlate with diet because this region had the highest incidence of T2D in those with hi-hi glycemic diets, at 17.2%.

Rising T2D rates in younger people is a worldwide concern. Looking at the United States in particular, Weill et al. found that the prevalence of this disease in children had increased from 0.3-1.2/100,000/year before 1992 to 2.4/100,000/year in 1994; many of them had a family history of T2D [126]. Furthermore, the CDC estimated that more than half of new T2D diagnoses in the U.S. were among adults aged 45 to 64 years [127], which shows that even this middle age group has experienced an increase in T2D prevalence.

These findings match those in [25], [26], and [27], which found a strong correlation between age and the prevalence of T2D in both Jeddah and Japan, as well as 199 other countries. Our results also match a study done in Oman, which found a correlation between older patients and a lack of knowledge of DM risk factors and prevention [34], and another study from Ruhr, Germany, which found an association between traffic-related air pollution and elderly women in particular [128].

5.1.2 BMI

According to the WHO, “1 in 3 adults aged over 18 years is overweight and 1 in 10 is obese” [129]. The WHO also reported that, since 1975, obesity rates have

tripled; this is due in part to a decrease in physical activity and an increase in unhealthy dietary choices [130]. In each of the fifty states in the U.S., the population was more than 20% obese in 2016, with the highest prevalence in the Southern and then Midwestern states [131]. Another CDC study on risk factor data for those diagnosed with T2D in the U.S. found that "87.5% (95% CI, 84.8%–89.7%) of adults were overweight or obese, defined as a body mass index (BMI) of 25 kg/m2 or higher" [127].

Our study found that the second most common risk factor for T2D is BMI. The following regions were most affected by this risk factor: Najran, Al-Baha, Northern Borders, Al-Madinah, Eastern, Al-Jouf, Makkah, Aseer, and Riyadh. People who were obese or overweight had a higher risk for T2D.

In Al-Madinah, the odds ratio for the obese group is 2.9, indicating that obesity carries a higher risk of T2D than normal weight. In Al-Baha, the odds ratio for the obese group is 3.95, and the odds ratio for the overweight group is 2.4, indicating that both groups carry a higher risk of T2D than normal weight. In Aseer, the odds ratio for the obese group is 3.95, indicating that obese people have a higher risk of T2D than people of normal weight. In Najran, the odds ratio for the obese group is 3.55, indicating that obesity carries a higher risk of T2D than normal weight. In Northern Borders, the odds ratio for the overweight group is 3.22, indicating that overweight people have a higher risk of T2D than people of normal weight. In Makkah, the odds ratio for obese people is 2.5, indicating that obesity carries a higher risk of T2D than normal weight. In Al-Jouf, the odds ratio for overweight people is 5.5, indicating that overweight people have a higher risk of T2D than people of normal weight. In Riyadh, the odds ratio for obese people is 3.05, indicating that obese people have a higher risk of T2D than people of normal

weight. In Eastern, the odds ratio for the obese group was 4.3, indicating that obese people have a higher risk of T2D than people of normal weight.

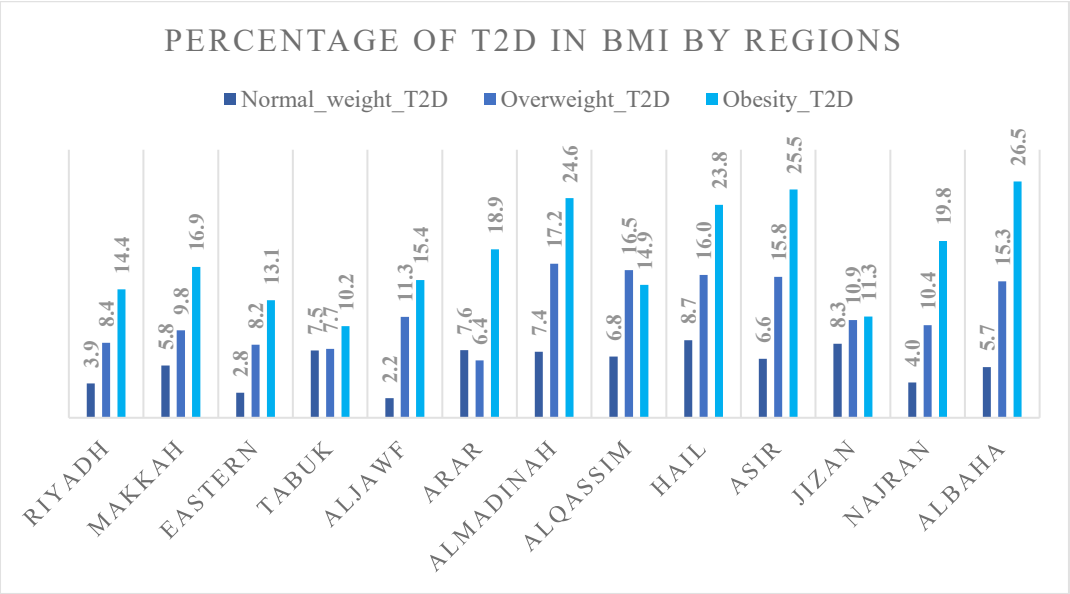


Figure 115: Percentage of T2D in BMI by regions

Al-Baha, Aseer, and Al-Madinah had the highest incidences of obesity accompanied by T2D at 26.5%, 25.5%, and 24.6%, respectively. Some of this increased risk may be contributed to geology. Aseer and Al-Baha have pleasant climates but there are mountains; residents do not walk much because of the difficult terrain. Instead, they are physically inactive. Diet was also a significant predictor of T2D in Aseer, which is discussed in detail in section 5.1.7.

In Al-Madinah, the weather is hot which means that many residents are physically inactive. There are a lot of tourists in this region, which is the home of the Holy Mosque, so Al-Madinah is more urbanized; residents can take cars instead of walk places. This urbanization has also led to an increase in fast food, which has negative health effects.

In most regions, however, we found that the obese group had the highest risk for T2D. Other studies have come to the similar conclusions. For example, [45] found

that BMI and obesity were important factors in understanding Asian Indians' likelihood of developing diabetes. [62] found that diabetes diagnoses increase as BMI increases. [65] found that soft drink consumption has increased, which has led to weight increases that are linked to diabetes. [64] studied Asian countries and found a correlation between a higher BMI and diabetes prevalence.

A person's BMI is primarily affected by both diet and exercise. To begin with the former, many Saudi Arabian dishes are made with rice, meat, and dates. Furthermore, it is common for people to drink coffee and eat dates, sometimes two or three or four times a day. Risks related to diet are discussed in further detail in section 5.1.7.

Physical activity is also closely linked to both BMI and T2D risk factors in Saudi Arabia. A CDC study on risk factor data for those diagnosed with T2D in the U.S. found that "40.8% (95% CI, 36.8%–45.0%) of adults were physically inactive, defined as getting less than 10 minutes a week of moderate or vigorous activity" [127]. [132] found a high level of inactivity within Saudi Arabia, as high as 66.6%. We can't compare our study with this one because their youngest participants were 30 while ours were 15.

Another study, though, found that the closer a person lived to green space, or park areas, the more likely they were to meet the recommended amount of physical activity; those who lived closest to parks were therefore less likely to be obese or overweight [133]. [134] found that people who lived both near large parks or open space and in an area with walkability were less likely to develop pre-diabetes or diabetes. Though further research is needed, a Canadian study also found that higher walkability led to a lower occurrence of obesity and diabetes over a span of 11 years [135].

Of interest is the normal weight group in Northern Borders, which actually had a higher incidence of T2D than the overweight group in the same region. In the normal weight group, 7.6% had T2D and in the overweight group, 6.4% had T2D. One possible reason for this is traditional food in this region. They often eat *mansaf*, which is rice and bread with yogurt and fatty meat. They also consume dates, which are high in sugar. Traditional tea is dark and sweetened with sugar.

BMI was not an effective predictor of T2D in every region; logistic regression on data from Tabuk, Al-Qassim, Hail, and Jizan did not show an association between BMI and diabetes. In Al-Qassim, the overweight group had a higher percentage of T2D than the obese group, at 16.5% and 14.9%, respectively. In this region, there are many farmers who hire both labor and foremen to work the land; they do not do the work themselves, and this lack of physical activity may contribute to the higher risk factor for the overweight group. Because many of these farmers are wealthy, they are accustomed to being served and therefore not doing the work themselves.

BMI's insignificance may be explained with emerging research on the waist-to-hip ratio, which measures the distribution of body fat, specifically targeting the abdominal area. This area is important because it is more strongly correlated to T2D prevalence than other methods of measuring body fat (such as BMI) [136]. Our data does not account for the hip-to-waist ratio.

In Jizan, the overweight and obese groups had nearly the same risk factor: in the overweight group 10.9% had T2D while the obese group had 11.3%. Furthermore, the risk factor for the normal weight group was also similar, with 8.3% of the group diagnosed with T2D. This may be due to the number of jobs requiring manual labor in this region. Because Jizan borders the sea, diets are often comprised of fish. As

with Hail and Al-Qassim, though, logistic regression showed no significant relationship between T2D and BMI in Jizan.

Other studies may explain why only some of Saudi Arabia's regions are affected: [46] did not find a correlation between DM and BMI in the Democratic Republic of the Congo.

5.1.3 Work Status

Work status was an important risk factor for developing T2D. Tabuk, Eastern, Al-Jouf, and Aseer were the regions most affected by work status. Generally, those who were retired had the highest prevalence of T2D, which matches our findings about the correlation between T2D and age, discussed in 5.1.1.

In Eastern and Al-Jouf, for example, the odds ratios for the retired group are 3 and 4.6, respectively, indicating that those who are retired have a higher risk of T2D than the employed group. In Tabuk as well, the odds ratio for the retired group is 3.45 when compared to the employed group. The odds ratio for the unemployed group in Aseer was .511, indicating that the employed have a higher risk than those who are unemployed.

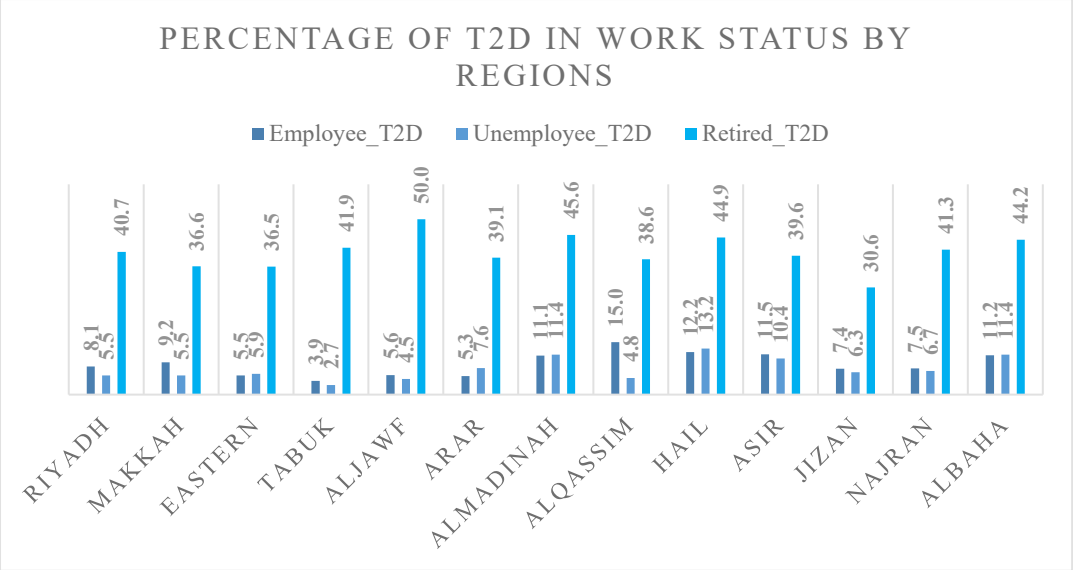


Figure 116: Percentage of T2D in work status by regions

In Al-Madinah and Al-Baha, the percentages are almost the same for the employed and unemployed groups. In Al-Madinah, the employed group accounts for 11.1% of T2D cases and the unemployed group is 11.4%; in Al-Baha, the employed group is 11.2% and the unemployed group is 11.4%. In Eastern, the employed group accounts for 5.5% of T2D cases and the unemployed group accounts for 5.9%. In Hail, the percentages are 12.2% for the employed group and 13.2% for the unemployed group. In Northern Borders, the unemployed group is at a higher risk for T2D than the employed group; their percentages are 7.6% and 5.3%, respectively.

In Al-Qassim, the employed group had three times as many T2D cases than the unemployed group, at 15.0% and 4.8%, respectively. In no other region is the gap between these two groups so large.

Tabuk, Eastern, Al-Jouf, and Aseer were the regions most affected by work status—and three of these regions have military bases: Tabuk, Eastern, and Aseer. Work stress related to the military may contribute to this increased risk within these regions due to the high-pressure nature of military jobs. Social stress may also

contribute to the T2D risk; because those working in the military move around a lot for their jobs, they may become isolated from friends and family.

In Aseer, many retired people are still involved in farm work, meaning they are more active than retired people in other regions. Other studies may explain why the employed group also has a risk for T2D. [35] found that in a study of 402 people, the diabetes patients cited higher levels of work-related stress, which the unemployed group would not experience; these higher stress levels may have contributed to the diabetes patients' diagnoses. In a survey of occupational stress in Saudi Arabia, [137] found that Saudi employees experienced the highest levels of stress compared to employees from other countries.

Shift work employees, in particular, had a higher prevalence of T2D, as found by [51] and [50]. [50] found that these risks were particularly high for people who worked shifts for 20 or more years, even after they retired. [138] found a correlation between retirement and both T2D and impaired fasting glucose.

5.1.4 Smoking Status

Smoking status was not as effective as the previously mentioned risk factors at predicting the prevalence of T2D. Smoking status was an effective predictor only in Hail, Al-Qassim, Riyadh, and Makkah. Generally, ex-smokers were most likely to be diagnosed with T2D.

In Hail, for example, the odds ratio for ex-smokers was 3.5, indicating that ex-smokers have a higher risk of T2D than those who never smoked. People in this region often spend their leisure time smoking in places called *Astraha*. These are places that people either rent or own to relax, meet with friends or family, and smoke. *Astraha* may also explain the relationship between T2D, marital status, and

smoking: some people spend too much time away from their families, which puts stress on their marriages and can lead to a higher divorce rate.

The odds ratio for ex-smokers was 6 in Al-Qassim, indicating that ex-smokers have a higher risk of T2D than those who never smoked. In Makkah, the odds ratio for ex-smokers was 2.6, indicating that ex-smokers have a higher risk of T2D than those who have never smoked. In Riyadh, the odds ratio for ex-smokers was 2.3 when compared to group that never smoked.

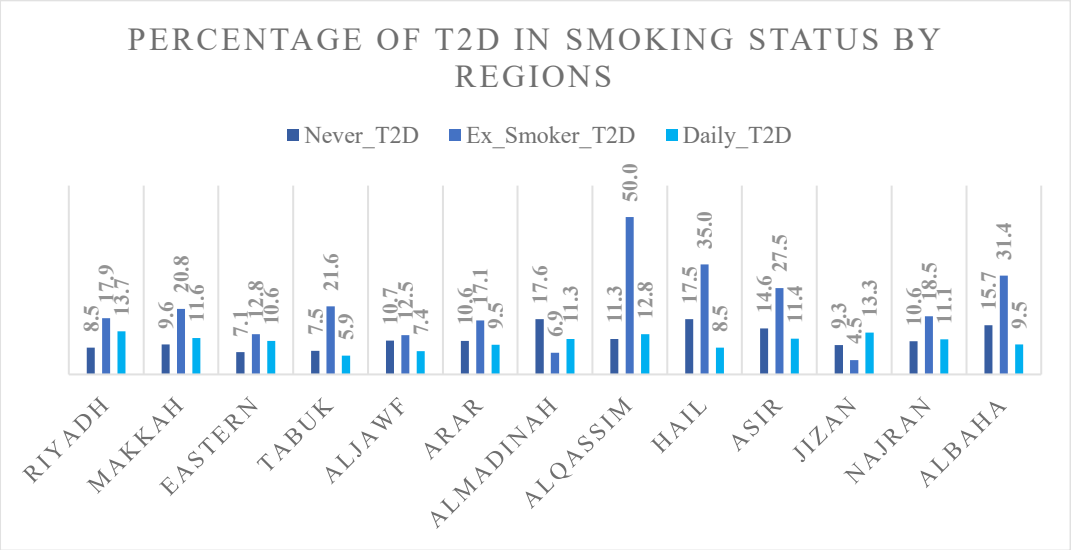


Figure 117: Percentage of T2D in smoking status by regions

Smoking was statistically significant in three regions: Al-Qassim, Hail, and Riyadh. In all regions, the ex-smokers group had the highest prevalence of T2D. Of particular note, though, was the ex-smokers group in Al-Qassim: 50% of this group had T2D, which was the highest of any region. This percentage may seem high, but other studies have also found a strong correlation here. In a study on risk factors affecting those diagnosed with diabetes, the CDC stated that, “34.5% (95% CI, 31.7%–37.3%) had quit smoking but had a history of smoking at least 100 cigarettes in their lifetime” [127].

Worth noting is that, in Al-Madinah and Jizan, the percentages for those who had never smoked were higher than the ex-smoking group. In Al-Madinah, ex-smokers represented 6.9% of T2D cases and those who had never smoked represented 17.6%. In Jizan, ex-smokers represented 4.5% of T2D cases and those who had never smoked represented 9.3%.

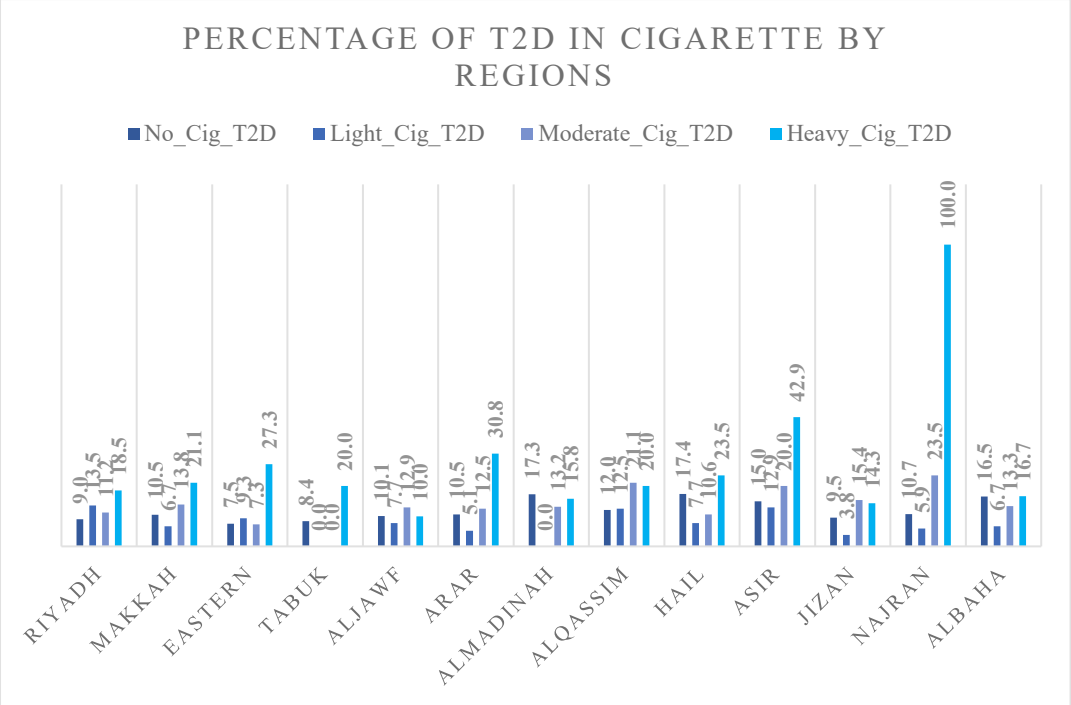


Figure 118: Percentage of T2D in cigarette by regions

Other studies may explain the correlation between smoking and T2D. [139] found that students in Riyadh were more likely to smoke if they had a friend who did so; this percentage could be as high as 60.5%. In the same study, current smokers cited relaxing and having free time as reasons to smoke, which supports our *Astraha* theory. [69], [102], [103], and [104] found that quitting smoking is associated with a higher risk of diabetes due to the weight gain that comes with quitting (more information on BMI can be found in section 5.1.2).

This increased risk does not last forever, though. [100] and [105] found that the weight gain associated with quitting smoking may decrease after 12 years or 10 years (respectively).

Because smoking is often prohibited, many Saudis will hide their smoking habits, particularly during interviews where family is present, such as those conducted for the Saudi national survey (from which our data is drawn).

5.1.5 Marital Status

Marital status was an effective predictor of T2D for only Hail, Al-Qassim, and Riyadh. In all three of these regions, people who were divorced, widowed, or separated had the highest risk for T2D. This matches [32], a study that found that widowhood was associated with an increased risk for T2D. In Hail, the odds ratio for the divorced, widowed and separated group is 32.4 in comparison to the never-married group. Likewise, in Al-Qassim, the odds ratio for the divorced, widowed and separated group is 15.3, indicating that this group has a higher risk of T2D than those who never married. Finally, in Riyadh, the odds ratio for the divorced, widowed and separated group is 4.9, indicating that this group has a higher risk of T2D than those who never married.

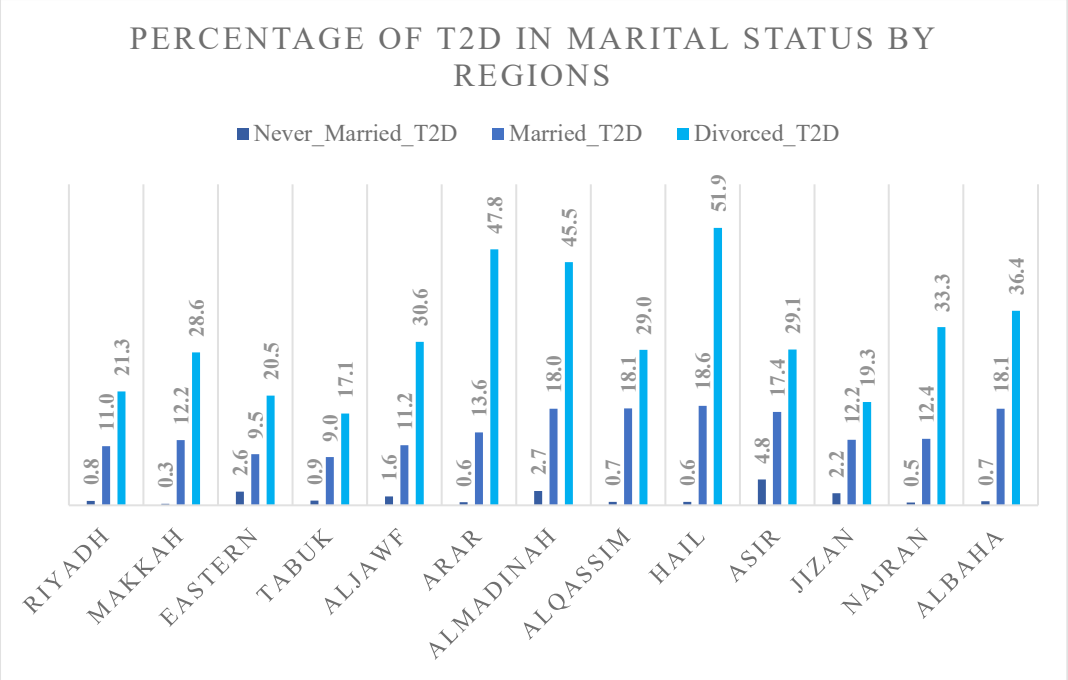


Figure 119: Percentage of T2D in marital status by regions

Hail had the highest prevalence in the divorced, separated, and widowed group, at 51.9%. In Northern Borders and Al-Madinah, this group had the highest prevalence as well, at 47.8% and 45.5%, respectively.

Hail also had the highest prevalence in the married group, at 18.6%. The lowest prevalence in the married group was in Tabuk, at 9.0%. Aseer had the highest prevalence in the never married group, at 4.8%. This matches our data in section 5.1.1 about age, where the 15- to 44-year-old age group was a higher risk for T2D. Makkah had the lowest prevalence of T2D in the never married group at 0.3%.

Why is the risk so high for those in the divorced, separated, and widowed group? Both male and female divorcees face stigmas and psychological and financial pressures; [140] estimates that there were more than 50,000 divorce cases in 2017, which increased from 2016's figures. The prevalence of divorce and the pressures faced by divorcees may explain the increased risk for T2D.

Marital status, however, is a complicated risk factor. In Hail, the odds ratio for the married group is 10.5, indicating that this group has a higher risk of T2D than

those who never married, but a risk less than that of the divorced, widowed, and separated group. Domestic violence may play a role in this increased risk for the married group; in a self-administered questionnaire, 20% of women reported experiencing domestic violence in the past year [141]This percentage may not be accurate, however, because participants may not have been comfortable being honest about their experiences.

Other studies also found a higher prevalence of T2D in other groups. [34] found that divorced/separated men and widowers were more likely to have lost weight than their married counterparts; [33] also found that widowed or divorced men were likely to experience a drop in their BMI, which would lessen that risk factor.

5.1.6 Education Level

Education was an effective predictor of T2D for Riyadh and Aseer. The illiterate group has the highest risk for T2D. In Riyadh, the odds ratio for the elementary and intermediate educated group is 2.52, indicating that this group has a higher risk of T2D than the highly educated reference group. Likewise, in Aseer, the odds ratio for the illiterate group is 4.32 and the odds ratio for the elementary and intermediate educated group is 4.2, indicating that both groups have a higher risk of T2D than the highly educated reference group.

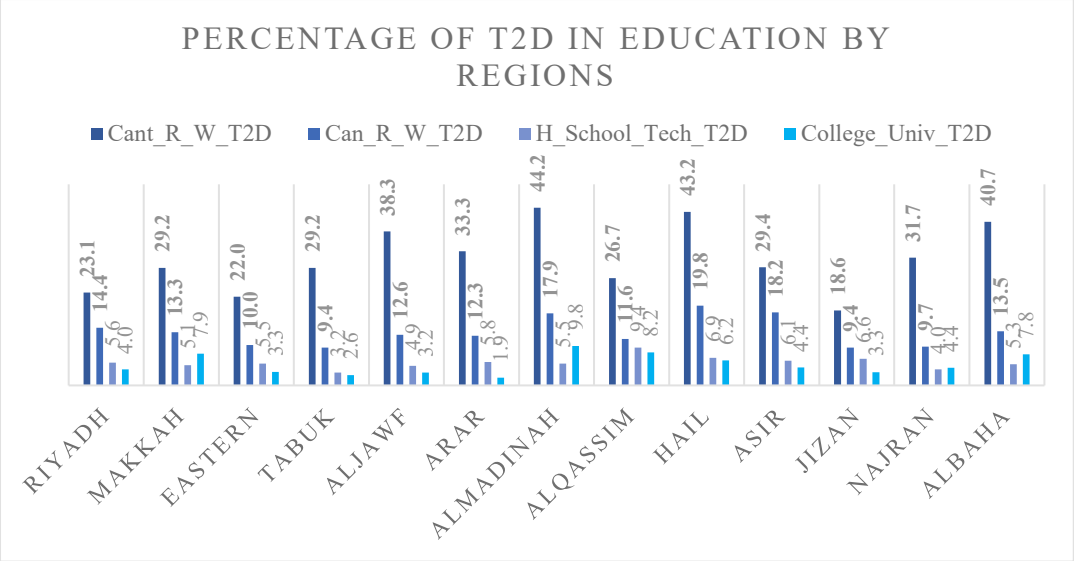


Figure 120: Percentage of T2D in education by regions

Though the illiterate group is at the highest risk for T2D, the college and postgraduate group also faces an increased risk in some regions. For example, this group is at the highest risk in Al-Madinah, at 9.8%. In Al-Qassim this group's percentage is 8.2%. This increased risk may be due, in part, to the sedentary work that highly educated people perform. The college and postgraduate group made up the smallest percentage of T2D diagnoses in Northern Borders, with only 1.9% of them having diabetes.

In western Saudi Arabia, both Al-Madinah and Makkah had a higher prevalence of T2D in the college and postgraduate group than in the high school graduate group. In Al-Madinah, 5.5% of the high school group had T2D; 9.8% of the college and postgraduate group had T2D. In Makkah, 5.1% of the high school graduate group had T2D; 7.9% of the college and postgraduate group had T2D. As suggested above, this may be because the higher educated groups are more sedentary in their work. It may also be because these regions are urbanized and forms of transportation other than walking are available.

This matches the results found by [29] and [30], which both found that participants with lower levels of education faced increased health risks. [31] found that Saudi patients with lower levels of education were not taking their medication, 60% of patients were not taking their medication the correct number of times, and 50% were not taking them at the correct time of day. [64] found that lower levels of education were associated with higher T2D risks, and [138], which studied China, found that patients with lower education were linked to poor glycemic control.

5.1.7 High Glycemic Diet

Diet was a good predictor of T2D only in Aseer. In this region, the odds ratio for low-hi glycemic foods were 5.91, indicating that those who consumed low-hi glycemic food had a higher risk of T2D than those consuming hi-hi glycemic foods.

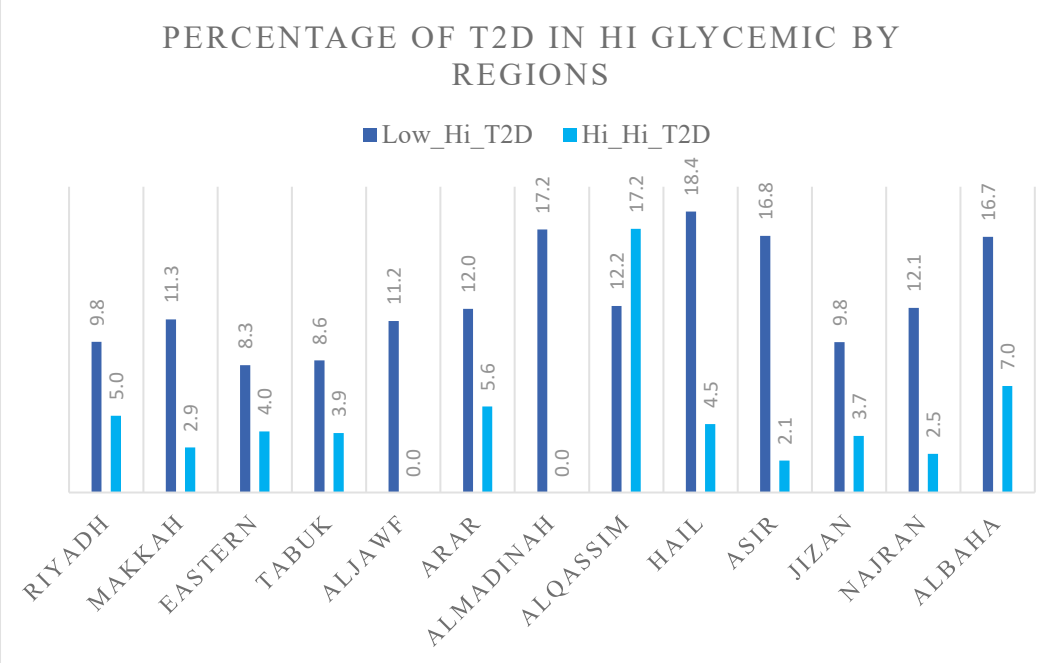


Figure 121: Percentage of T2D in diet Hi glycemic by regions

Diet may be significant in Aseer because they consume the highest amount of fruit in Saudi Arabia. Furthermore, traditional foods in Aseer include Al-Fattah,

which is made with honey, sugar, and dates; Al-Qurs, which is made with flour; and Al-Aseedah, which is made from either wheat flour, corn flour, or barley. Al-Qurmah (also known as Al-Hamisah) is made with sheep meat and fat.

Dietary changes can be difficult for many reasons. One reason is a lack of social support. Traditional Saudi foods may not be compatible with diabetes-specific diets, and this lack of support can contribute to a patient's failure to make these changes [142].

Financial barriers may also cause problems for those making dietary changes. Healthy food is typically more expensive, as is exercise equipment and diabetes supplies, so those of a lower socio-economic status may not be able to afford to make these changes and improve or monitor their T2D [143]. Because our study did not look at socio-economic factors, our conclusions are limited regarding finances.

Our literature review found that many patients did not monitor their diets, leading to a higher BMI and a higher risk for T2D. [49], for example, found that 82% of their participants were overweight or obese, and that 62% did not eat enough fruits or vegetables, which exposed them to higher risk. [50] found that lessening one's consumption of starches, refined foods, and sugary drinks was correlated to a decreased risk of T2D; [53] also found that both sugar- and artificially sweetened beverages were linked to an increased risk of T2D.

5.1.8 Shisha/Hookah Use

Shisha/hookah use was an effective predictor of T2D only in Riyadh. Our results show that light smokers had a higher risk of T2D than those who had never smoked. We also found, however, that heavy smokers have the same risk as those who had smoked shisha or hookah. The odds ratio for light smokers of shisha was

6.02, indicating that this group had a higher risk of T2D than those who had never smoked. This risk may be related to how people spend their leisure time. In Riyadh, there are many cafés where men meet with their friends. This is the most popular option for relaxing, and people often smoke shisha and cigarettes there, even if they would not normally smoke elsewhere.

Interestingly, shisha is more common in eastern and western Saudi Arabia, though it was statistically significant only in Riyadh. One explanation is that there are fewer cultural restrictions in Riyadh. For example, women are forbidden from purchasing or using shisha in Saudi Arabia's eastern and western regions; this is not true in Riyadh. Additionally, because the Holy Mosque is in the western region, there are diverse cultural influences from people originating in many different countries. Riyadh, on the other hand, has fewer of these influences; people living there may be more likely to hide their smoking habits (as discussed in section 5.1.4).

Our literature review also found that shisha smoking is associated with health risks [81], and that hookah use has increased [77]. One study comparing cigarettes and hookah found that both forms of smoking were associated with high serum NO(x) levels [79].

5.2 Sex

In Al-Baha, Aseer, and Jizan, women have a higher prevalence of T2D than men. In Hail, Northern Borders, and Al-Jouf, the prevalence between the sexes is approximately the same. In all of the other regions, men have a higher prevalence of T2D than women.

Several factors may explain this difference. One is physical activity. Women are less likely to be physically active [144]. Their schools do not often offer physical education classes and, culturally, their families may not encourage them to participate in sports or other outside physical activities. This is currently changing, however; women will soon be allowed to play sports in school.

Another important factor is education. Our data shows that illiterate women have a higher prevalence of T2D than illiterate men. For the groups that have completed some level of schooling, though, men are more likely to have T2D than women. These findings are supported by, which found that women in rural areas had less education than women in cities, which explains why central, eastern, and western Saudi Arabia—areas that are more urban—has a different male-to-female T2D ratio.

A third factor is work status. Our study shows women who are unemployed are more likely to have T2D. Most of the women in Aseer, for example, were unemployed, which may explain why the prevalence of women with T2D was so high.

5.3 Limitations

There are three main limitations of our research. The first is that the data we used came from a cross-sectional survey; this means that we cannot evaluate causality within the data. Our second limitation is the self-reported nature of the data from SHIS. This means that there is no way of knowing if participants have lied about their information (such as their diet or smoking, for example), or if they have misremembered any of it. That said, the SHIS included a large sample and used a standardized methodology. The third limitation is that only 52% of survey

participants visited their local health clinics to have their blood drawn. To combat this, we applied a post-stratification weight adjustment using various data from the household surveys (such as demographic information and previous diagnoses, for example).

Future studies should look at additional factors for T2D, such as the correlation between socioeconomic class as in [113] and road traffic or urban noise as in [145]; looking at data for other factors will help further our understanding of diabetes and its prevalence.

5.3 Conclusion

The goal of our study was to better understand the relationship between T2D and its risk factors in Saudi Arabia. It is important to define the relationship between diabetes and its risk factors to lower the prevalence of T2D and decrease healthcare expenditures—particularly because T2D prevalence is on the rise; if it continues to rise, healthcare expenditures related to both diabetes and its complications will continue to increase.

We looked at various risk factors such as age, BMI, work status, smoking status, marital status, education, diet, and shisha (hookah) use. Overall, we found that age and BMI were the two most crucial factors in predicting T2D occurrence. Age was an effective predictor in all thirteen regions of Saudi Arabia; patients 65 years old or above have a higher prevalence of T2D than their younger counterparts.
BMI was an effective predictor in nine regions, revealing that people who are obese had a higher risk for T2D.

Work status was an effective predictor in five regions. Generally, those who were retired had the highest prevalence of T2D, which matches our findings about the correlation between T2D and age.

Smoking status was an effective predictor in four regions: Hail, Al-Qassim, Riyadh, and Makkah. Generally, ex-smokers were most likely to be diagnosed with T2D.

Marital status was an effective predictor of T2D for only Hail, Al-Qassim, and Riyadh. In all three of these regions, people who were divorced, widowed, or separated had the highest risk for T2D.

Education was an effective predictor of T2D for Riyadh and Aseer. The illiterate group has the highest risk for T2D.

Diet was a good predictor of T2D only in Aseer. Traditional foods in this region often include sugar, flour, meat, and fat.

Shisha and hookah use was an effective predictor of T2D only in Riyadh. Our results show that light smokers had a higher risk of T2D than those who had never smoked.

Saudi Arabia should increase awareness of type 2 diabetes. In addition to Ministry of Health should be involved many ministries such as Ministry of Education, Ministry of Islamic Affairs, Endowments, Da'wah and Guidance and Ministry of Municipal and Rural Affairs.

Saudi Arabia should increase citizens' awareness of type 2 diabetes. In addition, the Ministry of Health should involve other ministries such as the Ministry of Education, the Ministry of Islamic Affairs, Endowments, Da'wah and Guidance and the Ministry of Municipal and Rural Affairs. To decrease healthcare expenditures, the Ministry of Health should focus on health education, ensuring that Saudi Arabians understand the importance of indoor physical activity and proper

diet to lower their risk factors for T2D. Further analysis in each region can help address each individual region's needs, such as the accessibility of health care facilities. Also, future surveys should use technology for to ensure privacy and reliable answers.

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APPENDIX A: REGIONS AND THEIR CODES

Regions and their Codes

Region	Code
Riyadh	1
Makkah	2
Eastern	3
Tabuk	4
Al-Jouf	5
Northern Borders	6
Al-Madinah	7
Al-Qassim	8
Hail	9
Aseer	10
Jizan	11
Najran	12
Al-Baha	13

Codes for Sex

Sex	Code
Male	1
Female	2

Codes for Age

Age	Code
15-44	1
45-64	2
65+	3

Codes for Marital Status

Marital	Code
Never been married	1
Married	2
Divorced/sep/Widowed	3

Codes for Work Status

Work	**Code**
Employee	**1**
Homemaker/ Unemployed	**2**
Retired	**3**

Codes for Education Level

Education	Code
Can't read or write	1
Read and Write-Intermediate school	2
High school/Technical	3
College/University/Post-Graduate	4

Codes for Smoking Status

Smoke	Code
Never	1
Ex-smoker	2
Daily	3

Codes for High Glycemic Diets

High Glycemic	Code
Low_Hi	1
Hi_Hi	2

Codes for Low Glycemic Diets

Low Glycemic	Code
Low_Hi	1
Hi_Hi	2

Codes for Cigarette Smoking

Cigarette	Code
NO	0
Light	1
Moderate	2
Heavy	3

Codes for Cigarette Smoking

Cigarette	Code
NO	0
Light	1
Moderate	2
Heavy	3

Codes for BMI

BMI	Code
Normal Weight	1
Obese	2
Overweight	3

Codes for Shisha Sugar Use

Shisha Sugar	Code
NO	0
Low	1
High	2

Codes for Shisha Use

Shisha	Code
NO	0
Low	1
High	2