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Original article

A RETROSPECTIVE STUDY EVALUATING GLYCAEMIC CONTROL AND LIPID PROFILES IN DIABETIC PATIENTS FROM KWAZULU-NATAL, SOUTH AFRICA.

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Abstract

Background:

This study aimed to investigate the lipid profile of diabetic patients in KwaZulu-Natal (KZN), South Africa, a region with a high burden of diabetes. Dyslipidaemia is a common comorbidity in diabetes and is a major risk factor for cardiovascular disease, which is the leading cause of morbidity and mortality in diabetic patients.

Methodology:

A total of 160 serum sample data were analysed from the laboratory information system, including 80 diabetic patients and 80 non-diabetic individuals as controls. Lipid profiles, fasting glucose, and glycosylated haemoglobin levels were measured and compared between the two groups. Descriptive statistics were used to summarize the data, and inferential statistics were used to compare means between groups.

Results:

The study found that diabetic patients in KZN had significantly higher levels of total cholesterol (TC), triglycerides (TG), and low-density lipoprotein (LDL) cholesterol, and significantly lower levels of high-density lipoprotein (HDL) cholesterol, compared to non-diabetic individuals. The mean TC, TG, LDL, and HDL levels were 5.5 mmol/L, 2.5 mmol/L, 3.5 mmol/L, and 1.0 mmol/L, respectively, in diabetic patients, and 4.4 mmol/L, 1.4 mmol/L, 2.4 mmol/L, and 1.4 mmol/L, respectively, in non-diabetic individuals.

Conclusion:

The study underscores the importance of early detection and management of lipid abnormalities in diabetic patients in KZN to reduce the risk of cardiovascular disease. The findings have implications for healthcare providers and policymakers in the region who are responsible for addressing the burden of diabetes and its complications.

Recommendation:

Further, studies with larger sample sizes and in different regions of South Africa are needed to investigate the prevalence of dyslipidaemia and poor glycaemic control in diabetic patients. Such studies can inform the development of tailored interventions to improve cardiovascular outcomes in diabetic patients in South Africa and other regions of the world with a high burden of diabetes.

Keywords: Type 2 diabetes, Lipid profile, Glycaemic control, Fasting glucose, Glycosylated haemoglobin (HBA1C), South Africa., Submitted: 2023-03-15 Accepted: 2023-04-13

1. BACKGROUND

Diabetes is a metabolic disorder characterized by disturbances in carbohydrate, protein, and lipid metabolism, leading to chronic hyperglycaemia (American Diabetes Association, 2022). The relationship between diabetes mellitus, serum lipid profile, and blood glucose has been investigated in several studies. Rosenson et al. (2016) demonstrated that dyslipidaemia is a predominant risk factor for cardiovascular disease in type 2 diabetes, characterized by decreased high-density lipoprotein (HDL) levels, elevated triglyceride-rich lipoprotein levels, and an increase in pro-atherogenic small dense low-density lipoproteins. These changes were closely associated with low-grade inflammation and oxidative stress. The dyslipidaemia in type 2 diabetes resulted in altered HDL particle composition, arrangement, and breakdown, leading to dysfunctional HDLs. Monitoring serum lipid levels in patients with type 2 diabetes is considered the gold standard for diabetes care (American Diabetes Association, 2022). The breakdown of low-density lipoprotein (LDL) in type 2 diabetes showed significant changes, with small dense LDL particles tending to form fat deposits in the arteries, leading to atherogenic complications (Ai et al., 2010). Exercise interventions have been used to reduce these complications, with a substantial decrease in plasma triglycerides reported in the exercise intervention group (Aggarwala et al., 2016). In conclusion, early detection and treatment of lipid abnormalities are crucial in reducing the risk of atherogenic cardiovascular disorders in patients with type 2 diabetes. Exercise and regular monitoring of serum lipid and glycosylated haemoglobin levels are essential for diabetes care.

According to Aschner et al. (2021), the global prevalence of diabetes was high and rising due to the increase in obesity and unhealthy lifestyles. The latest estimates showed a prevalence rate of 11.1% in 2019, with an expected rise to 13% by 2045 in Northern America and Caribbean regions. The Middle East and North African regions had the highest prevalence rate, predicted to rise to 13.9% by 2045, while Africa had the lowest prevalence rate of 4.7%, expected to increase to 5.2% in 2045. South-East Asian and South American countries had either high or intermediate incidences. The global prevalence of diabetes was estimated to reach 10.2% by 2030 and 10.9% by 2045. Uncontrolled diabetes could lead to serious complications such as diabetic nephropathy, ketoacidosis, free radical-associated damage, atherosclerosis, cardiovascular disease, and hypertension (Gatwood et al., 2018). Diabetic nephropathy was characterized by damage to the basement of glomerular capillaries, disrupting protein crosslinking, and allowing proteins in the urine to leak through. Diabetic ketoacidosis was a feature of insulin insufficiency, which characterized by type two diabetes. Diabetic patients had a higher risk of free radical-associated damage, leading to atherosclerosis, cardiovascular disease, and hypertension. Diabetic patients also had a higher prevalence of coronary artery disease, heart disease, and sudden cardiac death. Therefore, early detection of diabetes, assessment of lipid profiles, and the development of targeted drugs were appropriate steps to control the disease (Alam et al., 2021).

The serum lipid profile encompasses a variety of triglycerides that are categorised as namely Total Cholesterol, High-Density Lipoprotein Cholesterol, Low-Density Lipoprotein Cholesterol, and Triglycerides (Schofield et al., 2016). One of the predisposing factors to diabetes is obesity, which is hallmarked by high serum lipid content. As such patients with type 11 diabetes are often obese, which poses a significant health risk. The elevated serum lipid may complicate cardiovascular disorders such as (coronary artery disease, high blood pressure, cardiac arrest, congestive heart failure, arrhythmia, peripheral heart disease strokes, and congenital heart disease (Lega and Lipscombe, 2020). Rosenson et al. (2016) stated that type two diabetic patients display increased cardiovascular risk which is characterized by the presence of a constellation of cardiovascular risk

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factors, diabetic dyslipidaemia being a central feature. Rosenson et al. (2016) further specified that in type two diabetes, dyslipidaemia features decreased levels of HDL cholesterol, increased levels of TG-rich lipoproteins (notably, very low-density lipoprotein), and a multitude of proatherogenic small, dense low-density lipoprotein and this lipid profile is intimately allied with chronic low-grade inflammation and oxidative stress.

Diabetes is known to have a significant impact on lipid metabolism, resulting in altered levels of serum lipids, including total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) (Rosenson et al., 2016). Dyslipidaemia is one of the major cardiovascular risk factors in patients with diabetes, particularly in those with type 2 diabetes (Rosenson et al., 2016). In type 2 diabetes, dyslipidaemia is characterized by increased levels of triglyceride-rich lipoproteins, low levels of HDL-C, and increased levels of small, dense LDL particles, which are particularly atherogenic (Rosenson et al.,

Furthermore, decreased levels of HDL-C are common in diabetes and are associated with an increased risk of cardiovascular disease (CVD) (Rosenson et al., 2016). In addition to decreased HDL-C, increased levels of LDL-C are also associated with an increased risk of CVD (Ai et al, 2010). According to Ai et al (2010), small, dense LDL particles tend to form fat deposits in the arteries, contributing to the development of atherosclerosis.

Uncontrolled diabetes can lead to serious complications, such as diabetic nephropathy, ketoacidosis, and cardiovascular disease, all of which are associated with altered lipid metabolism (Thomas et al., 2018). Diabetic nephropathy, for example, can result in increased proteinuria due to the damage of the basement membrane of glomerular capillaries and disruption of protein crosslinking (Thomas et al., 2018). In addition, diabetic patients are at a higher risk of oxidative stress-induced damage, which contributes to the development of atherosclerosis and hypertension (Thomas et al., 2018).

In conclusion, there is a strong interrelatedness between diabetes and lipid profile. Dyslipidaemia is a common feature in patients with diabetes and is a major risk factor for CVD. Decreased levels of HDL-C and increased levels of LDL-C are associated with an increased risk of CVD, and small, dense LDL particles tend to form fat deposits in the arteries. Diabetes also puts individuals at a higher risk for other complications, such as diabetic nephropathy and oxidative stress-induced damage, which can further exacerbate dyslipidaemia and increase the risk of CVD. Therefore, early detection of diabetes and dyslipidaemia, as well as targeted interventions to manage lipid metabolism, are essential in the prevention and management of diabetes-related complications.

In a study published in Diabetes Care in 2020, researchers found that individuals with type 2 diabetes had higher levels of LDL cholesterol and triglycerides compared to those without diabetes, and that these lipid markers were associated with an increased risk of cardiovascular disease (CVD) (Zhong et al., 2020). Another study published in Diabetes Research and Clinical Practice in 2021 found that high levels of LDL cholesterol and low levels of HDL cholesterol were associated with an increased risk of developing type 2 diabetes in women (Li et al., 2021).

A 2020 meta-analysis published in the Journal of Diabetes and its Complications found that individuals with type 2 diabetes had higher levels of total cholesterol, LDL cholesterol, and triglycerides, and lower levels of HDL cholesterol, compared to those without diabetes, and that these lipid markers were associated with an increased risk of CVD (Shen et al., 2020). In a study published in the Journal of Diabetes and its Complications in 2021, researchers found that changes in lipid profiles were associated with improved glycaemic control in individuals with type 2 diabetes (Yang et al., 2021).

2. METHODOLOGY

2.1. *Study Design:*

The study design refers to the methods and techniques used to collect and analyse data. This retrospective cross-sectional study aimed to evaluate the interrelatedness of diabetes to the lipid profile of patients residing in KwaZulu-Natal a province located in South Africa in the African Continent.

2.2. *Study Setting and Population:*

The relevant clinical chemistry data pertaining to lipid profiles and glycaemic indices were collected from patient serum samples between the period of June 2021 and November 2021. The geographical location of the study was KwaZulu-Natal (KZN), the easternmost province of South Africa. The name is KwaZulu-Natal translates to "Kingdom of the Zulu," in honour of the native African people who have inhabited the region for centuries. KwaZulu-Natal (KZN) Health is the provincial department responsible for providing healthcare services to the citizens of KZN. The Ministry of Health regulates both the public and private health sectors. However, the current study was conducted in a private clinical laboratory. The study focused on patients who received a diagnosis and treatment at the hospital and followed up at nearby doctor's rooms. The sample included patients from the middle and upper classes who could afford medical aid or pay cash for their treatment, the middle class. Furthermore, the location of the health facility under-study services a limited amount of the population.

As such, the initial sample size was 385 patients however due to the unobtainability of patient results that had both lipid profile and HBA1C the sample size was narrowed down to 97 patients, including both males and females ranging from 18-90 years of age, from all ethnic groups (Black African, Indian, Coloured, and White) that fit these criteria. The inclusion criteria included patients with type 2 diabetes and an HbA1c greater than 6.5%. The exclusion criteria excluded type 1 diabetic patients.

To explain briefly, the formulae for an unknown total population, indicated below was used to calculate, it computed the minimum number of necessary samples to meet the desired statistical constraints. For this study, 97 or more measurements were needed to have a confidence level of 95% that the real value is within ±10% of the measured value. A total of 160 patient sample data was extracted from the laboratory information system.

$$\text{Unlimited population: } n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2}$$

$$\text{Finite population: } n' = \frac{n}{1 + \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2 N}}$$

Where:

z is the z score ε *is the margin of error N is the population size* $\hat{p}$ *is the population proportion.*

2.3. *Bias:*

In efforts to ensure no bias occurred the study designed had a defined objective, and validated methods which were standardized and blind data collection. The study population was clearly defined and was accessible and reliably obtained in an electronic format to avoid bias. Furthermore, during the investigation, the ratio of females to males was considered, and the inclusion of all racial groups in KwaZulu-Natal was considered to avoid a bias of a specific ethnical group's lipid profiles being greatly affected as opposed to looking at all groups, respectively.

2.4. *Data Collection:*

The study obtained ethical clearance and permission from the laboratory to access patient data. The lab test results required the Lipid profile test which constituted of analysing of total cholesterol, triglycerides, low-density lipoproteins, and high-density lipoproteins. The test results of selected patients were obtained from the Laboratory Information System and COBAS line one and two clinical chemistry analysers for the period of June 2021 to November 2021.

2.5. Statistical Analysis:

Data were analysed using Microsoft Excel, and continuous variables were presented as mean ± standard deviation. Data were presented in table forms, in figures comparing the variations of the lipid profiles of type 2 diabetic patients in the following categories: age groups, gender, and ethnicity of the patients to draw a better conclusion of the results. Overall, this study design aimed to analyse the relationship between diabetes and lipid profiles in a specific population, using a retrospective cross-sectional approach to collect and analyse data.

2.6. Ethical considerations:

The ethical considerations of this study were carefully considered to protect patient confidentiality and privacy. Prior to accessing patient data, an ethics clearance letter was sought from the institutional research committee of Mangosuthu University (RDS/2022). Additionally, a formal request letter was sent to the diagnostic laboratory for permission to retrieve the required information. Only relevant data related to the research topic was retrieved, with all patient identifiers removed to ensure anonymity. The data was accessible only to the supervisor and researcher and was kept in a password-protected format that only the researcher had access to. The study did not inflict any harm on the patients during the study period, and all ethical principles were followed in accordance with the Declaration of Helsinki.

3. RESULTS AND DISCUSSION

3.1. The demographic profile and study population

A total of 160 patient samples were enrolled from an initial sample size of 200 patient results. The majority were from were male (53%) than females (47%) and with a mean age of 57.7 years. Several studies have reported a higher prevalence of type 2 diabetes among males than females (Misra et al., 2017; El-Kafrawi et al., 2018). In addition, the mean age of the study population in this study is consistent with the typical age of onset for type 2 diabetes, which is generally higher than that of type 1 diabetes (American Diabetes Association, 2022).

3.2. Ethnic distribution of diabetes

3.2.1. Percentage distribution of diabetes amongst the different ethnic groups within the region.

Type 2 diabetes (T2D) is a growing health concern in KwaZulu-Natal (KZN), with a prevalence of approximately 14.2% in the province (Mayisela et al., 2021). Ethnicity plays a significant role in the distribution of T2D, with Indian and Coloured populations having a higher prevalence compared to African and White populations (Erasmus, 2001; Motala, 2008,). In a previous study in KZN, Indian, and Coloured populations have a T2D prevalence of 17.5% and 12.5%, respectively, while African and White populations have a prevalence of 7.4% and 5.7%, respectively (Mayisela et al, 2021). However, our study found in this region of KwaZulu Natal, the prevalence of diabetes is distributed among different ethnic groups as follows: Indian: 46.00%; White: 36%; Coloured: 10% and African Black: 8%. This means that out of the total population in this region who have diabetes, 46.00% are Indian, 36% are White, 10% are Coloured, and 8% are African-Black. Furthermore, based on the information garnered, we can see that the prevalence of diabetes differs among genders in each ethnic group in this particular region of KwaZulu Natal. In the African Black and Coloured ethnic groups, females have a slightly higher prevalence of diabetes than males. Among African-Black individuals, 3.74% of females have diabetes compared to 4.67% of males. Among Coloured individuals, 5.61% of females have diabetes compared to 4.67% of males. On the other hand, in the Indian and White ethnic groups, males have a slightly higher prevalence of diabetes than females. Among Indian individuals, 23.36% of males have diabetes compared to 22.43% of females. Among White individuals, 13.08% of males have diabetes compared to 11.94% of females. Nevertheless, these findings highlight the

Table 1: **Demographic details**

Gender	N	%	Mean Age
Female	76	47	53.9
Male	84	53	57.7

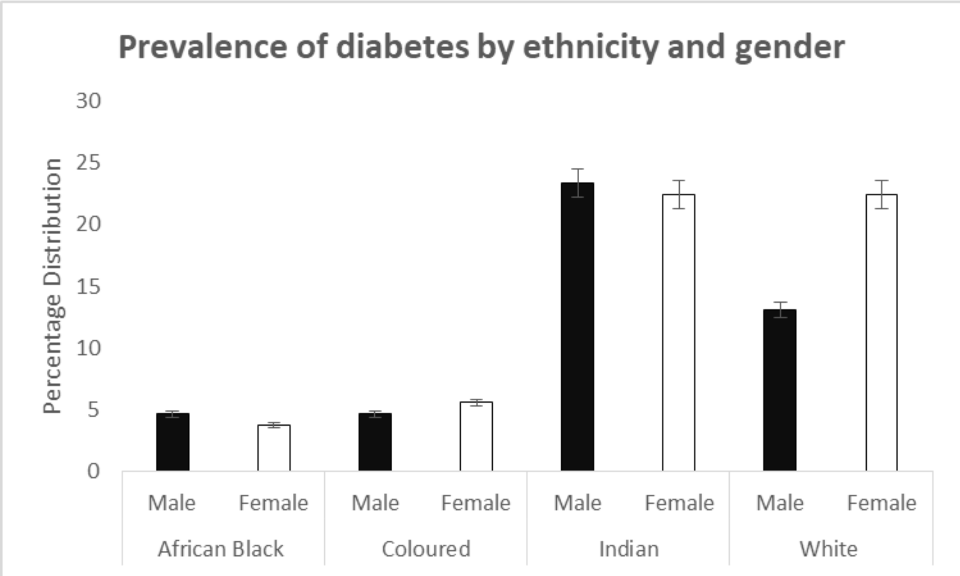

Figure 1: **The ethnic distribution of diabetes amongst the patients.**

need for targeted prevention and management strategies to address the disproportionate burden of T2D among Indian and White populations in KZN.

3.3. *Serum lipid profiles*

This section depicts the lipid profiles of the diabetic and non-diabetic patients. The reference ranges for the lipid profiles were as follows: Total cholesterol: 2.8-4.9mmol/l; Triglycerides: 0.5-1.6mmol/l; HDL cholesterol: 1.0-1.9mmol/l and LDL cholesterol: <3.0mmol/l.

3.3.1. *Lipid profile of Diabetic patients.*

Table 2 shows the serum lipid profiles of diabetic patients, with separate columns for diabetic males and diabetic females. The lipid profiles include Total Cholesterol (TC), Triglycerides (TG), High-density lipoprotein (HDL), and Low-density lipoprotein (LDL). The "Range" column displays the minimum and maximum values for each lipid profile, while the "MEAN" column shows the mean values for each lipid profile.

In general, the lipid profiles of diabetic males and diabetic females are similar. The mean TC levels for diabetic males and females are 5.34mmol/l and 5.03mmol/l respectively, which are within the normal range. The mean TG levels for diabetic males and females are 2.56mmol/l and 2.15mmol/l respectively, which are slightly higher than the normal range. The mean HDL levels for diabetic males and females are 1.27mmol/l and 1.49mmol/l respectively, which are within the normal range. The mean LDL levels for diabetic males and females are 3.71mmol/l and 3.3mmol/l respectively, which are higher than the normal range. It is important to note that the reference ranges for lipid profiles may differ depending on the laboratory and population being studied. In addition, the interpretation of lipid profiles should be done in conjunction with other risk factors for cardiovascular disease in diabetic patients.

Table 2: SERUM LIPID PROFILES OF DIABETIC PATIENTS

Lipid profiles	**Diabetic Males**		**Diabetic Females**	
	Group Range	**MEAN**	**Group Range**	**MEAN**
TC	3.5-7.8mmol/l	5.34mmol/l	3.2-7.7mmol/l	5.03mmol/l
TG	0.8-7.8mmol/l	2.56mmol/l	0.4-8.1mmol/l	2.15mmol/l
HDL	0.7-3.1mmol/l	1.27mmol/l	0.8-3.2mmol/l	1.49mmol/l
LDL	1.4-5.9mmol/l	3.71mmol/l	1.6-5.8mmol/l	3.3mmol/l

Additionally, many studies have reported similar findings regarding serum lipid profiles in individuals with type 2 diabetes. One study conducted in India found that type 2 diabetes patients had higher levels of total cholesterol, triglycerides, and low-density lipoprotein (LDL) cholesterol, and lower levels of high-density lipoprotein (HDL) cholesterol compared to non-diabetic individuals (Kaveeshwar and Cornwall, 2014). Another study from Saudi Arabia reported similar results, with type 2 diabetes patients having significantly higher levels of total cholesterol, triglycerides, and LDL cholesterol compared to non-diabetic individuals (Al-Rubeaan et al., 2014). Similarly, a study from Nigeria found that type 2 diabetes patients had significantly higher levels of total cholesterol, triglycerides, and LDL cholesterol compared to non-diabetic individuals and lower levels of HDL cholesterol (Adegbija et al., 2014). Generally, these studies support the findings of the current study that individuals with type 2 diabetes tend to have dyslipidaemia characterized by elevated total cholesterol, triglycerides, and LDL cholesterol levels, and reduced HDL cholesterol levels.

3.3.2. Lipid profile of patients without diabetes.

provides information on the serum lipid profiles of non-diabetic patients, with separate data for males and females. The mean values for total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) are presented for each group. Several studies have reported similar findings innondiabetic populations. For example, a study conducted in India found that non-diabetic individuals had mean total cholesterol levels of 4.91 mmol/L for males and 4.87 mmol/L for females, which is slightly higher than the values in **Table 3** (Borah et al., 2018).

However, the mean triglyceride levels in the Indian study were lower than in this table, with values of 0.92 mmol/L for males and 0.98 mmol/L for females. Another study conducted in China found that non-diabetic individuals had mean total cholesterol levels of 4.30 mmol/L for males and 4.49 mmol/L for females, which are similar to the values in this table. However, the mean triglyceride levels in the Chinese study were higher than in this table, with values of 1.54 mmol/L for males and 1.26 mmol/L for females (Huang et al., 2015). Overall, the lipid profiles presented in this table for non-diabetic patients are consistent with values reported in other studies, but there is some variation across populations.

Comparison of lipid values between patients with diabetes versus patients without diabetes

When comparing the findings from both tables, we can observe some notable differences in the lipid profiles of diabetic and non-diabetic patients. Firstly, in terms of total cholesterol (TC), both diabetic males and females have higher mean levels compared to non-diabetic males and females. The mean TC levels for diabetic males and females were 5.34 mmol/l and 5.03 mmol/l respectively, while the mean TC levels for non-diabetic males and females were 4.01 mmol/l and 3.87 mmol/l, respectively. Secondly, both diabetic males and females have higher mean levels of triglycerides (TG) compared to non-diabetic males and females. The mean TG levels for diabetic males and females were 2.56 mmol/l and

Table 3: SERUM LIPID PROFILES OF NON-DIABETIC PATIENTS

Lipid profiles	**Non - Diabetic Males**		**Non - Diabetic Females**	
	Group Range	**MEAN**	**Group Range**	**MEAN**
TC	2.6-4.8mmol/l	4.01mmol/l	3.0-4.8mmol/l	3.87mmol/l
TG	0.5-3.8mmol/l	1.35mmol/l	0.6-4.4mmol/l	1.78mmol/l
HDL	0.7-2.3mmol/l	1.44mmol/l	0.9-1.8mmol/l	1.38mmol/l
LDL	1.1-3.4mmol/l	2.64mmo/l	0.8-2.8mmol/l	2.27mmol/l

2.15 mmol/l respectively, while the mean TG levels for non-diabetic males and females were 1.35 mmol/l and 1.78 mmol/l, respectively.

Thirdly, in terms of high-density lipoprotein (HDL), non-diabetic males had higher mean levels compared to diabetic males, while diabetic females had higher mean levels compared to non-diabetic females. The mean HDL levels for non-diabetic males and females were 1.44 mmol/l and 1.38 mmol/l respectively, while the mean HDL levels for diabetic males and females were 1.27 mmol/l and 1.49 mmol/l, respectively. Lastly, diabetic males had higher mean levels of low-density lipoprotein (LDL) compared to non-diabetic males, while there was no significant difference observed between diabetic and non-diabetic females. The mean LDL levels for diabetic males and non-diabetic males were 3.71 mmol/l and 2.64 mmol/l respectively, while the mean LDL levels for diabetic females and non-diabetic females were 3.3 mmol/l and 2.27 mmol/l, respectively.

Overall, these findings suggest that the lipid profile of diabetic patients differs significantly from that of non-diabetic patients. Diabetic patients tend to have higher levels of TC and TG, and lower levels of HDL, which are major risk factors for cardiovascular diseases. Therefore, diabetic patients need to undergo regular lipid profile testing and receive appropriate management to control their lipid levels and reduce the risk of cardiovascular complications.

shows the fasting glucose (FG) and glycosylated haemoglobin (HbA1c) levels of diabetic males and females. The references range for the FG and HBA1C are as follows: FG: 3.9-6.0mmol/l and HBA1C: 4.0-6.0%. The mean fasting glucose level for males was 6.52mmol/L and for females was 6.82 mmol/L.

The HbA1c level for males was 6.41% and for females was 7.62%. These findings suggest that the females had higher levels of both FG and HbA1c compared to males, indicating poorer glycaemic control in females. HbA1c levels above 6.5% are generally considered indicative of poor glycaemic control and an increased risk for diabetes-related complications. Therefore, the higher HbA1c levels in females suggest a need for more aggressive management of their diabetes to reduce their risk of complications.

The findings of elevated fasting glucose and HbA1c levels in diabetic patients in this study are consistent with previous research on the topic. For instance, a study conducted by Tsioufis et al. (2019) in Greece found that diabetic patients had significantly higher fasting glucose and HbA1c levels compared to non-diabetic individuals. Similarly, a study by Hussain et al. (2019) in Pakistan found that diabetic patients had higher fasting glucose and HbA1c levels than non-diabetic individuals. Moreover, a systematic review and meta-analysis conducted by Cavero-Redondo et al. (2017) reported that diabetic patients had higher HbA1c levels than non-diabetic individuals. The study also found that higher HbA1c levels were associated with an increased risk of cardiovascular disease and mortality in diabetic patients.

In summary, several studies support the findings of this study that diabetic patients have elevated fasting glucose and HbA1c levels compared to non-diabetic individuals. These findings high-

Table 4: Fasting glucose(FG) and glycosylated haemoglobin (hba1c) of diabetic males and females

Diabetic Patients	Group	Range	Mean
Fasting Glucose (FG)	Male	4.9-6.9mmol/l	6.52mmol/l
	Female	5.9-7.4mmol/l	6.82mmol/l
HBA1C	Male	6.0-8.6%	6.41%
	Female	6.0-8.6%	7.62%

light the importance of monitoring blood glucose levels in diabetic patients to manage their condition effectively and reduce the risk of complications. In conclusion, our study examined the lipid profile and glycaemic control of diabetic patients in KwaZulu-Natal, South Africa. Our findings suggest that diabetic patients have dyslipidaemia and poor glycaemic control, which could increase their risk of developing cardiovascular complications. Our study also found significant gender differences in lipid profiles and glycaemic control among diabetic patients.

4. DISCUSSION

The objective of this investigation was to examine the lipid profiles, fasting glucose, and glycosylated haemoglobin levels among diabetic patients in KwaZulu-Natal, South Africa. Additionally, the study aimed to compare the lipid profiles and glycaemic control of diabetic patients with those of non-diabetic individuals in the same region. These proceeding findings provide insight into the ethnic and gender distribution of diabetes prevalence in a particular region of KwaZulu Natal. The data suggests that there are differences in diabetes prevalence between different ethnic groups and genders.

The highest prevalence of diabetes is observed in the Indian ethnic group, with 23.36% of males and 22.43% of females having diabetes. This is followed by the White ethnic group with 13.08% of males and 11.94% of females having diabetes. The Coloured and African Black ethnic groups have lower prevalence rates, with Coloured females having the highest prevalence rate of 5.61%, and African Black males having the highest prevalence rate of 4.67%.

These findings may have implications for healthcare providers and policymakers in the region who are responsible for addressing the burden of diabetes. Understanding the distribution of diabetes by ethnicity and gender can help healthcare providers tailor their prevention and treatment strategies to better target the groups most affected. Additionally, policymakers can use this information to design targeted public health campaigns and allocate resources more effectively to address diabetes in the region.

Our study's findings are consistent with previous studies that have reported an association between dyslipidaemia and poor glycaemic control in diabetic patients (Shah et al., 2017; Fatima et al., 2020; Wang et al., 2020). Our study also found that diabetic women have higher HDL levels and worse glycaemic control compared to men. This gender difference has also been reported in other studies and could be attributed to differences in hormonal and metabolic factors (Morford and Mauvais-Jarvis, 2022).

A previous study in the same province of KwaZulu Natal investigating the factors associated with glycaemic control among South African adult residents of Mkhondo municipality living with diabetes mellitus found: High rates of poor glycaemic control (77.71%) were found, possibly linked to religious affiliation, fast food consumption, and dyslipidaemia. Half of the sample had very poor control (HbA1c≥9%), predominantly among younger people. Interventions should address religious practices, diet, dyslipidaemia, and be tailored for youth (Masilela et al., 2020). The results of our study have significant clinical implications for the management of diabetes in KwaZulu-Natal. Our findings suggest that healthcare providers should pay more atten-

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tion to lipid profiles and glycaemic control among diabetic patients to prevent cardiovascular complications. Additionally, our study highlights the importance of gender-specific management strategies for diabetic patients.

5. CONCLUSION

This research sought to investigate the lipid profiles, fasting glucose, and glycosylated haemoglobin of diabetic patients in KwaZulu-Natal, South Africa. The study also aimed to compare the lipid profiles and glycaemic control of diabetic patients with non-diabetic individuals in the same region. The findings of the study suggested that more females were diabetic and Indian patients were more prone to diabetes whilst female Coloureds were more prone to diabetes from this study and with significant dyslipidaemia and hyperglycaemia and apparent non-compliance to treatment as indicated by HBA1C. This, therefore, suggests that more stringent approaches need to be implemented to ensure good health. The study suggested that common lipid abnormalities during diabetes-induced dyslipidaemia are hypertriglyceridemia and elevated LDL cholesterol. Results suggested a high prevalence of dyslipidaemia, which may be playing a role in the development of cardiovascular diseases and cerebrovascular accidents among diabetic patients. Therapeutic monitoring and management for diabetic patients should therefore include routine monitoring of blood glucose to ensure glycaemic control and monitoring of the serum lipid profile to establish compliance.

6. LIMITATIONS OF THE STUDY

Our study has some limitations that should be considered when interpreting our findings. Firstly, our sample size was relatively small, and the findings may not be generalizable to the wider population of diabetic patients in KwaZulu-Natal. Secondly, our study only examined lipid profiles and glycaemic control and did not assess other cardiovascular risks factors, such as blood pressure and body mass index. Lastly, our study design was cross-sectional, and we could not establish causality between dyslipidaemia and poor glycaemic control.

7. FUTURE WORKS AND INVESTIGATIONS

Future research should address the limitations of our study by conducting larger, longitudinal studies that examine a broader range of cardiovascular risk factors. Additionally, future research should explore gender-specific management strategies for diabetic patients in KwaZulu-Natal, considering the significant gender differences observed in our study. Finally, future studies should investigate the socio-economic factors that contribute to poor diabetes management in this region. Overall, our study's findings highlight the urgent need for effective diabetes management strategies that address dyslipidaemia and poor glycaemic control among diabetic patients in KwaZulu-Natal, South Africa.

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9. LIST OF ABBREVIATIONS

HDL-High density lipoprotein
LDL- Low density lipoprotein
T2DM- Type Two Diabetes Mellitus
FG- Fasting Glucose
HBA1C- Glycosylated Haemoglobin
TC- Total Cholesterol

10. SOURCE OF FUNDING

No funding was required or provided for this investigation.

11. CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Author biography

Nokukhanya Thembane background is a board-certified Medical Laboratory Scientist with expertise in Clinical Pathology (Microbiology, Haematology, and Clinical Chemistry), and has extensive experience in medical education and community engagement in the field of Medical Laboratory Science and Medical Technology. Her passion for education and educating the next generation of Medical Laboratory Scientists as well as researchers is her contribution to the advancement of the field. Her research and supervision of research projects are directed at diagnostic medicine, pathogenesis, and epidemiology, development of alternative treatment interventions that can improve patient outcomes and advance our understanding of diseases.

Minenhle Madlala is a dedicated BHSC: MLS student at the Mangosuthu University of Technology with a strong interest in clinical pathology. As part of her fourth-year studies, she conducted research in this field and will now be responsible for monitoring diseases and treatments through analysis of bodily fluids and tissues. This role requires a high level of analytical thinking and a clear understanding of medical laboratory science procedures, skills that Minenhle possesses. Her commitment and passion for clinical pathology are evident in her research project, which has the potential to make a significant contribution to the medical field upon her graduation.