Concomitant conditions and associated diseases in diabetic patients

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Roll No.: 0121/20

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Public Health.

One Health Institute

Chattogram Veterinary and Animal Sciences University

Chattogram-4225, Bangladesh

March 2023

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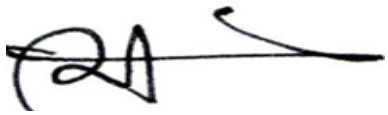

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PLAGIARISM VERIFICATION

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Dedicated

To my

Beloved

Family, Friends and

Honorable Teacher

Table of Content

List of Figures

List of Tables

List of Abbreviations

ADA	American Diabetic Association
BMI	Body Mass Index
BP	Blood Pressure
CDGH	Chattogram Diabetic General Hospital
CVD	Cardiovascular Disease
DM	Diabetes Mellitus
GDM	Gestational Diabetes Mellitus
HbA1C	Glycosylated Hemoglobin
HDL	High-Density Lipoprotein
HSC	Higher Secondary Certificate
HTN	Hypertension
IHD	Ischemic Heart Disease
IDF	International Diabetes Federation
LDL	Low-Density Lipoprotein
NCD	Non-communicable disease
OGTT	Oral Glucose Tolerance Test
SGLT	Sodium-Glucose Transport protein
SGPT	Serum Glutamic Pyruvic Transaminase
SSC	Secondary School Certificate
T1DM	Type-1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
TG	Triglycerides
WHO	World Health Organization

Abstract

Diabetes Mellitus (DM) is a chronic metabolic disorder. It imposes a social and economic burden, with increased manifolds globally with high morbidity and mortality in patients of both developed and developing countries. It causes various types of complications (e.g., macro- and micro-vascular) if it remains uncontrolled. The purpose of the study was to determine factors (e.g.: age, gender, duration of diabetes, frequency of checking clinical parameters related to diabetes) and associated diseases or disease conditions (e.g.: diabetic retinopathy, nephropathy, neuropathy) in DM patients visited for medical services at Chattogram Diabetic General Hospital, Chattogram, Bangladesh. This was a cross-sectional study, and a total of 400 patients' data were considered for the present study. Data was collected by using a pretested questionnaire with the written consent of the participants. The data included general information (e.g.name, address, contact), demographic information (e.g. gender, education status of the patient, marital status), disease characteristics (e.g. frequency of checking clinical parameters such as HbA1c level, lipid profile), and self-management behaviors (e.g. physical exercises, oral drugs, outside food consumption). Results demonstrated that there was an association between age, education, duration of diabetes, frequency of checking blood glucose levels, fasting blood glucose levels, and diabetic-related complications. Diabetic patients who have suffered for more than 15 years [3.21, 95% Confidence Interval (CI): 1.75 - 5.89] were more likely to develop diabetes-associated diseases. The patients whose ages were more than 60 years (95% CI: 1.63 – 57.92) were more prevalent in developing diabetes-related complications. Those patients who had no formal education were (3.85, 95% CI: 1.8 – 8.22) more prone to have diabetes-related complications. The patients who didn't check their blood glucose levels regularly were more likely (21.5, 95% CI: 3.64 – 127.06) to have DM-related complications. It was also found the patients who didn't have their blood glucose level under control were more likely to have (3.13, 95% CI: 1.62 – 6.05) times of having diabetes-related complications. This study reported that among DM patients' multiple complications were predominantly seen in patients taking both insulin and oral drugs such as neuropathy, dental problems, nephropathy, foot problems, cardiovascular disease, skin problems, and other concomitant diseases or disease conditions (e.g. tuberculosis, streptococcal pneumonia, musculoskeletal disorder). The findings of the current study suggested that the regular monitoring and management of blood sugar levels, as well as close communication with healthcare providers, can help to minimize the risk of complications in these patients.

Keywords: Diabetes mellitus, concomitant conditions, diseases, complications.

Chapter-1: Introduction

Diabetes mellitus is a collection of metabolic disorders defined by chronic hyperglycemia caused by abnormalities in insulin secretion, insulin action, or insulin receptor function, or both (Basith et al., 2020). There are two main types of diabetes: Type 1, which is an autoimmune condition that results in the destruction of insulin-producing cells in the pancreas, and Type 2, which is a condition that occurs when the body becomes resistant to insulin or doesn't produce enough insulin to regulate glucose levels in the blood. Risk factors for developing diabetes include obesity, physical inactivity, poor diet, family history, and age (Kharroubi and Darwish, 2015). It is a tremendous and expanding clinical and public health concern.

According to the International Diabetes Federation (IDF) Diabetes Atlas 2021, 537 million individuals are anticipated to have diabetes; this figure is projected to increase to 643 million by 2030 and 785 million by 2045 (Martinez and Zahra, 2022). It also projected in 2012 that 3.8 million or 4.8% of Bangladesh's population had diabetes. The number is projected to reach 7.4 million by 2025, representing 6.1% of the population. Diabetes is becoming one of the most common noncommunicable diseases in the world. It is the fourth or fifth greatest cause of death in most high-income nations, and there is significant evidence that it is an epidemic in the majority of low- and middle-income nations, such as Bangladesh. Diabetes will probably be one of the most difficult health challenges of the twenty-first century (Sicree et al., 2010).

Diabetes can lead to a range of associated conditions and complications, including cardiovascular disease, neuropathy, retinopathy, nephropathy, and foot ulcers. These conditions can cause significant morbidity and mortality and can have a major impact on the quality of life of people with diabetes (Basith et al., 2020). One of the most common complications of diabetes is cardiovascular disease. People with diabetes are at increased risk of developing heart disease, including coronary artery disease, stroke, and peripheral arterial disease. This is due to the damage that high levels of glucose can cause to blood vessels and heart (Wass and Stewart, 2002). Diabetes can also cause neuropathy, which is damage to the nerves that can result in numbness, tingling, or pain in the hands and feet. This can also lead to problems with digestion, urination, and sexual function. Retinopathy is another common complication of diabetes. This is damage to the blood vessels in the retina, which can lead to vision loss and blindness if left untreated

(Lone et al., 2013). Nephropathy, or kidney damage, is also a potential complication of diabetes. Over time, high levels of glucose in the blood can damage the kidneys' small blood vessels, leading to kidney disease. Finally, people with diabetes are at increased risk of developing foot ulcers and infections, particularly if they have poor circulation or neuropathy. These ulcers can be difficult to treat and can lead to amputations in severe cases (Yuan et al., 1999).

Patients with diabetes are at a significant risk for developing microvascular problems of tiny blood vessels and macrovascular complications of larger blood vessels (Dormandy et al., 2005). Microvascular complications of diabetes are those long-term complications that affect small blood vessels. Typical examples are retinopathy, nephropathy, and neuropathy. Most diabetic macrovascular problems include the coronary arteries, peripheral arteries, and cerebrovascular. Early macrovascular disease is related to the presence of atherosclerotic plaque in the blood vessels that supply the heart, brain, limbs, and other organs. In the advanced stages of macrovascular disease, these blood channels become completely obstructed, which might raise the risk of myocardial infarction (MI), stroke, claudication, and gangrene (Zimmerman, 2016).

Diabetes impairs functional capacities and quality of life, resulting in substantial morbidity and premature death (Ramtahal et al., 2015). Concerns have recently been raised over the fact that more than one-third of diabetes-related deaths occur in those under the age of 60 (Alotaibi et al., 2017). These changes have been attributed to increased consumption of unhealthy diets and sedentary lifestyles, which result in raised Body Mass Index (BMI) and fasting plasma glucose (Lone et al., 2017). Specifically, those with a higher BMI are more prone to develop diabetes (Mahanta et al., 2013). The aging of the human population is also a factor, as diabetes is more prevalent among older adults (Oluyombo et al., 2015). The expense of diabetes care exceeds the average per capita healthcare spending by at least 3.2 times, and by 9.4 times in the presence of complications (Basith et al., 2020).In 2015, the IDF estimated that diabetes accounts for 5–20% of total healthcare expenses in most countries. By 2040, the global cost of treating diabetes and its consequences is anticipated to reach $802 billion, up from an estimated $673 billion in 2015 (Herman, 2016).

In Bangladesh, the IDF ranked Bangladesh 8th of countries with the highest number of adults (20–79 years) with diabetes (13.1 million cases), and it is expected to be ranked 7th in 2045. It is also seen that diabetic patients face different types of comorbidities due

to the long-term duration of this disease (Islam et al, 2015). Thus, it has become a great public health concern. Despite the growing burden of diabetes in Bangladesh, there is a significant gap in knowledge regarding the prevalence, risk factors, and impact of concomitant conditions and associated diseases in diabetic patients (Hossain et al., 2022). While some studies in Bangladesh have investigated the prevalence of individual comorbidities, such as hypertension and dyslipidemia, there is a lack of comprehensive research that examines the full spectrum of concomitant conditions and associated diseases that commonly coexist with diabetes (Afroz et al., 2019). Moreover, there is a need to identify the risk factors that contribute to the development of these comorbidities in diabetic patients, as well as their impact on diabetes management and patient outcomes. Therefore, the present study was carried out to find out the concomitant conditions and associated diseases in diabetic patients visited for medical services at Chattogram Diabetic General Hospital, Chattogram, Bangladesh

The specific objectives of the present investigation were as follows: -

- To determine the prevalence and risk factors for developing diabetes and search for associated diseases in diabetic patients.
- To evaluate the management and treatment of diabetic patients, including medication use, lifestyle interventions, and healthcare utilization.

Chapter-2: Literature Review

2.1. Diabetes mellitus as a public health concern

Pathophysiology of diabetes mellitus

Diabetes mellitus is characterized by a complex pathophysiology and variable clinical presentation; hence, any classification of this ailment is arbitrary, but informative, and is frequently impacted by the physiological parameters present during assessment and diagnosis. Current disease classification is based on both the etiology and pathophysiology of disease and is useful for clinical disease evaluation and therapy determination. According to this categorization, diabetes can be split into four major forms or groups: Type 1 diabetes mellitus (T1DM), Type 2 diabetes mellitus (T2DM), Gestational diabetes mellitus (GDM), and Specific types of diabetes due to other causes (Herman, 2016).

2.2. Type 1 diabetes mellitus

Diabetes mellitus type 1 is caused by a complete lack of insulin and has an autoimmune foundation. Until the reclassification of diabetes mellitus based on etiopathology, this condition was previously classified as insulin-dependent diabetes mellitus (IDDM). The characteristic of the illness is the immune-mediated death of beta cells, and hyperglycemia only occurs when 90 percent of b cells are gone (Alam et al., 2014).

Diabetes type 1 is a chronic condition. In persons with type 1 diabetes, pancreatic cells that produce insulin are damaged, rendering the body incapable of producing insulin. Insulin is a hormone that assists cells in converting glucose (sugar) into energy. The glucose in the bloodstream comes from the food that has been consumed. Insulin permits glucose to enter the cells of the body from the bloodstream. When the cells have sufficient glucose, the liver and muscle tissues store the excess glucose as glycogen. It is converted to blood sugar and released when energy is required between meals, during activity, or while sleeping. Due to a lack of insulin, the body cannot metabolize glucose in type 1 diabetes. The glucose from the diet cannot enter cells. This causes excessive glucose to circulate in the circulation. High blood sugar can cause both short- and long-term complications (Zimmerman, 2016).

Symptoms of type 1 diabetes

The symptoms of T1DM are extreme thirst, increased hunger (especially after eating), dry mouth, upset stomach and vomiting, frequent urination, unexplained weight loss, fatigue, blurry vision, heavy, labored breathing, frequent infections of your skin, urinary tract, or vagina, crankiness or mood changes (Alam et al., 2014).

2.3. Type 2 diabetes mellitus

The most prevalent form of diabetes, accounting for 90–95% of cases (American Diabetes Association, 2010a), is type 2 diabetes. It occurs due to a relative insulin deficit; however, insulin resistance is the fundamental problem (Alam et al., 2014).

Type 2 diabetes is a chronic condition that prevents the body from properly utilizing insulin. People with type 2 diabetes are known to have insulin resistance. The most susceptible age group for this type of diabetes is middle-aged or older. It was formerly known as adult-onset diabetes. But because of childhood obesity, type 2 diabetes also affects children and adolescents (Dansinger, 2022).

Signs and symptoms of type 2 diabetes

The signs and symptoms of T2DM are being very thirsty, peeing a lot, blurry vision,

being cranky, tingling or numbness in your hands or feet, fatigue/feeling worn out, and wounds that don't heal (Wass and Stewart, 2002).

Gestational diabetes

Gestational diabetes refers to carbohydrate intolerance that originates or is first recognized during pregnancy. Previously undiagnosed diabetes mellitus (either type 1 or type 2) may reveal itself during pregnancy, especially during initial evaluations. However, gestational diabetes is distinguished from type 2 diabetes. As pregnancy progresses, the rising insulin resistance increases the need for insulin. The equilibrium between insulin resistance and insulin supply is maintained in most pregnancies. However, if resistance prevails, the pregnant woman will develop hyperglycemia (Alam et al., 2014).

Symptoms of gestational diabetes

Women with gestational diabetes typically have no symptoms or may attribute symptoms to pregnancy. The majority are diagnosed through routine screenings. One may be thirstier, and hungrier and eat more, pee more than usual (Stewart, 2002).

2.4. Specific type of diabetes due to other causes:

This type of diabetes includes monogenic diabetes syndromes [such as neonatal diabetes and maturity-onset diabetes of the young (MODY)], diseases of the exocrine pancreas (such as cystic fibrosis and pancreatitis), and drug- or chemical-induced diabetes (such as with glucocorticoid use, the treatment of HIV/AIDS, or following organ transplantation) (ADA, 2018).

2.5. Diagnosis of diabetes mellitus

Diabetes can be diagnosed in a variety of ways. Typically, each method must be conducted a second time to confirm diabetes-

HbA1C:

The Glycosylated Hemoglobin, known as HbA1C or A1C, refers to the average blood sugar level for the previous two to three months. If the A1C is greater than or equal to 6.5%, diabetes is diagnosed. (The hemoglobin A1c test indicates the average level of blood sugar over the last 2 to 3 months.

Table 1: Diagnosis of DM regarding HbA1c (Adapted from ADA, 2022)

Condition	HbA1c
Normal	Less than 5.7%
Prediabetes	5.7% to 6.4%
Diabetes	6.5% or higher

Fasting Plasma Glucose (FPG)

The test measures fasting glucose levels. Fasting is abstaining from eating and drinking (other than water) for at least eight hours before a test. Typically, this test is completed first thing in the morning, before breakfast. If fasting blood sugar is greater than or equal to 126 mg/dL, diabetes is confirmed.

Table 2: Diagnosis of DM regarding Fasting Plasma Glucose (Adapted from ADA, 2022

Condition	Fasting Plasma Glucose (FPG)
Normal	less than 100 mg/dl
Prediabetes	100 mg/dl to 125 mg/dl
Diabetes	126 mg/dl or higher

Oral Glucose Tolerance Test (OGTT)

The OGTT is a test that measures blood sugar levels before and two hours after consuming a sweet drink, typically 75g of oral glucose solution. It informs us of how our bodies digest sugar. Diabetes is diagnosed at a 2-hour blood sugar level of 200 mg/dL or above.

Table 3: Diagnosis of DM regarding Oral Glucose Tolerance Test (OGTT) (Adapted from ADA, 2022)

Condition	Oral Glucose Tolerance Test (OGTT)
Normal	less than 140 mg/dl
Prediabetes	140 mg/dl to 199 mg/dl
Diabetes	200 mg/dl or higher

Random (also called Casual) Plasma Glucose Test

This is a blood test that can be performed at any time of day if someone exhibits severe diabetic symptoms. Diabetes is diagnosed when blood sugar levels are 200 mg/dL or above (ADA, 2018).

2.6. Risk factors for diabetes mellitus

As with any disease, the disease is caused by both modifiable and non-modifiable risk factors. Genetics, gender, race, and age cannot be altered. Those with type 1 diabetes who are genetically predisposed to a damaging and heightened autoimmune response are unable to control it. People over 65 and of African American heritage are at a larger risk for acquiring type 2 diabetes, although these risk factors cannot be controlled (Stewart, 2002).

2.7. Non-modifiable risk factors for diabetes

Immutable risk factors that enhance your likelihood of acquiring prediabetes and Type 2 diabetes include:

Family history: Some diabetes risk factors are inherited from one's parents or close biological relatives. If a person has a diabetic blood relative, their risk of having diabetes is greatly raised.

Race or ethnic background: Diabetes is more likely to develop in people of African-American, Asian-American, Latino/Hispanic-American, Native American, or Pacific-Islander origin.

Age: Age increases the likelihood of developing prediabetes and Type 2 diabetes. After age 40, type 2 diabetes affects middle-aged adults the most commonly. However, physicians are diagnosing an increasing number of children and adolescents with Type 2 diabetes.

Gestational diabetes: If a woman has diabetes during pregnancy, she has a greater chance of having the disease again later in life (Naik et al., 2012).

2.8. Modifiable risk factors for diabetes mellitus

Certain health conditions are strongly linked to the onset of diabetes. These health conditions are neither absolute nor independent causes of the disease, i.e., not all individuals with these conditions acquire diabetes. Nonetheless, they are substantial risk factors since they contribute to the onset or progression of diabetes in predisposed individuals.

Weight: Diabetes is more likely to occur if a person is overweight or obese. In addition to regular physical activity, losing 5 to 10 percent of body weight can greatly reduce the

chance of acquiring diabetes. The danger falls much further if weight is lost. A body mass index calculator will produce a good weight-to-height ratio for most individuals.

Physical activity: Inactivity is a significant modifiable risk factor for prediabetes and Type 2 diabetes. Regular exercise can reduce insulin resistance. This implies the body can utilize its insulin more efficiently. Even a brisk 30-minute walk at least five days a week significantly reduces the risk of diabetes and cardiovascular disease.

Blood pressure: In addition to affecting the cardiovascular system, untreated hypertension has been linked to diabetes-related problems. People with diabetes and hypertension should keep their blood pressure below 130/80 mm Hg. Under 120/80 mm Hg, blood pressure is considered normal.

Cholesterol (Lipid) levels: Diabetes relates to atherosclerosis and blood vessel damage. Low levels of "good" HDL cholesterol and/or elevated triglycerides can raise the risk of Type 2 diabetes and cardiovascular disease. Adopting a balanced diet, engaging in regular physical activity, and achieving and maintaining a healthy weight can assist in reducing abnormal cholesterol levels. Occasionally, drugs are also required.

Smoking: One of the causes of type 2 diabetes is smoking. Cigarette smokers have a 30%–40% increased risk of developing type 2 diabetes compared to nonsmokers. People with diabetes who smoke are more likely to struggle with insulin dose and controlling their disease than those who do not smoke.

Diet: It is essential to consume healthy foods in the proper quantities. Diet is one of the most important risk factors that can be modified for prediabetes and Type 2 diabetes. The American Heart Association suggests a diet consisting of fruits and vegetables, whole grains, chicken and fish without skin, legumes, non-tropical vegetable oils, and unsalted nuts and seeds. In addition to replacing saturated fats with monounsaturated and polyunsaturated fats, avoiding trans fats, reducing cholesterol and sodium (salt), and limiting red and processed meats, refined carbs, and sugary beverages, a healthy diet should also include these elements.

Alcohol: Heavy alcohol consumption can inflame the pancreas and reduce its ability to produce enough insulin. Alcohol can harm the liver and increase the amount of sugar and starch in the diet, which must be utilized or stored as fat.

Stress and well-being: Everyone experiences stress, but responses vary. Stress management is an essential component of a healthy lifestyle, not only for diabetes but also for heart disease and numerous other disorders.

Sleep: Adults should sleep between seven and nine hours per night. The benefits of sleep extend to the heart and brain. It enhances disposition, memory, and reasoning. Too little or too much sleep is also associated with a high A1C level in persons with Type 2 diabetes, according to research (American Heart Association, 2021).

2.9. Burden of diabetes mellitus in the community

Complications of diabetes mellitus

Regarding the health problems of diabetes mellitus, microvascular (retinopathy, neuropathy, and nephropathy) and macrovascular (stroke and myocardial infarction) complications are well-known. Microvascular and macrovascular processes result in amputations of the lower extremities (Centers for Disease Control and Prevention., 2014).

Depending on the underlying pathophysiology, chronic complications of diabetes are classed as either macrovascular or microvascular. Diabetes is the only disease that causes the microvascular trifecta of retinopathy, nephropathy, and neuropathy. During their condition, most people with diabetes will exhibit one or more of them as overt or subclinical signs (Stewart, 2002).

Microvascular complications

Microvascular disease (sometimes referred to as small vessel disease (SVD) or microvascular dysfunction) is a disease of the micro-vessels, the small blood vessels of the microcirculation (Cheung et al., 2010).

Long-term diabetes is one of the causes of microvascular illness. High blood glucose levels in this instance lead the endothelial cells lining the blood arteries to absorb more glucose than usual (these cells do not depend on insulin). They then produce abnormally high levels of glycoproteins on their surface and cause the basement membrane in the vessel wall to become abnormally thicker and weaker (Cheung et al., 2010). As a result, they bleed, leak protein, and slow blood flow in the body. As a result, several organs, and tissues, such as the retina (diabetic retinopathy) and kidneys, do not receive sufficient blood (carrying oxygen and nutrients) and are harmed (diabetic nephropathy). If nerves

and neurons are not adequately nourished with blood, they become injured and lose function (diabetic neuropathy, especially peripheral neuropathy) (Yau et al., 2012).

Diabetic retinopathy

Diabetic retinopathy, the most prevalent and specific microvascular complication of diabetes mellitus (DM), continues to be the leading cause of vision impairment and preventable blindness in the working-age population of many developed countries (Yau et al., 2012). DR is a chronic, progressive disease that may be asymptomatic in its early stages. If left untreated, it will progress to a sight-threatening proliferative stage characterized by neovascularization of the optic disc or elsewhere, retinal, and vitreous hemorrhage (Sivaprasad et al., 2012). The negative visual function may also result in decreased mobility, depression, and lower quality of life, imposing a significant burden on individuals, families, communities, and societies (Saaddine et al., 2008). Without more effective interventions, the global burden of DR is expected to increase as a result of the aging of the global population and the rising prevalence of diabetes (Zheng et al., 2012).

Hyperglycemia has been observed to be substantially associated with microvascular disease (Ghaemi et al., 2018). Although hyperglycemia is still substantial, few patients may have early symptoms of retinopathy as early as seven years before the onset of full-blown T2D, indicating the role of insulin resistance (Beckman et al., 2016). According to the World Health Organization (WHO), 2% of diabetics may have legal blindness within 15 years of the disease's inception, while almost 10% may get severely impaired eyesight. This has been recorded in approximately 77% of T2D patients within 10 years of illness initiation, and (Klein, 1995) virtually all T1D patients. In addition to the danger posed by hyperglycemia and the length of diabetes mellitus, other risk factors for retinopathy include hypertension, smoking, and dyslipidemia. In addition to other pathophysiologic mechanisms such as insulin resistance and inflammation, these factors may contribute to the severity of microvascular illness (Nguyen et al., 2007).

Diabetes neuropathy

Diabetic neuropathy is a highly prevalent condition that has a significant impact on patients by increasing falls, causing pain, and decreasing quality of life (QOL) (Pop et al., 2017).

Diabetic neuropathy is a distinct neurodegenerative condition of the peripheral nervous system that affects sensory axons, autonomic axons, and eventually, to a lesser degree, motor axons. How diabetes mellitus impacts sensory neurons remains controversial. Progressive diabetic neuropathy is characterized by terminal sensory axons in the periphery retracting and "dying back" with relative preservation of the perikarya (cell bodies) (Sharma et al., 2005). Diabetic neuropathy is termed a length-dependent neuropathy due to its' stocking and glove' pattern of involvement, which indicates damage to the longest sensory axons first. For instance, loss of distal leg epidermal axons precedes loss in more proximal limbs (Gumy et al., 2008). Diabetes targets the entire neuron, from the perikaryon to the terminal, according to substantial experimental evidence. It is debatable whether peripheral axons and their associated Schwann cells or the neuron perikarya that sit in the dorsal root ganglia (DRG) and support axons are damaged first (Dunnigan et al., 2013).

Although diabetic neuropathy is not generally regarded as a demyelinating neuropathy, prolonged hyperglycemia targets Schwann cells, and more severe cases of diabetic neuropathy in patients exhibit demyelinating symptoms (Mizisin et al., 1998).

Diabetic nephropathy

Diabetic nephropathy is a clinical syndrome characterized by persistent albuminuria, arterial blood pressure elevation, a relentless decline in glomerular filtration rate (GFR), and a high risk of cardiovascular morbidity and mortality (Parving, 2001). It is a clinical phenomenon distinguished by the co-occurrence of chronic albuminuria with type 1 and type 2 diabetes. This major life-threatening complication develops in approximately 35% of type 1 diabetic patients (Andersen et al., 1983). Diabetic nephropathy is a leading cause of end-stage renal disease. However, the decline in GFR is highly variable, ranging from 2 to 20 mL/min/year (Viberti et al., 1983). The risk factors for losing filtration power, that is, the so-called progression promoters, have not been studied extensively. Hypertension and proteinuria contribute to the progressive loss of renal function, while other progression promoters, for example, glycemic control and lipids, are still debatable (Rossing, 2004).

Macrovascular complications

Macrovascular disease is a disorder of the body's big (macro) blood arteries. It is a disease affecting the great blood vessels, such as the coronary arteries, aorta, and the substantial arteries in the brain and limbs (Rossing et al., 1995).

When a person has diabetes for an extended period, this can sometimes occur. In the big blood vessels, fat and blood clots accumulate and adhere to the vessel walls (Belanjer et al., 2020).

Coronary disease (in the heart), cerebrovascular disease (in the brain), and peripheral vascular disease are three prevalent macrovascular complications (in the limbs) (Parving et al., 1981).

Atherosclerosis is what macrovascular disease (macroangiopathy) refers to. Plaque deposits of lipids, fibrous connective tissue, calcium, and other blood components characterize atherosclerosis, a form of arteriosclerosis (thickening and hardening of artery walls). Atherosclerosis affects only medium and large arteries (excluding arterioles) (Mogensen, 2011).

Cardiovascular disease

Diabetes is associated with an elevated risk of cardiovascular disease (CVD), such that an individual with diabetes has the same risk of myocardial infarction as non-diabetic individuals who have previously experienced a myocardial infarction. CVD is the leading cause of death in the diabetic community, and diabetes is associated with a threefold greater risk of myocardial infarction relative to the general population (Mogensen, 2011). In type 1 diabetes, the development of CVD without a decline in kidney function is uncommon. In type 2 diabetes, renal dysfunction, along with dyslipidemia, poor glycemic control, and persistent increases in blood pressure, is a key risk factor for early CVD (Zimmerman, 2016).

Stroke

Diabetes and the risk of stroke are difficult to correlate due to the diversity of stroke forms. Diabetes mellitus type 1 was related to an increased risk of both ischemic and hemorrhagic strokes, while diabetes mellitus type 2 was associated with an increased risk of ischemic stroke but not hemorrhagic stroke (Janghorbani et al., 2007).

There are multiple conceivable mechanisms through which diabetes might cause a stroke. These include vascular endothelial dysfunction, elevated early-age arterial stiffness, systemic inflammation, and capillary basal membrane thickening. In type II diabetes, abnormalities in early left ventricular diastolic filling are prevalent. Microvascular disease, metabolic derangements, interstitial fibrosis, hypertension, and

autonomic dysfunction are the hypothesized mechanisms of congestive heart failure in type II diabetes (Quast et al., 1997).

Uncontrolled diabetes puts patients at risk for both ischemic and hemorrhagic strokes. Diabetes is associated with specific clinical patterns of ischemic stroke. Compared to those without diabetes, individuals with diabetes are more likely to exhibit limb weakness and dysarthria as symptoms of lacunar cerebral infarction (Karapanayiotides et al., 2004).

Hyperglycemia is a common occurrence in the early acute phase of a stroke. It may be related to non-fasting status and stress-induced glucose metabolism impairment (Quast et al., 1997).

Peripheral artery disease

Peripheral artery disease, also known as peripheral arterial disease, is a prevalent disorder in which constricted arteries restrict blood flow to the arms or legs. In peripheral artery disease (PAD), blood flow to the legs or arms, typically the legs, is insufficient to meet demand. This may result in walking-related leg pain (claudication) and other symptoms. In most cases, peripheral arterial disease is caused by a buildup of fatty deposits in the arteries (atherosclerosis). Atherosclerosis produces a constriction of the arteries, which can limit blood flow to the legs and, occasionally, the arms (Sachdev, 2021).

Atherosclerosis is the fundamental pathophysiological theme of PAD in diabetes. It begins with atherogenesis and ultimately leads to blockage and decreased blood flow. In subclinical atherosclerosis, pathological alterations may precede the diagnosis of impaired fasting glucose and diabetes mellitus (Drexel et al., 2005).

Endothelial damage and hyperglycemia stimulate adhesion, activation, and aggregation of platelets. Platelet activation and an increase in oxidative stress due to the generation of reactive oxygen species are caused by uncontrolled glucose absorption in hyperglycemia. In addition, hyperglycemia is related to coagulation problems such as reduced antithrombin, poor fibrinolytic function, and excessive PAI-1 generation. Therefore, platelet activation and aggregation are crucial factors in the development of atherosclerosis (Clark, 2003).

Cerebrovascular disease

Cerebrovascular disease is a condition of the brain's blood vessels, particularly the arteries, and it is one of the primary risk factors for stroke. Medical problems induce repeated inflammation and damage to the inner lining of blood vessels. Over time, cerebrovascular disease occurs because of this progressive injury. Damage to the inner lining of blood arteries leads them to become constricted, rigid, and occasionally asymmetrical. Frequently, diseased blood arteries are referred to as having atherosclerosis, a hardening of the inner lining that is typically caused by cholesterol buildup (Clark, 2003).

Diabetic cerebrovascular illnesses are characterized as cerebral vascular diseases caused by diabetes with sugar, fat, and a series of nutrient material metabolic abnormalities, causing intracranial big and small vessel diseases. Approximately 20-40% of patients with type 2 diabetes have cerebral blood vessel damage. In people with diabetes mellitus, diabetic cerebrovascular disorders are the leading cause of death (Zhou et al., 2014).

Atherosclerosis is the primary cause of cerebrovascular illness in people with type 2 diabetes. However, it has been observed that atherosclerosis is fundamentally an inflammatory reaction (Ross, 1999).

Other comorbidities

Dyslipidemia

The most common lipid abnormality in people with T2DM is a low HDL cholesterol level. Blood levels of HDL should be >40 mg/dl in men and >50 mg/dl in women to be considered healthy; however, persons with type 2 diabetes typically have HDL levels below the goal ranges. In addition, these individuals typically have blood triglyceride levels that exceed the healthy goal threshold of 150 mg/dl. In addition, numerous people with type 2 diabetes have LDL cholesterol levels that exceed the desirable goal level of 100 mg/dl (ADA, 2015).

Diabetes patients with this cluster of dyslipidemias—low HDL cholesterol, high triglycerides, and high LDL cholesterol—have a high risk of developing cardiovascular disease, which can lead to myocardial infarction, heart failure, or stroke. For establishing the requirement for anti-lipid therapy, diabetes is regarded as a risk factor on par with known heart illness for determining LDL target levels. The ADA now recommends statins for cholesterol-lowering efforts (ADA, 2015).

Hypertension

75% of people with type 2 diabetes have hypertension (high blood pressure). This link is in part a direct consequence of diabetes. Chronic hyperglycemia induces a thickening and rigidity of the arteriole walls, which results in hypertension (Maitra, 2009). As with dyslipidemia, hypertension increases the risk of cardiovascular disease in those with type 2 diabetes.

Frequently, people with diabetes will need to take two or more drugs to bring their blood pressure below 130/80 mm Hg. If the patient has normal kidney function, the second medicine is typically a thiazide diuretic (ADA, 2015).

Foods that are generally seen as healthful and promoted as components of the DASH diet (Appel et al., 2006) are frequently inaccessible or unaffordable to the residents of these communities, due to lack of availability or price. Instead, they consume inexpensive, high-sodium, and high-calorie foods, a practice that inevitably results in obesity and hypertension (Belanjer et al., 2020).

2.10 Global burden of diabetes

According to the International Diabetes Federation (IDF), an estimated 537 million adults (20-79 years old) worldwide were living with diabetes in 2021and this number is projected to reach 643 million by 2030, and 783 million by 2045. In addition, 541 million people are estimated to have impaired glucose tolerance in 2021. It is also estimated that over 6.7 million people aged 20–79 will die from diabetes-related causes in 2021.Thus, while the world's population is estimated to grow by 20% over this period, the number with diabetes is estimated to increase by 46%. The number of children and adolescents (i.e., up to 19 years old) living with diabetes increases annually. In 2021, over 1.2 million children and adolescents have type 1 diabetes. The majority of people with diabetes live in low- and middle-income countries. Hyperglycemia in pregnancy (HIP) affects approximately one in six pregnancies. Another cause for alarm is the consistently high percentage (45%) of people with undiagnosed diabetes, which is overwhelmingly type 2. Type 2 diabetes accounts for around 90% of all diabetes cases. Diabetes is a major driver of mortality worldwide, though its impact varies by region. Excluding the mortality risks associated with the COVID-19 pandemic, approximately

6.7 million adults between the age of 20–79 is estimated to have died because of diabetes or its complications in 2021.

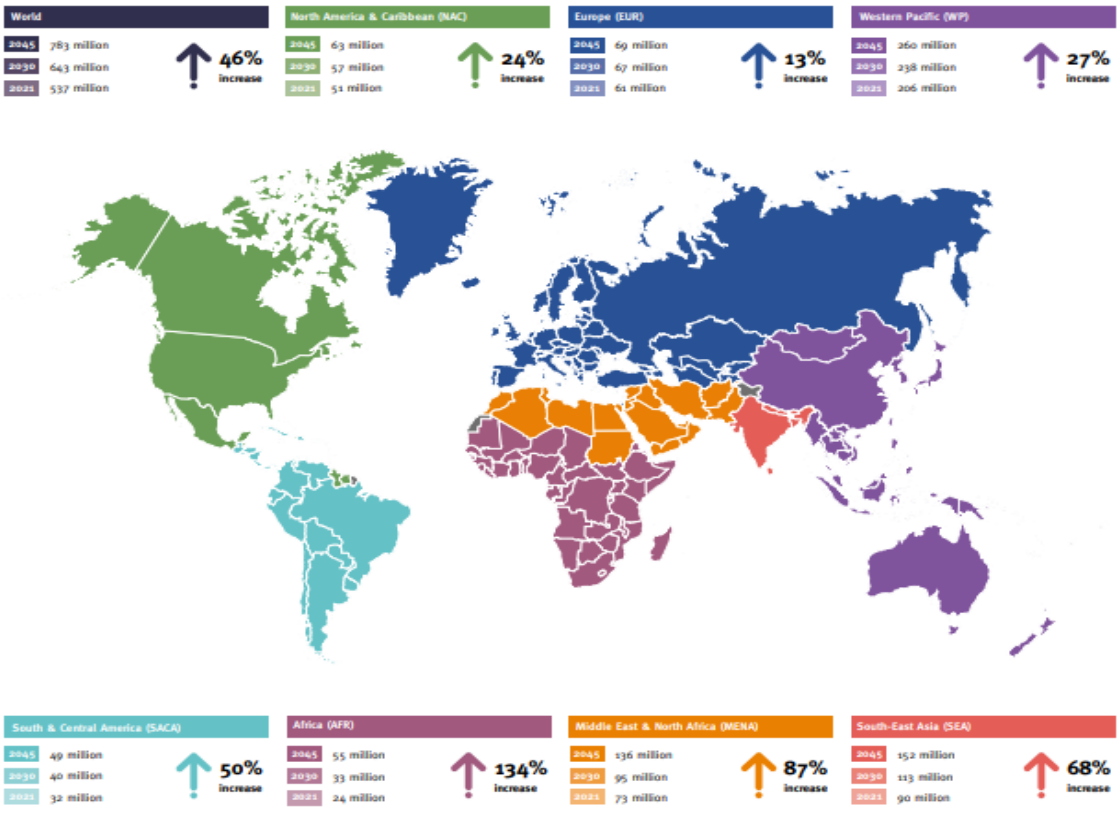


Figure 1: Number of people with diabetes worldwide and per IDF region in 2021-2045 (20-79 years) (Dysted et al., 2021)

This corresponds to 12.2% of global deaths from all causes in this age group. Approximately one-third (32.6%) of all deaths from diabetes occur in people of working age (under the age of 60). This corresponds to 11.8% of total global deaths in people under 60. Diabetes estimates for 2021 show an increasing prevalence of diabetes by age. Similar trends are predicted for 2045. Prevalence is lowest among adults aged 20–24 years (2.2% in 2021) (Figure 3.1). Among adults aged 75–79 years diabetes prevalence is estimated to be 24.0% in 2021 and predicted to rise to 24.7% in 2045. The aging of the world's population will produce an increasing proportion of those with diabetes over the age of 60 years. The estimated prevalence of diabetes in women aged 20–79 years is slightly lower than in men (10.2% vs 10.8%). In 2021, there are 17.7 million more men than women living with diabetes. Diabetes is a leading cause of cardiovascular disease, blindness, kidney failure, and lower limb amputation. The increase in global health expenditure due to diabetes has been considerable, growing from USD 232 billion in

2007 to USD 966 billion in 2021 for adults aged 20–79 years representing a 316% increase over the 15 years.

2.11 Prevalence of diabetes in Bangladesh

According to the International Diabetes Federation (IDF), an estimated 8.4 million adults (20-79 years old) were living with diabetes in Bangladesh in 2019. The prevalence of diabetes in Bangladesh is approximately 8.4%, which is higher than the global average of 9.3%. Type 2 diabetes accounts for around 95% of all diabetes cases in Bangladesh, and the disease is more common in urban areas than in rural areas. Risk factors for diabetes in Bangladesh include obesity, physical inactivity, poor diet, and a family history of diabetes (Akhter et al.,2020).

The prevalence of diabetes in Bangladesh is expected to continue to rise in the coming years, due in part to changing lifestyles and an aging population. Individuals in Bangladesh need to take steps to prevent diabetes by maintaining a healthy diet, staying physically active, and managing their weight (Akhter et al.,2020).

Chapter-3: Methodology

3.1 Study area and site

Chattogram is the second largest city as well as the port city of Bangladesh. The city is situated on the bank of the Karnafuli River between the Chittagong Hill Tracts and the Bay of Bengal. It has a reputation for mystique and beauty. The city is set amongst rolling green hills, ancient architecture, and interesting religious sites. The population of the city is around 6 million.

The study site was Chattogram Diabetic General Hospital (CDGH). It is a specialized medical hospital located in the city of Chattogram, Bangladesh. This hospital focuses on providing comprehensive care for patients suffering from diabetes, including both inpatient and outpatient services. The hospital has a total of 200 beds, with separate units for indoor and outdoor patients. The indoor unit consists of modern, well-equipped rooms and provides 24/7 medical care to patients. The outdoor unit has specialized clinics that provide regular check-ups, consultations, and treatments for diabetic patients. I chose this hospital as a study site due to its reputation as a leading healthcare provider in Chattogram, with a team of highly skilled doctors and nurses who are experienced in managing diabetes-related complications. Additionally, there is a huge number of diabetic patients who regularly visit this hospital for checkups and treatment and the hospital provides a range of services such as laboratory testing, radiology, and emergency care, making it an excellent research site for investigating diabetes management and treatment outcomes **(Appendix-I: page 56).**

3.2 Ethical Implications

An appropriate institutional ethical approval has been taken before conducting this study. [(Memo no. CVASU/Dir(R&E)EC/2022/405/18 (**Appendix-II: page 57**)].

During collecting data, prior written content was taken from patients. Participants received a briefing on the study's goals, methods, and implications. All participants gave their written permission after being fully informed. A printed handout containing comprehensive study-related material was read out loud and explained in the local language. All information, including the right to remain anonymous and the option to withdraw from the research, was specifically disclosed.

3.3 Study population and period

Diabetes Mellitus patients of Chattogram Diabetic General Hospital (CGDH) were considered as the study population. The data were collected for a period of two months between September to October 2022.

3.4 Study design and data collection strategies

For carrying out the current investigation, a cross-sectional study was performed on the patients of Chattogram Diabetic General Hospital. Data was collected through a pretested questionnaire **(Appendix-III, page: 58)**. The factors that speed up the associated conditions of diabetic patients have been reported in a thorough literature review and tool that was created after looking at related literature. The application was first created in English and then converted into Bangla. An appropriate skilled person evaluated and provided advice on linguistic validation and context validation before pretesting the questionnaire.

Diabetes Mellitus (DM) patients who visited (outdoor patients/patients come for a regular checkup) CDGH, Specific inclusion criteria such as the patient being an adult and of more than 25 years old or more were considered for inclusion of DM patients for the current study. Data included general information (e.g.name, address, contact), demographic information (e.g. gender, education level, marital status), clinical parameters (e.g. frequency of checking glucose level, HbA1c level, lipid profile), and self-management behaviors (e.g. taking physical exercises, weight gain in past 4 months, outside food consumption) **(Appendix-IV, page: 58)**.

The questionnaire comprised four parts **(Appendix-V, page: 58)**. The first part of the questionnaire included general information like the name, address, age group, gender, marital status, and contact number of participants. Further, the age category was from 30 years to more than 60 years. The second part included other demographic information such as occupation (housewife, service holder, businessman), level of education (university, secondary and higher secondary completed, junior school completed, and no educational background), family history of diabetes, and duration of diabetes. The third section included the daily, weekly, and monthly checkup of blood glucose level, blood glucose level before (fasting) and 2 hours after breakfast, HbA1c level (of last 4 months), triglyceride level (of last four months), and other comorbidities (retinopathy, neuropathy, nephropathy, etc.) of the participants which was obtained from the patients' diabetic check-up book and test report which they had tested on that day or in the previous 4

months. The fourth part of the questionnaire included the dietary habits of the participants, frequency of physical exercise, physical exercise time, smoking frequency, BMI, and forgetting to take medicines in the last 4 months.

3.5 Sample size calculation

A total number of 400 samples were collected and the sample size was calculated according to a previously published article (Dean, 2010). Briefly, the sample size estimation for the current study is presented below:

Sample Size Estimation Formula:

For an unlimited population, n== $[Z^2 * p\ (1 - p)]/ C^2$

Here, Z= Z score (1.96), C=margin of error (0.05), p= population proportion (0.50), Confidence Interval= 95%.

So, Sample Size, n= [(1.96*1.96) {0.50(1-0.50)}]/ (0.05*0.05)

The estimated sample size was 385, but we have considered 400 to avoid any missed cases or so.

3.6 Statistical analysis

Following data collection, the collected data was stored in Microsoft Excel-19 ®spreadsheet. After sorting, data were imported into STATA-17 ® (STATA Crop, 4905, Lake Way Drive, College Station, Texas 77,845, USA) to conduct analyses of the data.

Descriptive analysis was done to calculate the proportionated prevalence of developing diabetes-associated diseases in diabetic patients. A Chi-Square test was performed to find out the association of risk of developing diabetes-associated diseases for different socio-economic and health-related factors of the diabetic patients. Factors determined as a significant level of $p \leq 0.05$ in the univariate model were put forward to multivariate analysis. A multivariate logistic regression model was fitted by using a forward selection process. The confounding effect of the variables was checked by adding or removing a variable from the model and assessing the coefficient changes. Finally, the predictive ability of the model was determined by the Receiver Operating Characteristic (ROC) curve. A p-value of ≤ 0.05 in the final model was considered to indicate the potential risk factors for developing diabetes-related diseases. The outputs of the logistic regression model were expressed in Odds Ratio (OR), p-value, and 95% Confidence Interval (CI).

Chapter-4: Results

4.1. Proportionate commonness of kinds of diabetes in types with related patients and their associated factors

Proportionate prevalence of diabetes in patients of CGDH based on demographic information with associated patient factors

Patients with diabetes mellitus (DM) at Chattogram General Diabetic Hospital (CDGH) had a proportionate prevalence of patients taking insulin and oral drugs both and patients only taking oral drugswas51.75% (95% CI: 46.73 – 56.74) and48.25% (95% CI: 43.26 – 53.27), respectively (CGDH). Most DM patients (83.75%) came from metropolitan areas contrast to the patients who came from rural regions, although it was not statistically significant. The DM patients from both urban and rural regions showed that insulin and oral drug-taking patients were more common than patients taking only oral drugs in both urban and rural areas **(Table 4).**

Females (61.5%) had a greater overall DM prevalence than males (38.5%). Male DM patients were more likely to have only oral drugs (51.3%) than female DM patients (46.34%), however, there was a small difference **(Table 4).**

Age-wise analysis showed that the overall prevalence of DM was higher in people whose ages ranged from 46-60 years (48.25%, 95% CI: 43.26-53.27). The prevalence of DM patients taking oral drugs was found higher in people aged 31-45 years (58.73%) compared to patients taking insulin and drugs (41.67%). Again, the prevalence of DM patients taking oral drugs was found lower in people aged 46-60 years (47.15%) compared to patients taking insulin and drugs (52.85%). Furthermore, the prevalence of DM patients taking oral drugs was found highly lower in people aged >60 years (36.62%) compared to patients taking insulin and drugs (63.38%) (**Table 4**).

Based on the variable marriage, it was found that the overall prevalence of diabetes mellitus was higher in people who were married (92.75%) and lower in the people who were either single divorced, or widowed (7.25%). Among the married ones, a higher prevalence was seen in the diabetic patients taking insulin and drugs (51.21%) compared to the diabetic patients taking oral drugs (48.79%). Between the unmarried, widowed, and separated people, diabetic patients taking insulin and oral drugs (58.62%) were seen as predominant than the diabetic patients taking oral drugs (41.38%) **(Table 4)**.

Based on occupation, it was found that the overall prevalence of diabetes mellitus was higher in participants who didn't do any job (70%, 95% CI:65.25 – 74.45) compared to job holders (19.5%), and businessmen (10.5%). Among the job holders, the number of diabetic patients taking oral drugs (56.41%) was higher than diabetic patients taking insulin and drugs (43.59%). The diabetic patients doing business were taking insulin and oral drugs (52.38%) diabetes followed by patients taking only oral drugs (47.62%). Among the patients who were housewives and unemployed, diabetes mellitus with taking insulin and oral drugs (53.93%) was seen predominant than with taking oral drugs (46.07%) **(Table 4)**

Table 4: Proportionate prevalence of diabetes in patients based on demographic information with associated patient factors

Variable	Category, (N)	Overall prevalence	95% CI	Patients taking oral drugs n, (%)	95% CI	Patients taking insulin and oral drugs n, (%)	95% CI	p-value
Location	Urban (335)	83.75	79.76 – 87.23	162, (48.36)	42.89 – 53.85	173, (51.64)	46.15 – 57.11	0.922
	Rural (65)	16.25	12.77 – 20.24	31, (47.69)	35.16 – 60.46	34, (52.31)	39.54 – 64.85	
Gender	Male (154)	38.5	33.71 – 43.46	79, (51.3)	43.12 – 59.42	75, (48.7)	40.58 – 56.88	0.334
	Female (246)	61.5	56.53 – 66.29	114, (46.34)	39.98 – 52.79	132, (53.66)	47.21 – 60.02	
Age	31-45 (136)	34	26.97 – 36.3	74, (58.73)	49.62 – 67.42	54, (41.27)	32.58 – 50.38	**0.005**
	46-60 (193)	48.25	43.26 – 53.27	91, (47.15)	39.94 – 54.45	102, (52.85)	45.55 – 60.06	
	>60 (71)	17.75	14.13 – 21.85	26, (36.62)	25.5 – 48.9	45, (63.38)	51.1 – 74.5	
Marital status	Married (371)	92.75	89.75 – 95.09	181, (48.79)	43.59 – 54	190, (51.21)	46 – 56.41	0.442
	Unmarried /Widow (29)	7.25	4.91 – 10.25	12, (41.38)	23.52 – 61.06	17, (58.62)	38.94 – 76.48	
Occupation	Service Holder (78)	19.5	15.73 – 23.73	44, (56.41)	44.7 – 67.61	34, (43.59)	32.38 – 55.29	0.270

	Business (42)	10.5	7.67 – 13.93	20, (47.62)	32 – 63.58	22, (52.38)	36.42 - 68	
	Unemployed (280)	70	65.25 – 74.45	129, (46.07)	40.12 – 52.1	151, (53.93)	47.9 – 59.88	
Education	Graduate (93)	23.25	19.2 – 27.7	52, (55.91)	45.24 – 66.2	41, (44.09)	33.8 – 54.76	**0.004**
	SSC and HSC (140)	35	30.33 – 39.9	76, (54.29)	45.66 – 62.72	64, (45.71)	37.28 – 54.34	
	Junior High School (98)	24.5	20.36 – 29.02	44, (44.9)	34.83 – 55.28	54, (55.1)	44.72 – 65.17	
	No formal Education (69)	17.25	13.68 – 21.32	21, (30.43)	19.92 – 42.69	48, (69.57)	57.31 – 80.07	
Family member	2 to 4 (136)	34	29.37 – 38.87	62, (45.59)	37.03 – 54.34	74, (54.41)	45.66 – 62.97	**0.012**
	5 to 6 (152)	38	33.22 – 42.96	87, (57.24)	48.97 – 65.22	65, (42.76)	34.78 – 51.03	
	≥7 (112)	28	23.65 – 32.68	44, (39.29)	30.19 – 48.96	68, (60.71)	51.04 – 69.81	

According to the research investigation based on educational status, the overall prevalence of DM was higher in participants who were read up to SSC and HSC (35%, 95% CI: 30.33 – 39.9). Those who were graduates had a higher prevalence in DM patients taking oral drugs (55.91%, 95% CI:45.24 – 66.2) followed by DM patients taking insulin and drugs (44.09%, 95% CI:33.8 – 54.76). The patients who had passed SSC and HSC were higher in DM patients taking oral drugs (54.29%, 95% CI:45.66 – 62.72) compared to DM patients taking insulin and oral drugs (45.71%, 95% CI:37.28-54.34). Those who had completed primary school and junior school had a higher prevalence among DM patients taking insulin and oral drugs (55.1%, 95% CI: 44.72 – 65.17) compared to DM patients taking oral drugs (44.9% 95% CI: 34.83 – 55.28). The patients who didn't receive any formal education had a higher prevalence in DM patients taking insulin and oral drugs than in DM patients taking oral drugs **(Table 4)**.

Based on family members in the research investigation, the overall prevalence of DM was higher in patients who had 5 to 6 family members (38%, 95% CI:33.22 – 42.96) compared to other patients. Again, the patients who had 2 to 4 members in their family had more diabetes mellitus taking insulin and oral drugs (54.41%, 95% CI:45.66 – 62.97) than diabetes mellitus taking oral drugs (45.59%, 95% CI:37.03 – 54.34). Of people who had 5 to 6 members in their family among them 57.24% of them had diabetes patients taking insulin and oral drugs which was predominant followed by diabetes patients taking oral drugs (42.76%). Patients who had 7 or more than 7 family members in their family among them diabetes patients taking insulin and oral drugs (60.71%) were seen as prominent compared to diabetes taking oral drugs **(Table 4)**.

Proportionate prevalence of diabetes in patients of CGDH based on associated patients' related variables

DM patients having diabetes 6 to 10 years had a higher overall prevalence (30.25%) compared to other groups. However, it was statistically significant, and higher prevalence was seen among the patients taking only oral drugs (61.17%) compared to patients taking both in the patients who had diabetes for 5 or less than 5 years. The patients having 6 to 10 years of diabetes, a higher prevalence was seen among the oral drug-mediated patients (54.55%) compared to the patients taking both. Patients having 11 to 15 years of diabetes had a higher prevalence of taking both insulin and drugs (60.64%) compared to only taking oral drugs (39.36%). The prevalence was seen higher

in DM patients taking both insulin and medicine (67.07%) with a duration of more than 15 years of diabetes **(Table 5).**

DM patients taking oral drugs (53.94%) were more in number than DM patients taking oral drugs and insulin (46.06%) having a history of having diabetes of either their father or mother or both whereas the patients who didn't have any previous family history of having diabetes patients in their family was higher in DM patients taking oral drugs and insulin (56.29%) than DM patients taking oral drugs (43.71%). Having a history of diabetes patients such as parents and 1st-degree relatives like sister and brother were more prominent in DM patients taking insulin and drugs (58.14%) than DM patients taking oral drugs (41.86%) and the patients who had only a history of having diabetic 1st-degree relatives was high in DM patients taking oral drugs (52%) than oral drugs and insulin-dependent DM patients (48%) **(Table 5)**.

Table 5: Proportionate prevalence of diabetes inpatients of CGDH based on associated patients' related variables

Variable	Category, (N)	Overall prevalence	95% CI	Patients taking oral drugs n, (%)	95% CI	Patients taking insulin and oral drugs n, (%)	95% CI	p-value
Duration of diabetes	≤5 years (103)	25.75	21.53 – 30.33	63, (61.17)	51.06 – 70.61	40, (38.83)	29.39 – 48.94	**0.000**
	6 to 10 years (121)	30.25	25.78 – 35.01	66, (54.55)	45.24 – 63.62	55, (45.45)	36.38 – 54.76	
	11 to 15 years (94)	23.5	19.43 – 27.97	37, (39.36)	29.44 – 49.97	57, (60.64)	50.02 – 70.56	
	>15 years	20.5	16.65 – 24.79	27, (32.93)	22.94 – 44.18	55, (67.07)	55.81 – 77.06	
Diabetes history in the family	Yes (233)	58.25	53.25 – 63.13	120, (51.5)	44.89 – 58.08	113, (48.5)	41.92 – 55.11	0.124
	No (167)	41.75	36.87 – 46.75	73, (43.71)	36.06 – 51.59	94, (56.29)	48.41 – 63.94	
Number of family members having diabetes	1 (95)	40.77	34.4 – 47.38	48, (50.53)	40.07 – 60.95	47, (49.47)	39.05 – 59.93	0.132
	2 (95)	40.77	34.4 – 47.38	55, (57.89)	47.33 – 67.96	40, (42.11)	32.04 – 52.67	
	>2 (43)	18.45	13.69 – 24.04	17, (39.53)	24.98 – 55.59	26, (60.47)	44.41 – 75.02	
Relationship with patients	Only Parents (165)	70.81	64.52 – 76.57	89, (53.94)	46.02 – 61.71	76, (46.06)	38.28 – 53.98	0.369
	Parents and Others (43)	18.45	13.69 – 24.04	18, (41.86)	27.01 – 57.87	25, (58.14)	42.13 – 72.99	

	Others (25)	10.73	7.06 – 15.43	13, (52)	31.31 – 72.2	12, (48)	27.8 – 68.69	
Smoking	Yes (91)	22.75	18.73 – 27.18	46, (50.55)	39.86 – 61.2	45, (49.45)	38.8 – 60.14	0.617
	No (309)	77.25	72.82 – 81.27	147, (47.57)	41.89 – 53.3	162, (52.43)	46.7 – 58.11	
Smoking frequency	Below 10 (14)	15.38	8.67 – 24.46	7, (50)	23.04 – 76.96	7, (50)	23.04 – 76.96	0.924
	10 to 20 (68)	74.73	64.53 – 83.25	35, (51.47)	39.03 – 63.78	33, (48.33)	36.22 – 60.97	
	More than 20 (9)	9.89	4.62 – 17.94	4, (44.44)	13.7 – 78.8	5, (55.56)	21.2 – 86.3	
BMI	< 18.5 (7)	1.75	0.71 – 3.57	2, (28.57)	3.67 – 70.96	5, (71.43)	29.04 – 96.33	**0.001**
	18.5 – 22.9 (68)	17	13.45 – 21.05	21, (30.88)	20.24 – 43.26	47, (69.12)	56.74 – 79.76	
	23 – 24.9 (79)	19.75	15.96 – 23.99	33, (41.77)	30.77 – 53.41	46, (58.23)	46.59 – 69.23	
	25 – 29.9 (194)	48.5	43.5 – 53.52	113, (58.25)	50.97 – 65.27	81, (41.75)	34.73 – 49.03	
	≥ 30 (52)	13	9.86 – 16.7	24, (46.15)	32.23 – 60.53	28, (53.85)	39.47 – 67.77	
Weight gain in previous 4 months	Yes (180)	45	40.05 – 50.02	87, (48.33)	40.84 – 55.89	93, (51.67)	44.11 – 59.16	0.976
	No (220)	55	49.98 – 59.95	106, (48.18)	41.42 - 55	114, (51.82)	45 – 58.58	

The next important part regarding the basic information of a DM patient taking oral drugs was the lifestyle and behavior pattern (Table 4) of the total participants, among the patients who were smokers, DM patients taking insulin and oral drugs (50.55%) was predominant in patients than DM participants taking oral drugs (49.45%). Among the non-smoker group, the prevalence in DM groups taking oral drugs and insulin (52.43%) was higher than in DM groups taking oral drugs (47.57%). Among the smoker patients, based on smoking frequency, 50% of DM patients taking oral drugs and DM patients taking insulin and oral drugs smoke 10 cigarettes or below daily. The patients who smoked 10 to 20 cigarettes had more DM taking oral drugs (51.47%) than DM taking oral drugs and insulin (48.33%). Moreover, DM patients taking insulin and oral drugs (55.56%) smoked more than 20 cigarettes which was more predominant than DM taking oral drugs (44.44%) **(Table 5)**.

Based on BMI**,** patients who had a BMI less than 18.5 (underweight**)** were higher in oral drugs and insulin-dependent DM (71.43%, 95% CI: 29.04 – 96.33) followed by oral drugs dependent DM (28.57%, 95% CI: 3.67 – 70.96).The patients who had a BMI between 18.5 to 22.9 (normal weight), oral drugs and insulin-dependent DM patients (69.12%, 95% CI: 56.74 – 79.76) had a higher prevalence than oral drugs dependent DM patients (30.88%, 95% CI:20.24 – 43.26). The patients who had a BMI between 23 to 24.9 (overweight) were higher in oral drugs and insulin-dependent DM patients (58.23%, 95% CI: 46.59 – 69.23) compared to oral drugs dependent DM patients (41.77%, 95% CI: 30.77 – 53.41). Among the patients who had a BMI ranging from 25 to 29.9 (pre-obese), DM patients taking oral drugs (58.25%, 95% CI: 50.97 – 65.27) had a higher prevalence than DM patients taking oral drugs and insulin (41.75%, 95% CI: 34.73 – 49.03). Among the patients who had a BMI of either 30 or more than 30 (obese) was higher in oral drugs and insulin DM patients (53.85%, 95% CI: 39.47 – 67.77) than oral drugs DM patients (46.15%, 95% CI: 32.23 – 60.53) (**Table 5**).

It was found that the patients who gained weight in the last 6 months were predominantly drugs and insulin-dependent DM patients (51.67%) compared to oral drugs dependent DM patients (48.33%) whereas the patients who didn't gain weight in the last 6 months were high in oral drugs and insulin-dependent DM (51.82%) compared to oral drugs dependent DM (48.18%) **(Table 5).**

Proportionate prevalence of diabetes of CGDH based on patients-related clinical parameters

DM patients taking insulin and oral drugs (55.77%, 95% CI: 47.61 – 63.71) had a higher prevalence than DM patients taking oral drugs (44.23%, 95% CI: 36.29 – 52.39) regarding having a triglyceride level of less than 150 (normal). In the case of having borderline triglyceride levels, oral drugs dependent DM participants (53.6%, 95% CI: 44.46 – 62.56) had a higher prevalence than oral drugs and insulin DM participants (46.4%, 95% CI: 37.44 – 55.54). The patients who had a high triglyceride level were predominant in oral drugs and insulin-dependent DM patients (52.1%, 95% CI: 42.75 – 61.34) followed by oral-dependent DM patients (**Table 6**).

Based on checking blood glucose levels regularly, oral drugs and insulin DM groups (71.43%) had a higher prevalence than oral drug-dependent DM groups (28.57%). The patients who didn't check their blood glucose levels regularly were higher in oral drugs and insulin-dependent DM patients (51.04%) than oral drug-dependent DM patients (48.96%). The patients who checked their blood glucose level daily were higher in oral-dependent DM patients (67%, 95% CI: 2.09 – 48.41) followed by oral drugs and insulin-dependent DM patients (83.33%, 95% CI: 51.59 – 97.91). The patients who checked their blood glucose level once a week were predominantly oral drugs and insulin-dependent DM patients (41.61%, 95% CI: 33.6 – 49.96) than oral drugs dependent DM patients (41.61%, 95% CI: 33.6 – 49.96). The patients who checked their blood glucose once a month were higher in oral drugs and insulin-dependent DM patients (48.25%, 95% CI: 39.82 – 56.75) compared to oral-dependent DM patients (48.25%, 95% CI: 39.82 – 56.75). The patients who checked their blood glucose level once in three/four/six months were predominantly in oral drugs dependent DM patients (62.5%, 95% CI: 52.03 – 72.18) followed by oral drugs and insulin-dependent DM patients (37.5%, 95% CI: 27.82 – 47.97) (Table 4). The patients who checked their triglyceride level once in six months were higher in oral drugs and insulin-dependent DM patients (52.65%) compared to oral-dependent DM patients (47.35%). Those who checked their triglyceride level multiple times in six months were higher in oral drug-dependent DM patients (56%) followed by oral drugs and insulin-dependent DM patients (43.9%) (**Table 6**).

Table 6: Proportionate prevalence of diabetes in patients of CGDH based on patients related clinical parameters

Variable	Category, (N)	Overall prevalence	95% CI	Patients taking oral drugs n, (%)	95% CI	Patients taking insulin and oral drugs n, (%)	95% CI	p-value
Frequency of checking blood glucose	Daily (12)	3	1.56 – 5.18	2, (16.67)	2.09 – 48.41	10, (83.33)	51.59 – 97.91	**0.002**
	Weekly (149)	37.25	32.5 – 42.19	62, (41.61)	33.6 – 49.96	87, (58.39)	50.04 – 66.4	
	Monthly (143)	35.75	31.05 – 40.66	69, (48.25)	39.82 – 56.75	74, (51.75)	43.25 – 60.17	
	Not regularly (96)	24	19.89 – 28.49	60, (62.5)	52.03 – 72.18	36, (37.5)	27.82 – 47.97	
Frequency of checking triglyceride level	Multiple times (more than once) (41)	10.25	7.46 – 13.65	23, (56)	39.75 – 71.53	18, (43.9)	28.47 – 60.25	0.288
	Single time (359)	89.75	86.35 – 92.54	170, (47.35)	42.09 – 52.66	189, (52.65)	47.34 – 57.91	
Frequency of checking HbA1	Single time (301)	75.25	70.72 – 79.4	150, (49.83)	44.04 – 55.62	151, (50.17)	44.37 – 55.95	0.269
	Multiple times (99)	24.75	20.6 – 29.28	43, (43.43)	33.5 – 53.77	56, (56.57)	46.23 – 66.5	
Triglyceride	< 150 (156)	39	34.19 – 43.97	69, (44.23)	36.29 – 52.39	87, (55.77)	47.61 – 63.71	0.294
	150 – 199 (125)	31.25	26.74 – 36.04	67, (53.6)	44.46 – 62.56	58, (46.4)	37.44 – 55.54	

	200 – 499 (119)	29.75	25.31 – 34.49	57, (47.9)	38.66 – 57.25	62, (52.1)	42.75 – 61.34	
Fasting blood glucose	Control (≤ 7.1) (68)	17	13.45 – 21.05	44, (64.71)	52.17 – 75.92	24, (35.29)	24.08 – 47.83	**0.003**
	Not Control (332)	83	78.95 – 86.55	149, (44.88)	39.44 – 50.41	183, (55.12)	49.59 – 60.55	
After breakfast blood glucose	Control (≤ 10) (102)/	25.5	21.3 – 30.07	54, (52.94)	42.8 – 62.9	48, (47.06)	37.1 – 57.2	0.272
	Not Control (298)	74.5	69.93 – 78.7	139, (46.64)	40.87 – 52.48	159, (53.36)	47.51 – 59.13	
HbA1 level	Control (/≤ 8) (42)	10.5	7.67 – 13.93	25, (59.52)	43.28 – 74.37	17, (40.48)	25.63 – 56.72	0.122
	Not Control (358)	89.5	86.07 – 92.33	168, (46.93)	41.66 – 52.24	190, (53.07)	47.76 – 58.34	

The patients who checked their HbA1C level once in six months had a higher prevalence in oral drugs and insulin-dependent DM patients (50.17%) than oral drug-dependent DM patients (49.83%). The patients who checked their HbA1C level multiple times in six months had a higher prevalence in DM patients taking oral drugs and insulin (56.57%) than in DM patients taking oral drugs (43.43%) (**Table 6**).

Based on the controlled fasting blood glucose level, oral drugs dependent DM patients (64.71%, 95% CI: 52.17 – 75.92) had a higher prevalence than oral drugs and insulin-dependent DM patients (35.29%, 95% CI: 24.08 –47.83). The patients whose fasting blood glucose level was not in control was higher in DM patients taking insulin and oral drugs (55.12%, 95% CI: 49.59 – 60.55) than DM patients taking oral drugs (44.88%, 95% CI: 39.44 – 50.41). The controlled blood glucose level after breakfast was higher in oral drug-dependent DM patients (52.94%) followed by oral drugs and insulin-dependent DM patients (47.06%). The uncontrolled blood glucose level after breakfast was higher in DM patients taking oral drugs and insulin (53.36%) compared to DM patients taking oral drugs (46.64%) (**Table 6**).

The patients who had their HbA1c level under control were high in DM patients taking oral drugs (59.52%) followed by DM patients taking oral drugs and insulin (40.48%). The patients who didn't have an HBA1C level not in a control position had a higher prevalence in oral drugs and insulin-dependent DM patients (53.07%) compared to oral drugs-dependent DM patients (46.93%) (**Table 6**).

Proportionate prevalence of diabetes in patients of CGDH based patients related management factors

The next important part regarding the basic information of a DM patient taking oral drugs was the lifestyle and behavior pattern (Table 4) of the total participants,

The result demonstrated that the patients who took regular physical exercise were more predominant in oral drugs consuming DM (51.35%) patients than oral drugs and insulin-taking DM patients (48.65%). Those who did not take regular physical exercise were high in oral drug consumption and insulin-taking DM (55.62%) followed by oral drugs consuming DM (44.38%). The participants who took 30 minutes or less physical exercise daily were higher in oral drugs and insulin-dependent DM (55.43%) than oral drug-dependent DM (44.57%). Oral drug-dependent DM patients walked for 31 to 60 minutes more (62.5%) than oral drugs and insulin-dependent DM patients (37.5%). Those who walked more than 1 hour daily were seen oral drugs dependent DM (52.44%) more predominantly than oral drugs and insulin-dependent DM (47.56%) **(Table 7)**

Table 7: Proportionate prevalence of diabetes in patients of CGDH based on patients-related management factors

Variable	Category, (N)	Overall prevalence	95% CI	Patients taking oral drugs n, (%)	95% CI	Patients taking insulin and drugs n, (%)	95% CI	p-value
Taking physical exercise	Yes (222)	55.5	50.48 – 60.44	114, (51.35)	44.57 – 58.09	108, (48.65)	41.91 – 55.43	0.166
	No (178)	44.5	39.56 – 49.52	79, (44.38)	36.95 - 52	99, (55.62)	48 – 63.05	
Average time of physical exercise (min)	≤ 30 (92)	41.44	34.89 – 48.23	41, (44.57)	34.19 – 55.3	51, (55.43)	44.7 – 65.8	0.127
	31 to less than 60 (48)	21.62	16.39 – 27.62	30, (62.5)	47.35 – 76.05	18, (37.5)	23.95 – 52.65	
	≥ 60 (82)	36.94	30.58 – 43.65	43, (52.44)	41.11 – 63.59	39, (47.56)	36.41 – 58.59	
Following a prescribed diet plan	Yes (361)	90.25	86.91 – 92.97	176, (48.75)	43.49 – 54.04	185, (51.25)	45.96 – 56.51	0.54
	No (39)	9.75	7.03 – 13.09	17, (43.59)	27.81 – 60.38	22, (56.41)	39.62 – 72.19	
Take meals away from outside	No (264)	66	61.13 – 70.63	118, (44.7)	38.6 – 50.91	146, (55.3)	49.08 – 61.4	**0.019**
	1 to 2 times (74)	18.5	14.81 – 22.66	35, (47.3)	35.57 – 59.25	39, (52.7)	40.75 – 64.43	
	More than 2 times (62)	15.5	12.09 – 19.42	40, (64.52)	51.34 – 76.26	22, (35.48)	23.74 – 48.66	
Forgotten to take the medication in the last 4 months	Yes (56)	15.09	11.61 – 19.15	36, (64.29)	50.36 – 76.64	20, (35.71)	23.36 – 49.64	**0.046**
	No (315)	84.91	80.85 – 88.39	157, (49.84)	44.18 – 55.5	158, (50.16)	44.5 – 55.81	

Based on following dietary guidelines of Diabetes Samity, DM patients taking oral drugs and insulin (51.25%) followed more than DM patients taking oral drugs (48.75%) whereas the patients who did not follow any guidelines were predominant in DM patients taking oral drugs and insulin (56.4%) than DM patients taking oral drugs (43.59%) **(Table 7)**.

The result further stated that the patients who didn't take foods from outside were predominant in oral drugs and insulin-dependent DM (55.3%, 95% CI: 49.08 – 61.4) than oral drugs dependent DM (44.7%, 95% CI: 38.6 – 50.91).Participants who consumed outside foods 1 to 2 times per week were predominant in oral drugs and insulin-dependent DM patients (52.7%, 95% CI: 40.75 – 64.43) followed by oral drugs dependent DM patients (47.3%, 95% CI: 35.57 – 59.25). The patients who consumed outside foods more than 2 times per week were higher in oral drug-dependent DM patients (64.52%, 95% CI: 51.34 – 76.26) than in oral drugs and insulin-dependent DM patients **(Table 7)**.

4.2. Univariable association of DM patients regarding developing DM-related complications

It was found that those patients who lived in rural areas had 1.03 times (0.922) high risk for DM-related complications. Based on gender, the female patients were 1.22 times (0.335) riskier than the male patients **(Table 8)**.

According to their age, the patients who were more than 60 in age, were at high risk (5.69 times) of having diabetic-related complications (0.032, 95% CI: 1.16 – 27.9) which were statistically significant followed by those whose ages were more than 46 to 60 **(Table 8)**.

Based on occupation, the patients who were unemployed and housewives were prone to having diabetes (0.107) related complications more than the service holders and businessmen (**Table 8)**.

The patients who had no formal education (0.001, 95% CI: 1.5 – 5.59) were at a higher risk (2.9 times) for developing diabetes-related complications than those who completed junior high school and SSC and HSC than the graduate ones **(Table 8)**.

According to family size, the patients who were 7 or more than 7 (0.049, 95% CI: 0.78 – 2.15) family members had a higher risk for developing diabetes-related complications followed by those who had 2 to 4 members and 5 to 6 members in their family **(Table 8)**.

Based on the frequency of smoking, those who smoke more than 20 cigarettes per day had a higher risk of having diabetes-related complications followed by those who smoke 10 to 20 cigarettes per day **(Table 8)**.

According to the duration of diabetes, the patients who had diabetes for more than 15 years (0.000, 95% CI: 1.75 – 5.89) had a high risk for developing diabetes-associated diseases followed by those who had diabetes between 11 to 15 years, and 6 to 10 years **(Table 8)**.

Based on BMI, those who had a BMI between 25-29.9 had a high risk for developing diabetes-related complications and it was statistically significant followed by those whose BMI is 18.5 – 22.9, 23 – 24.9, and others **(Table 8)**.

The patients who checked their blood glucose not regularly such as once twice or thrice in a month (0.008, 95% CI: 1.73 – 40.19) had a higher risk (8.33 times) for developing diabetes-related complications than those who checked weekly (2.34, 95% CI: 1.38 – 3.96) and monthly **(Table 8)**.

The patients who checked their lipid profile a single time had a higher risk of developing diabetes-related complications than those who checked their lipid level a single time **(Table 8)**.

The patients who checked their HbA1c test multiple times had a higher risk of developing diabetes related complications than those who checked for single time **(Table 8)**.

The patients whose triglyceride levels were between 200-499 had a high risk for developing diabetes-associated diseases followed by the patients whose triglyceride levels were between 150-199 and below 150 **(Table 8)**.

The patients who only took drugs had a higher risk for developing diabetes-related complications than those who took drugs and physical exercise who took drugs and diet and who took all the therapy **(Table 8)**.

The patients who did not take physical exercise regularly had a higher risk of developing diabetes-related complications than those who took physical exercise regularly. The patients who took 30 or less than 30 minutes of physical had a high risk for developing diabetes-related complications followed by those who took 60 or more than 60 minutes

of exercise (0.045, 95% CI: 0.40 – 1.32) and who took physical exercises between 31 to 60 minutes **(Table 8)**.

The patients who didn't follow any diet plan had a higher risk of developing diabetes-related diseases than those who followed a diet plan. The patients who gained weight had a higher risk of having diabetes-associated disorders than those who didn't gain weight. The patients who consumed outside foods more than 2 times a week (0.006, 95% CI:0.54 – 1.51) had a higher risk for developing diabetes-related diseases than those who consumed outside foods once a week **(Table 8).**

Table 8: Univariable association of DM patients regarding developing DM-related complications with associated patient factors

Variable	Category, (N)	Odds Ratio (OR)	95% CI	p-value
Demographic Data				
Location	Urban	Ref		
	Rural	1.03	0.6 – 1.74	0.922
Gender	Male	Ref		
	Female	1.22	0.81 – 1.83	0.335
Age	31-45	Ref		
	>60	5.69	1.16 – 27.9	**0.032**
	46-60	1.59	1.01 – 2.51	**0.044**
Marital Status	Married	Ref		
	Unmarried/Widow	1.35	0.63 – 2.9	0.443
Occupation	Service Holder	Ref		
	Business	1.42	0.67 – 3.02	0.358
	Unemployed	1.51	0.91 – 2.51	0.107
Education	Graduate	Ref		
	SSC and HSC	1.07	0.63 – 1.81	0.807
	Junior High School	1.56	0.88 – 2.76	0.129
	No formal Education	2.9	1.5 – 5.59	**0.001**
Family member	2 to 4	Ref		
	5 to 6	0.62	0.39 – 1	**0.049**
	≥7	1.29	0.78 – 2.15	0.318
Patients' related risk factors				
Duration of Diabetes	≤5 years	Ref		

	6 to 10 years	1.31	0.77 – 2.24	0.318
	11 to 15 years	2.43	1.37 – 4.3	**0.002**
	>15 years	3.21	1.75 – 5.89	**0.000**
Diabetes history in the family	Yes	Ref		
	No	1.37	0.92 – 2.04	0.125
Number of family members having diabetes	1	Ref		
	2	0.74	0.42 – 1.32	0.309
	>2	1.56	0.75 – 3.25	0.232
Relationship with patients	Only Parents	Ref		
	Parents and Others	1.63	0.82 – 3.21	0.16
	Others	1.08	0.47 – 2.51	0.856
Smoking	Yes	Ref		
	No	1.13	0.71 – 1.8	0.618
Smoking frequency	Below 10	Ref		
	10 to 20	0.94	0.3 – 2.98	0.92
	More than 20	1.25	0.23 – 6.71	0.795
BMI	≥ 30	Ref		
	18.5 – 22.9	1.92	0.91 – 4.06	0.088
	23 – 24.9	1.19	0.59 – 2.42	0.621
	< 18.5	0.61	0.33 – 1.14	0.121
	25 - 29.9	2.14	0.38 – 12.06	0.387
Weight Gain in 4 months	Yes	Ref		
	No	1.01	0.68 – 1.49	0.976
Clinical parameters				
Frequency of checking blood glucose	Daily	Ref		
	Weekly	2.34	1.38 – 3.96	**0.002**
	Monthly	1.79	1.05 – 3.03	**0.031**
	Not Regularly	8.33	1.73 – 40.19	**0.008**
Frequency of checking lipid profile	Multiple times	Ref		
	Single time	1.42	0.74 – 2.72	0.29
Frequency of checking HbA1	Single time	Ref		
	Multiple times	1.29	0.82 – 2.04	0.27
Triglyceride	< 150	Ref		

	150 – 199	0.69	0.43 – 1.1	0.119
	200 – 499	0.86	0.53 – 1.39	0.545
Fasting blood glucose	Control (≤ 7.1)	Ref		
	Not Control	2.25	1.31 – 3.87	**0.003**
After breakfast blood glucose	Control (≤ 10)	Ref		
	Not Control	1.29	0.82 – 2.02	0.273
HbA1 level	Control (≤ 8)	Ref		
	Not Control	1.66	0.87 – 3.18	0.125
Managemental factors				
Taking physical exercise	Yes	Ref		
	No	1.32	0.89 – 1.96	0.166
Average time of physical exercise (min)	≤ 30	Ref		
	31 to less than 60	0.48	0.24 – 0.99	**0.045**
	≥ 60	0.73	0.40 – 1.32	0.3
Following the prescribed diet Plan	Yes	Ref		
	No	1.23	0.63 – 2.4	0.61
Take meals away from outside	No	Ref		
	1 to 2 times	0.9	0.54 – 1.51	0.691
	More than 2 times	0.44	0.25 – 0.79	**0.006**
Forgotten to take medication	Yes	Ref		
	No	1.81	1 – 3.27	**0.048**

The patients who forgot to take medicines in the last 4 months (0.048, 95% CI: 1 – 3.27) had a higher risk for developing diabetes-associated disorders which were statistically significant than those who took medicines regularly. The patients whose fasting blood glucose level was not at a controlled level (0.003, 95% CI: 1.31 – 3.87) had a higher risk of developing diabetes-related diseases and it was statistically significant than those whose blood glucose level was at a controlled level. Those who had their blood glucose level after breakfast, not under control level had a higher risk of having diabetes-associated disorders than those whose blood glucose (1.29, 95% CI: 0.82 – 2.02) level was at a controlled level. The patients whose HbA1c level was not in control had a

higher risk of developing diabetes-related disorders than those whose HbA1c level was in under control **(Table 8)**.

4.3. Multi-variable association of DM patients regarding developing DM-related complications with associated patients' factors

The patients whose ages were more than 60 were at higher (9.71) risk than those aged 46-60 years for developing diabetes-associated diseases. The patients whose ages were less than 30 have a high risk for diabetes-related diseases. The patients who didn't have any formal education are more at risk (3.85) for having diabetes-related complications than those who had completed SSC and HSC, junior school education. The patients who had diabetes for more than 15 years were at higher risk (3.66) of developing diabetes-related complications than those who had diabetes between 6 to 10 years and 11 to 15 years **(Table 9).**

Table 9: Multi-variable association of DM patients regarding developing DM-related complications with associated patient factors

Variable	Category, (N)	Odds Ratio (OR)	95% CI	p-value
Age	31-45 year	Ref		
	>60 year	9.71	1.63 – 57.92	**0.013**
	46-60 year	1.93	0.52 – 1.65	0.793
Education	Graduate	Ref		
	SSC and HSC	0.87	0.48 – 1.57	0.649
	Junior High School	1.3	0.68 – 2.48	0.42
	No formal Education	3.85	1.8 – 8.22	**0.001**
Duration of Diabetes	≤5 years	Ref		
	6 to 10 years	1.29	0.71 – 2.36	0.407
	11 to 15 years	3.48	1.74 – 6.96	**0.000**
	>15 years	3.66	1.7 – 7.89	**0.001**
Frequency of checking Blood Glucose	Regularly	Ref		
	Weekly	3.12	1.73 – 5.65	**0.000**
	Monthly	1.79	1 – 3.21	0.052
	Not Regularly	21.5	3.64 –	**0.001**

			127.06	
Fasting Blood Glucose	Control (≤ 7.1 mmol/dl)	Ref		
	Not Control	3.13	1.62 – 6.05	**0.001**

The patients who didn't check their blood glucose level regularly had a high risk (21.5) of having DM-related complications compared to those checked weekly (3.12), monthly, and daily. The patients who didn't have their fasting blood glucose level under control had a high risk (3.13) of having diabetes-related complications **(Table 9)**.

4.4. Analysis of the type of complications in DM patients

Of patients with diabetes mellitus (DM) who had gone for checkup at Chattogram General Diabetic Hospital, 98.3% had diabetes-related comorbidities and 1.7% didn't have any. Higher comorbidities were seen in patients who were taking insulin and oral drugs (99.5%) compared to those who were taking only oral drugs **(Table 10).**

Our result demonstrated that multiple-disease patients (91.9%) were more predominant than single-disease patients (8.1%). The frequency was higher in patients taking both therapies (93.2%) in case of multiple comorbidities **(Table 10).**

It was found that almost 18.1% of DM patients had kidney problems which was found higher (20.4%) in patients taking both insulin and oral drugs. Eye problem was found in 82.7% of patients which was more predominant in patients who were taking oral drugs (83.4%) compared to the patients who were taking both. Foot problem was observed in 23.2% of patients and among them, the higher frequency was seen in the patients who were taking both insulin and oral drugs (24.3%) compared to those who were only taking oral drugs. Cardiovascular disease was seen in 93.9% of patients and the higher frequency was among the patients who were taking insulin and oral drugs (95.1%) **(Table 10).**

Table 10: Complications of DM patients in CDGH

Complications	**Overall**		**Patients Taking Insulin and Oral Drugs**		**Patients Taking Oral Drugs**	
	N	**%**	**N**	**%**	**N**	**%**
Yes	393	98.3%	206	99.5%	187	96.9%

No	7	1.7%	1	0.05%	6	3.1%
Single Complication	32	8.1%	14	6.8%	18	9.6%
Multiple Complications	361	91.9%	192	93.2%	169	90.4%
Nephropathy	71	18.1%	42	20.4%	29	15.5%
Retinopathy	325	82.7%	169	82.0%	156	83.4%
Diabetic foot	91	23.2%	50	24.3%	41	21.9%
Cardiovascular disease	369	93.9%	196	95.1%	173	92.5%
Neuropathy	76	19.3%	50	24.3%	26	13.9%
Dental Problem	205	52.2%	112	54.4%	93	49.7%
Non-alcoholic Fatty Liver Disease	63	16.0%	31	15.0%	32	17.1%
Skin Problem	94	23.9%	50	24.3%	44	23.5%
Pregnancy Complication	20	5.1%	10	4.9%	10	5.3%
Others	113	28.8%	70	34.0%	43	23.0%

Neuropathy was seen in 19.3% of patients and the higher frequency contained the patients who were taking insulin and oral drugs (24.3%). Dental problem was observed in 52.2% of patients and the frequency was higher in the patients who were taking insulin and oral drugs (54.4%). Non-alcoholic fatty liver disease was seen in 16% of DM patients and the frequency was observed higher in patients who were taking oral drugs only (17.1%) compared to the patients who were taking both. Skin problem was seen in 23.9% of DM patients, and it was higher in patients taking both insulin and oral drugs (24.3%). Complications during pregnancy were seen in 5.1% of DM patients which was higher among the patients who were taking only oral drugs (5.3%). Other complications such as tuberculosis, streptococcal pneumonia, musculoskeletal disorder, etc. were seen in 28.8% of patients and the frequency was higher among the patients who were taking both insulin and oral drugs (34%) compared to the patients who were taking only oral drugs **(Table 10).**

Chapter 5: Discussion

Diabetes is a worldwide problem. The fundamental issue with diabetes is hyperglycemia, which eventually leads to a variety of Microvascular and Macrovascular issues, which are also linked to several factors. The purpose of the study was to determine the concomitant conditions and associated diseases related to DM in Chattogram, Bangladesh. The author's goal was to discover the complications and associated factors of diabetes in a broader context, enlighten the greater audience about these, and discover the main risk factors behind the mechanism of complications. As a result, better lifestyle guidelines for diabetes patients are provided.

In this study, 400 individuals' data were taken where all the participants were from Chattogram Diabetic General Hospital (CDGH) from October 2022 to November 2022 by using a questionnaire with the written consent of the participants.

A cross-sectional study was performed to analyze the risk factors and associated diseases of diabetes. In the research investigation, five highly significant factors were found associated with causing diabetes-related complications. These factors were the age, education, duration of diabetes, frequency of blood glucose level, and fasting blood glucose level of the participants.

Patients who are at the age of 60 or more developed DM (OR: 9.71) than the other age groups. Patients who developed diabetes at a younger age had a longer exposure to high blood sugar levels, which led to the accumulation of damage over time. The longer a person has diabetes, the higher the risk of developing complications. Younger patients with diabetes had a harder time managing their blood sugar levels due to a lack of understanding or knowledge about their condition. Poorly controlled blood sugar levels over time lead to complications such as nerve damage, kidney disease, and eye problems (Modi et al., 2011). Younger patients do not always display typical symptoms of diabetes, which can lead to a delay in diagnosis. Delayed diagnosis might result in a longer period of uncontrolled blood sugar levels, leading to a higher risk of complications. Younger patients might have other risk factors that increase their risk of developing complications, such as a family history of diabetes or a genetic predisposition to certain complications (Yau et al., 2012).

It was found that the patients who had no formal education were more prone to diabetes-related complications (OR: 3.85). One of the main reasons was patients who didn't have formal education had no access to accurate information about diabetes and how to manage it. This led to poor self-care, such as not monitoring blood sugar levels, not taking medication as prescribed, and not following a healthy diet (Hellmuth et al.,2002). Similar research shows that patients had limited access to healthcare, which resulted in delayed diagnosis and treatment of diabetes. They did not have the resources to visit doctors or purchase medication, which led to uncontrolled diabetes and increased risk of complications. They were more likely to engage in unhealthy lifestyle habits such as a poor diet, lack of physical activity, and smoking. These habits increase the risk of developing diabetes and related complications (Clark, 2003).

Participants who had diabetes for more than 15 years were more prone to having diabetes-related complications (OR: 3.66) because of the cumulative damage that high blood sugar levels caused over time. Similar research shows that high blood sugar levels can damage the nerves in the body, leading to a condition called diabetic neuropathy. This can cause numbness, tingling, and pain in the hands and feet, as well as other complications such as gastroparesis (delayed stomach emptying) and erectile dysfunction (Owen et al., 2002). Long-term diabetes can increase the risk of developing cardiovascular disease, such as heart attack and stroke. High blood sugar levels can damage the blood vessels and nerves that control the heart and blood vessels, leading to atherosclerosis (hardening and narrowing of the arteries) and other heart-related problems. Diabetes can damage the kidneys over time, leading to a condition called diabetic nephropathy. This can cause protein to leak into the urine and can eventually lead to kidney failure. Long-term diabetes can damage the blood vessels in the eyes, leading to a condition called diabetic retinopathy. This can cause vision loss and blindness (Sicree et al., 2010).

It was found that patients with diabetes who did not check their blood glucose levels regularly are at a higher risk (OR: 21.5) of developing diabetes-related complications because they were not aware of how well their diabetes was being controlled. Similar research shows that checking blood glucose levels regularly can help people with diabetes adjust their medication doses as needed to keep their blood sugar levels within target ranges. If blood sugar levels are consistently high, this can increase the risk of complications such as nerve damage, kidney disease, and eye problems (Lu et al., 2010).

Daily blood glucose monitoring can help patients with diabetes identify patterns and trends in their blood sugar levels. This can help them adjust their diet, exercise, and medication routines to better control their diabetes. Checking blood glucose levels regularly can also help people with diabetes detect any early signs of complications, such as nerve damage, kidney disease, and eye problems. This can lead to earlier treatment and better outcomes. Diabetes can be a stressful condition to manage, and checking blood glucose levels regularly can help patients feel more in control of their diabetes management. This can lead to better mental health and overall well-being (Klein, 2007; Zheng et al., 2012).

Patients who have uncontrolled fasting blood glucose levels (OR:3.13) are more prone to diabetes-related complications because high blood sugar levels over a prolonged period could damage various organs and systems in the body. High blood sugar levels can damage the nerves in the body, leading to a condition called diabetic neuropathy. This can cause numbness, tingling, and pain in the hands and feet, as well as other complications such as gastroparesis (delayed stomach emptying) and erectile dysfunction. Uncontrolled fasting blood glucose levels can contribute to the development of diabetic neuropathy and cardiovascular diseases, such as heart attack and stroke (Chaudhury et al., 2017). High blood sugar levels can damage the blood vessels and nerves that control the heart and blood vessels, leading to atherosclerosis (hardening and narrowing of the arteries) and other heart-related problems. Uncontrolled fasting blood glucose levels can damage the kidneys over time, leading to a condition called diabetic nephropathy. This can cause protein to leak into the urine and can eventually lead to kidney failure. Uncontrolled fasting blood glucose levels can damage the blood vessels in the eyes, leading to a condition called diabetic retinopathy. This can cause vision loss and blindness (Sicree et al., 2010).

This study also shows that most of the DM patients had multiple complications. Among the complications, cardiovascular disease (93.3%) and retinopathy (82.7%) were more predominant in the patients. Patients who were taking insulin and oral drugs both were more prone to develop multiple DM-related complications. When patients use both insulin and oral drugs, it indicates that their diabetes is more difficult to manage and that they may have higher average blood sugar levels over time. High blood sugar levels can damage blood vessels and nerves throughout the body over time, resulting in several consequences including heart disease, kidney disease, nerve damage, and eye illness (Zheng et al., 2012). In addition, insulin therapy might result in hypoglycemia (low

blood sugar levels), which can be deadly if not addressed swiftly. This is especially true if the patient is also taking drugs that can cause hypoglycemia, such as sulfonylureas. Hypoglycemia increases the likelihood of falls, accidents, and other health issues (Klein,2007).

The study demonstrated that the patients who were taking both oral drugs and insulin were more prone to diabetic-related complications as well as multiple complications. To control blood sugar levels, people with diabetes start with oral medicines. To maintain normal blood sugar levels, some people need insulin in addition to oral drugs as the diabetes worsens. Those with DM who need to take insulin are at a higher risk of complications than people with the condition who simply take oral drugs. This is because insulin therapy is frequently used to treat more severe and advanced forms of diabetes, which is linked to more severe consequences. The risk of hypoglycemia (low blood sugar), which can be deadly if improperly controlled, is also increased using insulin therapy (Maskari et al., 2011). As diabetes is a progressive disease, patients who have had a longer duration of diabetes are likely to have reduced beta-cell function and require more intensive therapy compared to patients with more recently diagnosed diseases. Patients using oral drugs plus insulin therapy had a longer history of diabetes than patients using oral drugs alone. Patients using oral drugs plus insulin typically had a higher prevalence of complications and concomitant disease than patients using only oral drugs. Not surprisingly, the prevalence of complications and concomitant disease also increased with diabetes duration, a finding indicative of the association between the duration of hyperglycemia and the likelihood of adverse vascular effects (Ji et al., 2013).

Chapter 6: Conclusion

This study revealed that DM-related complications and associated factors are major burning issues not only for the patient himself but also for the family. The study aimed at the associated factors and complications in DM patients in Chattogram Diabetic General Hospital where one of the outcomes shows, there is an association between age, educational level, duration of diabetes, frequency of checking blood glucose level, fasting blood glucose level, and diabetic-related complications. Patients who had diabetes for more than 15 years had a higher risk of developing diabetes-related complications. Another outcome demonstrates that there is a clear association between the patients who didn't have any formal education had a high chance of developing DM complications. The study shows, that in Chattogram, the patients who have consumed outside foods or street foods more than 2 times per week have a higher chance of developing diabetes-associated complications. Also, the patients who were not checking their blood glucose levels regularly such as once in a month, once in two/three/four months were prone to develop diabetes-related complications more. BMI, outside consumption of food, and forgetting to take medication also accelerated diabetic-related complications as well. So, this study suggests a reduction of weight and taking extra care such as frequent checkups by healthcare providers as the age increases, regular monitoring, and physical exercises, and taking medicines and insulin regularly for DM patients to reduce the prevalence of DM complications.

Chapter 7: Strengths and Weakness

The strengths of the present study are the data have been collected on self by producing a pre-structured questionnaire from the hospital where the diabetic patient was physically checked up and directly interviewed by the author herself. The author assessed the socio-economic status, demographic information, and general health characteristics of 400 participants, and did the documentation, and data entry.

The strength of this study also includes the size of the sample which has been collected at a narrowly defined time by direct face-to-face interview. The collected data is also associated with instantly available biochemical laboratory values provided by the participants which are related to complications of DM.

The limitation of the study is some participants don't want to participate in the study. Sometimes they become offended if they are asked whether they smoke or not. Sometimes it becomes difficult to collect accurate samples for research. Another limitation was the dosage of insulin and medicines, and type of medicines such as Comet, Adelina, Comprid, etc. was not investigated as different patients used different types of medicines and it was challenging to list all the medicines and dosages of each patient.

Chapter 8: Recommendations and Future Perspectives

A comprehensive and multi-approach study is necessary regarding the large sample size, and different study locations covering nationwide where all categories of the citizen should be included. There is an importance for a multidisciplinary approach to managing the conditions and associated diseases in diabetic patients, including lifestyle modifications, pharmacotherapy, and regular monitoring and follow-up with healthcare providers. Future research should continue to investigate new therapies and technologies to improve management and outcomes for diabetic patients.

Chapter-9: Reference

Afroz A, Zhang W, Loh A J W, Lee D X J, Billah B. 2019. Macro-and micro-vascular complications and their determinants among people with type 2 diabetes in Bangladesh. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 13(5): 2939-2946.

Alam U, Asghar O, Azmi S, and Malik RA. 2014. General aspects of diabetes mellitus. Handbook of clinical neurology. P.211-222.

Alotaibi A, Perry L, Gholizadeh L, Ganmi A. 2017. Incidence and prevalence rates of diabetes mellitus in Saudi Arabia: An overview. Journal of Epidemiology and Global Health. 7(4): 211-218.

American Diabetes Association. 2015. Standards of Medical Care in Diabetes—2015: Summary of Revisions. 38(1). https://doi.org/10.2337/dc15-S003

American Heart Association. 2021. Diabetes Risk Factors [Diabetes]. https://www.heart.org/en/health-topics/diabetes/understand-your-risk-for-diabetes

Andersen A R, Christiansen J S, Andersen J K, Kreiner S, Deckert T. 1983. Diabetic nephropathy in type 1 (insulin-dependent) diabetes: An epidemiological study. Diabetologia. 25(10): 496-501.

Appel L J, Brands M W, Daniels S R, Karanja N, Elmer P J, Sacks F M. 2006. Dietary approaches to prevent and treat hypertension: A scientific statement from the American Heart Association. American Heart Association. 47(2): 296-308.

Basith K M A, Hashim M J, King J K, Devi G R, Mustafa H, Al K J. 2020. Epidemiology of Type 2 Diabetes—Global Burden of Disease and Forecasted Trends. Journal of Epidemiology and Global Health. 10(1): 107–111.

Beckman A J, Creager A M. 2016. Vascular Complications of Diabetes. Circulation Research. 118(4): 1771-1785.

Belanjer M J, Hill M A, Angelidi A M, Dalamaga M, Sowers J R, Mantzoros C S. 2020. Covid-19 and Disparities in Nutrition and Obesity. The New England Journal of Medicine. 383(11): 69-76.

Centers for Disease Control and Prevention. 2014. http://www.cdc.gov/diabetes/data/statistics/2014StatisticsReport.html

Chaudhury A, Duvoor C, Dendi V S R, Kraleti S, Chada A, Ravilla R, Macro A. 2017. Clinical Review of Antidiabetic Drugs: Implications for Type 2 Diabetes Mellitus Management. Frontiers in Endocrinology. 8(2): 123–126.

Cheung N, Mitchel P, Wong T Y. 2010. Diabetic retinopathy. Molecular Vision. 9(5): 178-187.

Clark N. 2003. Peripheral Arterial Disease in People With Diabetes. American Diabetes Association. 26(12): 3333-3341.

Dansinger M. 2022. Type 2 Diabetes. American Journal of Health Promotion. 37(6): 276-280.

Dean A, Sullivan KM, Soe MM. 2010. Open-Source Epidemiologic Statistics for Public Health. p.338.

Drexel H, Aczel S, Marte T, Berzer W, Langer P, Moli W. 2005. Is Atherosclerosis in Diabetes and Impaired Fasting Glucose Driven by Elevated LDL Cholesterol or by Decreased HDL Cholesterol. American Diabetes Association. 28 (1): 101-107.

Dunnigan S K, Ebadi H, Breiner A, Katzberg H D, Lovblom L E, Perkins B A, Bril V. 2013. Conduction slowing in diabetic sensorimotor polyneuropathy. American Diabetes Association. 36 (11): 3684-3690.

Dysted M, Esztergályos B, Gautam S, Helman B, Pinkepank M, Randi A, & Salim A S 2021. IDF Diabetes Atlas (10th edition). p.97. http://www.diabetesatlas.org/

Frank R N. 2004. Diabetic Retinopathy. The New England Journal of Medicine.350(1): 48-58.

Ghaemi N, Hasanabadi H, Ashrafzadeh F. 2018. Peripheral neuropathy in children and adolescents with insulin-dependent diabetes mellitus. Iranian Journal of Child Neurology. 12(2): 83-90.

Gumy L F, Bampton E T W, Tolkovsky A M. 2008. Hyperglycaemia inhibits Schwann cell proliferation and migration and restricts regeneration of axons and Schwann cells from adult murine DRG. Molecular and Cellular Neuroscience. 37(2): 298-311.

Wass H, Stewart P. 2002. Oxford Textbook of Endocrinology and Diabetes (Second). p.441.

Herman W H. 2016. The Global Burden of Diabetes: An Overview. SpringerLink. 45(2): 1-5.

Hossain M B, Khan M N, Oldroyd J, Rana J, Magliago J, Chowdhury D K, Nazmul K E, Islam R. 2022. Prevalence of, and risk factors for, diabetes and prediabetes in Bangladesh: Evidence from the national survey using a multilevel Poisson regression model with a robust variance. PLOS Global Public Health. 12(5): 112–117.

Islam S M S, Niessen L W, Seissler J, Ferrari U, Bisawas T, Islam A, Lechner A. 2015. Diabetes knowledge and glycemic control among patients with type 2 diabetes in Bangladesh. SpringerLink. 284(4): 97–101.

Johan F. 2013. Immunity, atherosclerosis and Cardiovascular Disease. BioMed Central. 117(11): 226-230.

Janghorbani M, Hu F B, Willett W C, Li T Y, Manson J E. 2007. Prospective Study of Type 1 and Type 2 Diabetes and Risk of Stroke Subtypes: The Nurses' Health Study. American Diabetes Association. 30(7): 1730-1735.

Ji L, Hu D, Pan C, Weng J, Hu Y, Ma C, Mu Y, Hao C, Ji Q, Ran X, Su B. 2013. Primacy of the 3B Approach to Control Risk Factors for Cardiovascular Disease in Type 2 Diabetes Patients. The American Journal of Medicine. 126(10): 925–927.

Karapanayiotides T, Piechowski J B, Melle G V, Bogousslavsky J, Devuyst G. 2004. Stroke patterns, etiology, and prognosis in patients with diabetes mellitus. American Academy of Neurology. 62(9): 523-530.

Kharroubi A T, Darwish H M. 2015. Diabetes mellitus: The epidemic of the century. World Journal of Diabetes. 6(6): 850-867.

Klein B. 2007. Overview of epidemiologic studies of diabetic retinopathy. Ophthalmic Epidemiology. 14(4): 179-183.

Klein R, Klein B. 1995. Vision Disorders in Diabetes. CABI publishing. p.293.

Lihteh W, Priscilla F L, Johanna S, Erick H B, Marisse M. 2013. Classification of diabetic retinopathy and diabetic macular edema. World Journal of Diabetes. 4(6); 290-294.

Lone S, Lone K, Khan S, Ahmed P R. 2017. Assessment of metabolic syndrome in Kashmiri population with type 2 diabetes employing the standard criteria's given by WHO, NCEPATP III and IDF. Journal of Epidemiology and Global Health. 7(4): 235-239.

Lu J, Yang W, Weng J, Jia W, Ji L, Xiao J, Shan Z. 2010. Prevalence of Diabetes among Men and Women in China. The New England Journal of Medicine. 362(11): 1090–1101.

Mahanta G, Joshi T, Mahanta B, Xavier D. 2013. Prevalence of modifiable cardiovascular risk factors among tea garden and general population in Dibrugarh, Assam, India. Journal of Epidemiology and Global Health. 3(3): 147-156.

Martinez C L, Zahra T. 2022. Chronic Complications of Diabetes. European Medical Journal. 10(1): 95-102.

Maskari A Y A, Maskari M Y A, Sudairy S A. 2011. Oral Manifestations and Complications of Diabetes Mellitus. Sultan Qaboos University Medical Journal. 11(2): 179–186.

Mizisin A P, Shelton G D, Wagner S, Rusbridg C, Powell H C. 1998. Myelin splitting, Schwann cell injury and demyelination in feline diabetic neuropathy. SpringerLink. 95(4): 171-174.

Modi S, Anoop M, Sharma R, Gulati S, Joshi S R, Sharma V, Ahmed I. 2011. Consensus Dietary Guidelines for Healthy Living and Prevention of Obesity, the metabolic Syndrome, Diabetes, and Related Disorders in Asian Indians. Diabetes Technology and Therapeutics. 13(6): 230-235.

Mogensen C E. 2011. Progression of Nephropathy in Long-Term Diabetics with Proteinuria and Effect of Initial Anti-Hypertensive Treatment. Scandinavian Journal of Clinical and Laboratory Investigation. 36(4): 383-388.

Naik A K, Tandan S K, Dudhgaonkar S P, Jadhav S H, Kataria M, Prakash R, Kumar D. 2012. Role of oxidative stress in pathophysiology of peripheral neuropathy and modulation by N-acetyl-l-cysteine in rats. European Journal of Pain. 10(7): 573-579.

Oluyombo R, Olamoyegun M A, Olaifa O, Lwuala O S, Babatunde A O. 2015. Cardiovascular risk factors in semi-urban communities in southwest Nigeria: Patterns and prevalence. Journal of Epidemiology and Global Health. 5(2): 167-174.

Owen N, Dunstan D W, Daly R M, Jolley D, Zimmet P. 2002. High-Intensity Resistance Training Improves Glycemic Control in Older Patients with Type 2 Diabetes. American Diabetes Association. 25(10): 1729–1736.

Parving H H. 2001. Diabetic Neuropathy: Prevention and Treatment. Kidney International. 60(5): 2041-2055.

Parving H H, Smidt U M, Friisberg B, Bonnevie N V, Andersen A R. 1981. A prospective study of glomerular filtration rate and arterial blood pressure in

insulin-dependent diabetics with diabetic nephropathy. SpringerLink. 20(8): 457-461.

Pop B R, Boulton J M, Feldman E L, Bril V, Freeman R, Malik R A, Sosenko J M, Ziegler D. 2017. Diabetic Neuropathy: A Position Statement by the American Diabetes Association. American Diabetes Association. 40(1): 136-154.

Quast J, Wei M, Huang N C. 1997. Perfusion Deficit Parallels Exacerbation of Cerebral Ischemia/Reperfusion Injury in Hyperglycemic Rats. Journal of Cerebral Blood Flow and Metabolism. 17(5): 225-230.

Ramtahal R, Khan C, Maharaj Khan K, Nallamothu S, Hinds A, Dhanoo A, Yeh H C, Hill B F, Lazo M. 2015. Prevalence of self-reported sleep duration and sleep habits in type 2 diabetes patients in South Trinidad. Journal of Epidemiology and Global Health. 5(4): 35-43.

Ross R. 1999. Atherosclerosis—An Inflammatory Disease. The New England Journal of Medicine. 340(9): 115-126.

Rossing P. 2004. Promotion, prediction and prevention of progression of nephropathy in Type 1 diabetes mellitus. Diabetic Medicine. 15(11): 900-919.

Rossing P, Rossing K, Jacobsen P, Parving H H. 1995. Unchanged Incidence of Diabetic Nephropathy in IDDM Patients. American Diabetes Association. 44(7): 739-743.

Saaddine J, Honeycutt A, Narayan K, Zhang X, Klein R, Boyle J. 2008. Projection of Diabetic Retinopathy and Other Major Eye Diseases Among People with Diabetes Mellitus: United States, 2005–2050. JAMA Ophthalmology. 126(12): 1740-1747.

Sachdev P. 2021. Diabetes and Peripheral Artery Disease: A Review. World Journal of Diabetes. 12(6): 827-838.

Sharma S, Oliver F A, Liu W, Buchhol P, Walt J. 2005. The impact of diabetic retinopathy on health-related quality of life. Current Opinion in Ophthalmology. 16(3): 155-159.

Sicree R, Shaw J, Zimmet P. 2010. The Global Burden. Diabetes and Impaired Glucose Tolerance. p.56.

Sivaprasad S, Gupta B, Crosby N R, Evans J. 2012. Prevalence of Diabetic Retinopathy in Various Ethnic Groups: A Worldwide Perspective. Survey of Ophthalmology. 57(4): 347-370.

Tan N T, Jin Wang J, Yin Wong T. 2007. Retinal Vascular Changes in Pre-Diabetes and Prehypertension: New findings and their research and clinical implications. Diabetes Care. 30(10): 2708-2715.

Viberti G C, Bilous R W, Mackintosh D, Keen H. 1983. Monitoring glomerular function in diabetic nephropathy: A prospective study. The American Journal of Medicine. 74(2): 256-264.

Yau J W Y, Rogers S L, Kawasaki R, Lamoureux E L. 2012. Global Prevalence and Major Risk Factors of Diabetic Retinopathy. American Diabetes Association. 35(3): 556-564.

Yuan S, Liu Y, Zhu L. 1999. Vascular Complications of Diabetes Mellitus. Circulation Research. 118(23): 1771-1785.

Zheng Y, He M, Congdon N. 2012. The worldwide epidemic of diabetic retinopathy. Indian Journal of Ophthalmology. 60(5): 428-431.

Zhou H, Zhang X, Lu J. 2014. Progress on diabetic cerebrovascular diseases. Journal of the Association of Basic Medical Sciences. 14(4): 185-190.

Zimmerman R S. 2016. Diabetes Mellitus: Management of Microvascular and Macrovascular Complications. Cleveland Clinic. Disease Management. 102(7): 520-526.

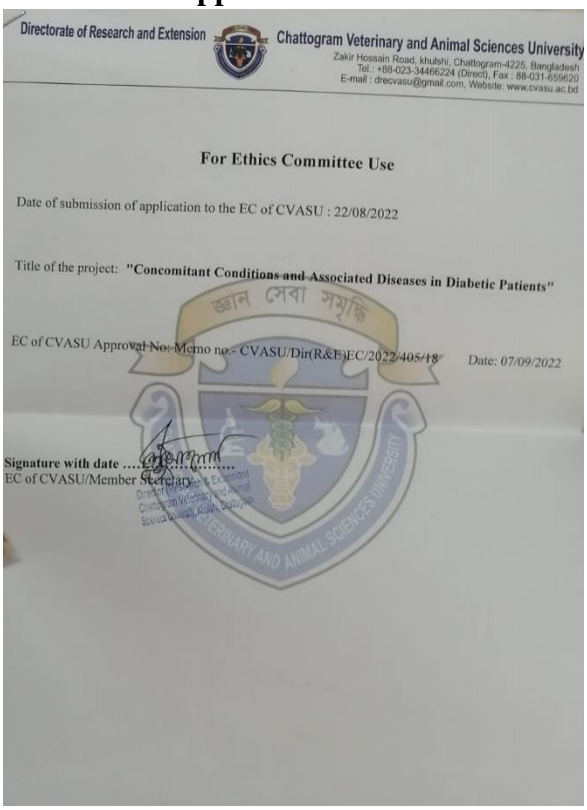
Chapter-10: Appendices

10.1 Annexes

Figure 2: Chattogram Diabetic General Hospital (CDGH)

Figure 3: Data collection from the patients

10.2. Ethical approval



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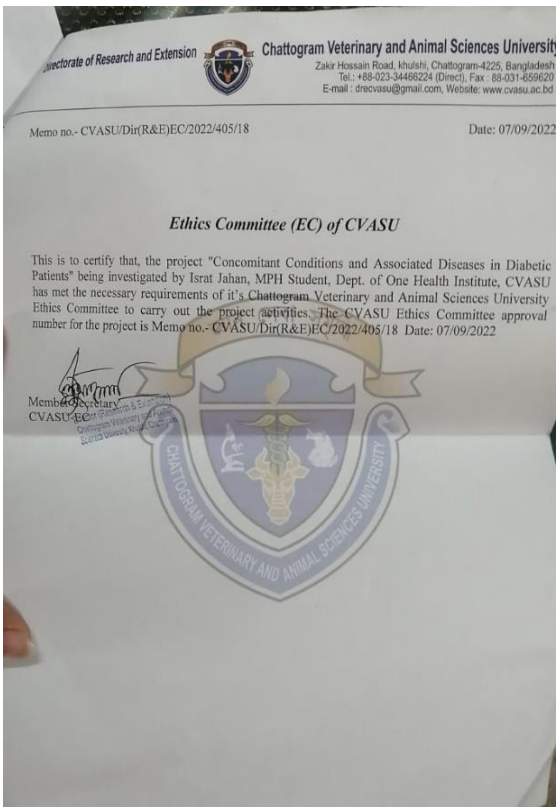
For Ethics Committee Use

Date of submission of application to the EC of CVASU : 22/08/2022

Title of the project: **"Concomitant Conditions and Associated Diseases in Diabetic Patients"**

EC of CVASU Approval No: Memo no.- CVASU/Dir(R&E)EC/2022/405/18 Date: 07/09/2022

Signature with date .....
EC of CVASU/Member Secretary



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Memo no.- CVASU/Dir(R&E)EC/2022/405/18 Date: 07/09/2022

Ethics Committee (EC) of CVASU

This is to certify that, the project "Concomitant Conditions and Associated Diseases in Diabetic Patients" being investigated by Israt Jahan, MPH Student, Dept. of One Health Institute, CVASU has met the necessary requirements of it's Chattogram Veterinary and Animal Sciences University Ethics Committee to carry out the project activities. The CVASU Ethics Committee approval number for the project is Memo no.- CVASU/Dir(R&E)EC/2022/405/18 Date: 07/09/2022

Member Secretary
CVASU-EC

Figure 4: Ethical Review Committee Approval

10.3 Questionnaire
Concomitant Conditions and Associated Diseases in Diabetes Patients

Place of questionnaire: Chattogram Diabetic General Hospital, Chattogram, Bangladesh

ID No.

General Information

Name: _____

Address: _____ Contact No: _____

Part A: Demographics and diseases characteristic

Questions:	**Answer**
1. Residence : (1) Urban (2) Rural	
2. Gender : (1) Male (2) Female (3) Others	
3. Age : _____ years old	
4. Marital status : (1) unmarried ; (2) married ; (3) divorced \separated\ widowed (4) others	
5. Occupation: _____	
6. Educational level : (1) No formal education ; (2) Primary school ; (3) Junior high school ; (4) Senior high school and higher ; (5) College and university education (6) Others	
7. Family members: _____	
8. Do you smoke? (1) Yes (2) No	
9. If yes, how often: _____	
10. When you were diagnosed with diabetes? _____	
11. Family History of having diabetes patients: (1) Yes (2) No If yes, no of patients: _____ Who are they? (1) Father (2) Mother (3) Others	
12. Blood Group: _____	
13. Height: _____	
14. Weight: _____	

15. Do you check your blood glucose level regularly? (1) Yes (2) No	
16. How often? (1) Once a day (2) 2 or more times a day (3) Once a week (4) Twice a week (5) Others_____	
17. Have you checked your lipid profile level in the last 1 year? 1) Yes (2) No	
18. If yes, how often? _____	
19. Have you checked your HbA1c level in the last 1 year? 1) Yes (2) No	
20. If yes, how often? _____	
21. Glucose level: (last week) a) Fasting: _____ b) After eating _____	
22. HbA1c test: _____ (last 6 month)	
23. Lipid Profile: _____ (last 6 month)	
24. Do you know about the diabetes and its associated conditions? (1) Yes (2) No	
25. Do you have the following diabetes-related comorbidities, you can choose more than one answer(s) (1) Diabetic nephropathy (kidney disease) (2) Diabetic eye complications (retinopathy) (3) Diabetic foot (4) Diabetic cardiovascular complications (5) Diabetic cerebrovascular disease (6) Diabetic neuropathy (nerve damage) (7) Stroke (8) Peripheral artery disease (9) Dental disease (10) Hypertension (11) Dyslipidemia (12) Non-alcoholic fatty liver disease (13) Tuberculosis (14) Streptococcal pneumonia (15) Skin problem (16) Any infection (17) Pregnancy complications (18) Immune dysfunction (19) Musculoskeletal disorder (20) Others, which was/were_____ (21) None	

Part B: Self-management Behaviors

Questions:	**Answer**
1. What type of therapy are you taking? (1) Oral drug (2) Insulin (3) Diet Control (4) Physical exercise (5) All of the above (6) None (7) Others	
2. Do you do Physical exercise? a. Yes b. No	
3. What type of physical exercise did you often take? (1). low intensity, e.g., walking; (2). middle-intensity, e.g., jogging and dancing; (3). high-intensity excise e.g., running and swimming	
4. Average exercise time in a day_____	
5. Do you follow any diet plan? (1) By Diabetes samity (2) Through internet (3) Self-implicated (4) No	
6. Has your weight changed in the past three months? (1) Yes (2) No (3) Did not check (4) Yes, I have gained weight	
7. How many times do you eat per day? (1) Meals_____ (2) Snacks_____	
8. How often is your meal away from home in a week? _____	
9. Are you on a medication for diabetes? (1) Yes (2) No	
10. If yes, have you ever forgotten to take your diabetes medication? (1) Yes (2) No	

10.4. Brief biography

Israt Jahan achieved a grade point average (GPA) of 5.00 on the Secondary School Certificate (SSC) Exams in 2012 and a GPA of 5.00 on the Higher Secondary Certificate (HSC) Examinations in 2014. She graduated from Chattogram Veterinary and Animal Sciences University (CVASU), Bangladesh, with a B.Sc. (Hons) in Food Science and Technology in 2019 (held in 2020). She is currently a candidate for the MS in Master's of Public Health under the One Health Institute at CVASU. She finds her interest & career objective is to work in research and development. She has a strong desire to work in a demanding setting where her capacity for creative problem-solving may be put to good use.