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RESEARCH ARTICLE **OPEN ACCESS**

The Health Status and Physical Activity Levels of Patients with T2DM in the Limpopo Province of South Africa

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Abstract:

Background: The prevalence of diabetes in Africa is increasing rapidly, reflecting broader global trends. In Limpopo communities, diabetes prevalence is relatively low at 3.2%, but it rises to 8.8% in urban areas. This disparity highlights an urgent need for public health interventions, particularly in urban settings where only 60% of people are aware of their condition. This signifies a substantial burden of undiagnosed diabetes, which necessitates public health action.

Aim: This study aimed to determine the health status and physical activity levels of patients with T2DM in the Elias Motsoaledi Municipality, Limpopo Province, South Africa.

Methods: A quantitative research approach was utilized, following a descriptive cross-sectional design. The current study included 202 participants in the Elias Motsoaledi Municipality, South Africa. The study targeted participants aged 18 years and older from Elias Motsoaledi Municipality. Recruitment was facilitated through local Department of Health facilities. A convenient sampling method was used to recruit participants based on Slovin's formula to obtain the sample size for the study. Descriptive statistics, including frequencies and chi-square tests, were employed to analyze the data.

Results: The results revealed that most participants suffered from additional non-communicable diseases alongside diabetes. Despite the benefits of participating in physical activities in managing diabetes, the results demonstrated that very few participants did not engage in any form of physical activity. The study identified various challenges and barriers that hinder their ability to engage in physical activities.

Conclusion: The study concluded that participants have a heavy reliance on medication among diabetic patients in the Elias Motsoaledi Municipality, with minimal emphasis on lifestyle modifications, such as diet and physical activity, for diabetes management. Therefore, there is a need for enhanced education and awareness programs that focus on comprehensive diabetes management strategies, including physical activity and nutrition, especially in resource-constrained settings like the Elias Motsoaledi Municipality.

Keywords: Diabetes management, Diabetes patients, Health awareness, Health status, Physical activity, Type II diabetes.

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1. INTRODUCTION

Diabetes mellitus, particularly type 2 diabetes (T2DM), has reached epidemic proportions globally, with an estimated 24 million cases in Africa in 2021 reported by the International Diabetes Federation, a number projected to rise to over 55 million by 2045 [1]. South Africa has the highest prevalence of diabetes in the sub-Saharan Africa region, driven by a complex interplay of socio-demographic transitions, urbanization, and the adoption of more sedentary, westernized lifestyles [1-4]. Previous studies have documented stark disparities in diabetes prevalence between urban and rural areas of South Africa. For example, a study by Motala *et al*. found a diabetes prevalence of just 3.2% in rural Limpopo communities compared to 8.8% in urban areas [5]. According to Duh *et al*. (2016) and Mokabane (2019), individuals who live in urban areas tend to eat foods that are high in calories and do not engage in physical activity compared to those who live in rural areas [6, 7].

Compounding this issue, studies have reported that a substantial proportion of diabetes cases in urban South Africa remain undiagnosed, estimated at around 25-33% in cities like Cape Town, Johannesburg, and Soweto [5, 8, 9]. The number of undiagnosed and undetected diabetic cases can develop into life-threatening health challenges, as well as complications before appropriate treatment and management can be initiated [10, 11]. According to the International Diabetes Federation (IDF) Diabetes Atlas and Dall *et al*., people around the world live with undetected diabetes, which leads to a high number of diabetes-related deaths [12, 13].

Despite this growing body of epidemiological research, there remains a paucity of studies examining the specific health status and physical activity levels of patients diagnosed with T2DM, particularly in more resource-constrained communities like the Elias Motsoaledi Municipality in Limpopo province. This knowledge gap is concerning, as physical activity and self-management are cornerstones of effective diabetes care, helping to prevent the development of debilitating microvascular and macrovascular complications [14, 15]. The present study aimed to determine the health status and physical activity levels of patients diagnosed with T2DM in the Elias Motsoaledi Municipality, Limpopo province of South Africa. Findings from this research can inform the development of tailored, community-based interventions to promote self-management, increase physical activity participation, and ultimately improve health outcomes among this high-risk population. Additionally, by shedding light on the burden of undiagnosed diabetes in this setting, the study can help guide public health efforts to strengthen diabetes screening and early detection.

Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia, which is commonly known as high blood sugar levels, and it results from defects in insulin secretion, insulin action, or both [16]. It leads to chronic hyperglycemia resulting from impairments in insulin production and utilization that disrupt carbohydrate, lipid, and protein metabolism [17, 18]. There are two main types of DM: type 1 diabetes mellitus (T1DM) results from autoimmune destruction of insulin-producing pancreatic beta cells, while type 2 diabetes mellitus (T2DM) is characterized by insulin resistance combined with relative insulin deficiency [19]. In both types of diabetes, the end result is hyperglycemia, which, over time, leads to serious damage to tissues and organs, especially the eyes, kidneys, nerves, heart, and blood vessels. Chronic hyperglycemia can cause both short and long-term complications if blood glucose levels are not well controlled [20].

The American Diabetes Association defines T2DM as a heterogeneous disease characterized by some degree of insulin resistance, insulin hypo-secretion, and increased hepatic glucose production [21]. According to the International Diabetes Federation, T2DM is a progressive condition in which the body becomes resistant to the normal effects of insulin and/or gradually loses the capacity to produce enough insulin in the pancreas [22]. In type 2 diabetes, the body either resists the effects of insulin or does not produce enough insulin to maintain normal glucose levels [23]. Type 2 DM represents 90-95% of diabetes cases and is increasing globally in conjunction with rising obesity rates and sedentary lifestyles [24]. According to the International Diabetes Federation, Type 2 Diabetes Mellitus (T2DM) has reached epidemic proportions globally, with over 460 million people living with T2DM worldwide in 2019, a number expected to increase to 700 million by 2045 [12, 25]. The majority of T2DM cases are attributed to obesity, poor diet, physical inactivity, and genetic factors [26].

The prevalence of diabetes in Africa is increasing rapidly, with an estimated 24 million cases in 2021 in Africa, as reported by the International Diabetes Federation, which is projected to rise to 55 million cases by 2045 [27]. According to the International Diabetes Federation (2021), South Africa has the highest prevalence of diabetes in the Sub-Saharan Africa region [28]. A study conducted by Motala *et al*. reported lower rates of diabetes prevalence, *i.e*., 3.2%, in rural Limpopo communities and a prevalence of 8.8% in urban areas [5]. Urban residents tend to have less healthy diets dominated by processed foods that are high in sugar and fat compared to their rural counterparts [29]. Urban adults and youth have higher rates of overweight or obesity compared to rural residents, which is a major risk factor for type 2 diabetes [30].

Multiple urban screening studies consistently demonstrated that around 25-33% of South African adults tested in cities like Cape Town, Johannesburg, and Soweto have undiagnosed diabetes [31-33]. There are racial and ethnic disparities, with higher rates of diabetes cases among those of South Asian, mixed ancestry, and urban Black African descent [34]. Only around 60% of people with diabetes are aware of their condition [35]. This signifies a substantial burden of undetected diabetes in urban populations that requires public health action. Socio-demographic transitions, urbanization, and adoption

of Westernized lifestyles have been reported as factors likely contributing to increasing diabetes prevalence in Limpopo [5]. Urbanization promotes reduced physical activity as more people use motorized transportation instead of walking or cycling, have more sedentary occupations, and are exposed to more passive entertainment options [36]. Urban areas are known to provide greater access to cheap, energy-dense processed foods and fast foods, and these lifestyle changes driven by urbanization result in increased rates of obesity and overweight [37, 38]. Obesity is a major risk factor for T2DM, with 80% of cases attributable to excess weight [38].

Diabetes poses an escalating public health challenge in Africa, with undiagnosed cases and complications still very common [39]. Diabetes requires comprehensive medical care and ongoing patient self-management education and support to prevent or delay complications through achieving optimal glucose control [38, 39]. Effective interventions to improve prevention, screening, and disease management are urgently needed [38]. The need for alternative healthcare systems became a reality during the COVID-19 pandemic, wherein various methods for managing the health and well-being of patients were explored [40]. The apparent need to manage the health and well-being of people is necessitated by the burden of diseases across the African continent. Therefore, this study aimed to determine the health status and physical activity levels of patients with T2DM in the Elias Motsoaledi Municipality, Limpopo Province, South Africa.

2. METHODOLOGY

2.1. Research Design

A quantitative research approach was used following a descriptive cross-sectional design. A survey was used to obtain the relevant information from all participants. The objectives of this study were to investigate the association between gender, health status, and physical activity levels of T2DM patients. According to Creswell, survey studies help researchers generalize their findings from a sample to a population so that inferences can be made about their characteristics, attitudes, or behavior within a specific population [41].

2.2. Study Setting

The study was conducted in Elias Motsoaledi Municipality and the local health facilities in Limpopo Province, South Africa. The Elias Motsoaledi Local Municipality (previously called the Greater Groblersdal Local Municipality) is located in the Sekhukhune District of the Limpopo Province. According to Statistics South Africa, Limpopo is the second-poorest province in South Africa [42]. Over 57% of the population comprises people who speak Northern Sotho, also known as Sepedi [43-45].

2.3. Population Size and Sampling

The study focused on participants from Elias Motsoaledi Municipality, South Africa, who were capable of independently understanding information to avoid coercion. Participants were identified and recruited in liaison with the managers and staff of the Department of Health facilities in the Elias Motsoaledi Municipality. Eligible participants for this study were individuals aged 18 years and older. A convenient sampling method was used to recruit participants for the study. The sample size was calculated using Slovin's formula ($n=N\div (1+Ne^2)$ [29]) [45]. With 410 patients diagnosed with T2DM recorded in the health facilities database from 2020 to date, Slovin's formula determined that 202 patients were recruited for this study.

2.4. Inclusion and Exclusion Criteria

The study exclusively involved patients diagnosed with T2DM. Participants were required to understand and speak either Sepedi or English to minimize misinterpretation during translation. Only those aged 18 years and older were invited and recruited for participation.

2.5. Data Collection

Data were collected through a survey questionnaire with a key focus on each section. The research instrument was comprised of questionnaires from multiple authors. ACSM and Manaf collected the data in this study [46, 47]. This part of the survey research instrument included the following subsections:

Section A: Demographic information

Section B: Health status

Section C: Physical activity levels.

To gather information for the second sub-objective, the researcher adopted the ACSM health status survey, which seeks to determine the medical profiles of patients with T2DM in Limpopo province. The research instrument included health screening, medical history, family history, medication, lifestyle, and other health history information [46]. To gather information on the physical activity levels as well as health and fitness goals, a questionnaire developed by Manaf was used [47].

2.6. Validity and Reliability

To promote the quality and validity of this study, reliability and validity measures were followed. Reliability refers to the consistent scores from a research instrument. To ensure validity, the researcher administered the research instrument as a pilot test [48]. Validity is defined as the accumulation of evidence to confirm that the interpretation of test scores concerning a concept or construct aligns with its intended use [48]. The questionnaires used in this study were validated by previous research. Therefore, a Cronbach's alpha test was used to check the reliability of the research instrument [48]. The survey's section on health status reported a Cronbach's alpha score of 0.769, which means a good score, and the physical activity levels reported a Cronbach's alpha score of 0.874, which also means a good score.

2.7. Pilot Study

For the pilot study, 20 participants with the same eligibility as the official participants but not part of the study were recruited through purposive sampling. A test-retest approach was used to check the reliability of the research instrument. According to Creswell, reliability is when the answers from the instrument are consistent and stable [48]. This was used to check if the question content matches the study's objective, which aids validity [48].

2.8. Statistical Analysis of Data

Descriptive statistics, which included frequencies and a chi-square, were used, utilizing IBM SPSS statistics 2024 (SPSS Inc., Chicago, IL, USA), with alpha set at the $p< 0.05$ level [48]. The statistics were used to report the frequencies of health status and physical activity levels of participants in this study. Additionally, a chi-square analysis was carried out to investigate the association between gender, health status, and physical activity levels of participants.

2.9. Ethics

The study received ethics approval from the University of the Western Cape's Biomedical Research Ethics Committee (Reference BM22/6/41). The study conformed to the Helsinki Declaration of 1975. All participants provided written consent to participate in the study. Consent was obtained from participants before data collection. The researchers explained the study details to the participants, clarified any questions, and provided an information letter before administering the questionnaire. Participants were informed that their participation was voluntary and that they could withdraw at any point during the data collection process without any prejudice. The study followed the guidelines of the Protection of Personal Information Act 4 of 2013 of South Africa (POPIA) for handling personal information.

3. RESULTS

The current study was conducted in three phases: the first section reports the demographic information of participants, the second section reports the health status of patients, and the third section reports the physical activity levels of patients with T2DM. The current study lays a descriptive foundation for the participants as part of a bigger study project.

In this study, both genders were included (Table **1**). Female participants represented a majority in this current study. Furthermore, the age categories of 56-65 years and 66 and older were the majority of participants in this study. The minority of these participants fell within the age category of 18-25 years old.

Table **2** indicates that a majority of participants responded no to having a major health issue associated with them. The majority of the participants were females who reported no health issues. The results in this table show no association between health issues and gender.

Table 1. Demographic characteristics of participants.

Characteristics	n	%
Gender		
Male	79	39.1
Female	123	60.9
Age		
18 – 25 years	2	1.0
26 – 35 years	13	6.4
36 – 45 years	33	16.3
46 – 55 years	38	18.8
56- 65 years	60	29.7
66 and older	56	27.7

Table 2. Health status of participants.

Characteristics	M		F		Chi-square
	No	Yes	No	Yes	
Do you have any personal history of heart disease (coronary/atherosclerotic disease)?	n =79	n =0	n =121	n =2	1.297
Any personal history of diabetes or other metabolic disease (thyroid, renal/liver)?	n =1	n =78	n =10	n =113	4.402
Any history of pulmonary disease, asthma, interstitial lung disease, or cystic fibrosis?	n =77	n =2	n =119	n =4	0.087
Have you experienced pain or discomfort in your chest due to blood flow deficiency?	n =79	-	n =123	-	-
Any unaccustomed shortness of breath during light exercise?	n =67	n =12	n =83	n =40	7.558
Have you had any problems with dizziness or fainting?	n =79	n =0	n =111	n =12	8.194
Do you have difficulty breathing while standing or sudden breathing problems at night?	n =77	n =2	n =123	n =0	3.145
Have you experienced a rapid throbbing or fluttering of the heart?	n =79	-	n =123	-	-
Do you suffer from ankle edema (swelling of the ankle)?	n =77	n =2	n =123	n =0	3.145

(Table 2) contd.....

Characteristics	M		F		Chi-square
	No	Yes	No	Yes	
Have you experienced severe pain in the leg muscle during walking?	n =63	n =16	n =81	n =42	4.536
Do you have a heart murmur?	n =79	-	n =123	-	-
Has your serum cholesterol been measured at a greater > than 200 mg/dl?	n =58	n =21	n =56	n =67	15.218
Are you a cigarette smoker?	n =31	n =48	n =114	n =9	67.829
Has your HDL (the good cholesterol) been measured at greater > than 60 mg/dl?	n =3	n =76	n =26	n =97	11.765
Have you had a high fasting blood glucose level of > 110 mg/dl on 2 or more occasions?	n =0	n =79	n =2	n =121	1.297
Are you 20% or more overweight, or have you been told your “BMI” was greater > than 30?	n =15	n =64	n =31	92	1.057
Have you been assessed for hypertension on at least 2 occasions (systolic 140 mmHg/ diastolic 90 mmHg)?	n =18	n =61	n =31	n =92	0.153
Do you have any family history of cardiac or pulmonary disease prior to age 55?	n =24	n =55	n =78	n =45	21.000
Are you currently being treated for high blood pressure?	n =11	n =68	n =41	n =82	9.480
Has the doctor imposed any activity restrictions?	n =79	n =0	n =122	n =1	0.645
Has a doctor diagnosed you with a heart condition and recommended exercise under supervision?	n =77	n =2	n =123	n =0	5.686
In the past month, have you experienced pain in the chest when you were active/inactive?	n =71	n =8	n =121	n =2	7.387
Do you have breathing difficulties when you are physically active?	n =74	n =5	n =119	n =4	1.070
Have you ever fallen down because of dizziness?	n =77	n =2	n =121	n =2	0.203
Do you have bone/joint problems that could be exacerbated by participating in physical activities?	n =65	n =14	n =84	n =39	4.862
Has a doctor ever diagnosed you with a heart/breathing illness?	n =79	-	n =123	-	-
Are you currently pregnant?	n =79	-	n =123	-	-
Do you know of any other reason why you cannot do physical activity?	n =77	n =2	n =121	n =2	0.203

Table 3. Conditions of participants.

Characteristics	M					F					Chi-square
	Asthma	Arthritis	Musculoskeletal problems	Persistent fatigue	None	Asthma	Arthritis	Musculoskeletal problems	Persistent fatigue	None	
Conditions you are diagnosed for	n =2	n =5	n =0	n =3	n =69	n =0	n =23	n =3	n =0	n =97	15.443

Table 4. Family history of participants.

Characteristics	M			F			Chi-square
	Diabetes	Combination of 2 diseases	Combination of 2 diseases	Diabetes	Combination of 2 diseases	Combination of 2 diseases	
Family history	n =12	n =66	n =1	n =35	n =81	n =7	8.085

Table 5. Medication used by participants.

Characteristics	M			F			Chi-square
	Insulin	Combination of 2 medicines	Combination of 3 or more medicines	Insulin	Combination of 2 medicines	Combination of 3 or more medicines	
Medication used	n =12	n =65	n =2	n =38	n =84	n =1	7.025

Table 6. Hereditary illnesses.

Characteristics	M					F					Chi-square
	High blood pressure	Type I diabetes	T2DM	Hemophilia	Combination of 2 diseases	High blood pressure	Type I diabetes	T2DM	Hemophilia	Combination of 2 diseases	
Do you have a hereditary illness?	n =46	n =0	n =33	n =0	n =0	n =39	n =6	n =75	n =2	n =1	17.139

Table 3 indicates that the majority of participants, both male and female participants in this study, were not diagnosed with any health conditions. However, arthritis was noted amongst the participants as a minority condition. There was no association between the conditions and gender in this study.

Table 4 shows that the majority of participants (male and female) in this study had a family history of a combination of two diseases. The minority of participants had a family history of three or more combination diseases. There was no association between family history and gender in this study.

Table 5 reports that the majority of participants (male and female) in this study used a combination of two medications for their conditions. Furthermore, only a minority of participants used a combination of three or more medications for their conditions. There was no association between the conditions and gender in this study.

Table 6 shows that the majority of participants in this study reported that they have T2DM as a hereditary illness. A minority of the participants reported having a combination of two diseases. Furthermore, there was no association between hereditary illness and gender.

The majority of participants (female) reported that they are neither habitual to alcohol nor drugs, as mentioned in Table 7. Only a minority (male) of the participants reported being habitual to only drugs. There was no association between alcohol and drugs, as well as gender, in this study.

The majority of participants (female) reported that they never had trouble taking medication as per the instructions (Table 8). Only a minority of the participants (male) sometimes had trouble taking medication as per the instructions.

Most of the male participants did not receive any medication, while female participants were prescribed four different medications in the past 24, as mentioned in Table 9. A minority of participants (male and female) in this study were prescribed only one prescription of their medication by a doctor.

Table 10 shows that the majority of participants (female) reported that they took their medication in the last 24 hours without help. Only a minority were unable to take their medication in the last 24 hours.

Table 7. Habitual characteristics of the participants.

Characteristics	M				F				Chi-square
	Yes, to both	Only to alcohol	Only to drugs	Neither	Yes, to both	Only to alcohol	Only to drugs	Neither	
Are you habitual to alcohol and drugs?	n =51	n =11	n =0	n =17	n =5	n =22	n =4	n =92	91.831

Table 8. Trouble taking medication.

Characteristics	M			F			Chi-square
	Seldom	Sometimes	Never	Seldom	Sometimes	Never	
How often do you have trouble taking medication the way you were instructed?	n =52	n =13	n =14	n =12	n =41	n =70	70.618

Table 9. Prescribed medication.

Characteristics	M					F					Chi square
	One	Two	Three	Four	None	One	Two	Three	Four	None	
How many medications have been prescribed by your doctor that you have taken in the last 24 hours?	n =2	n =5	n =7	n =14	n =51	n =6	n =9	n =15	n =46	n =49	12.851

Table 10. Medication intake of the participants.

Characteristics	M				F				Chi-square
	Without help	With some help	Completely unable to take it	Other	Without help	With some help	Completely unable to take it	Other	
In the last 24 hours, how did you take your medicine?	n =33	n =45	n =1	n =0	n =75	n =37	n =5	n =6	17.003

The majority of participants in this study (male and female) stated that they were severely physically impaired, as reported in Table **11**. Only a minority of participants reported being in good physical health.

Table **12** shows that the majority of participants (male and female) stated that they do not engage in physical activities. Only a minority reported engaging in physical activities, such as yoga or stretching, which includes cardio and strength exercises.

The majority of participants (male and female) stated that they did not participate, nor did they engage in any physical activity, as reported in Table **13**. Only a minority of participants (male) engaged in physical activities five days a week.

Table **14** reports that the majority of participants (male and female) engaged in physical activities for 10-15 minutes on average. Only a minority of participants reported being engaged in physical activities for an average of 20-60 minutes.

Table **15** shows that the majority of participants reported that they are somewhat and very likely to encounter a challenge or barrier when they participate in physical activity. The results indicated that participants are far unlikely to be barrier-free when they engage in physical activities.

Table 11. Overall health.

Characteristics	M				F				Chi-square
	In good physical health	Mildly physically impaired	Moderately physically impaired	Severely physically impaired	In good physical health	Mildly physically impaired	Moderately physically impaired	Severely physically impaired	
How would you evaluate your overall health?	n =0	n =2	n =15	n =62	n =6	n =7	n =36	n =74	9.343

Table 12. Physical activity levels of participants.

Characteristics	M		F		Chi-square
	No	Yes	No	Yes	
I rarely do any physical activity	n =1	n =78	n =20	n =103	16.450
I do light/moderate physical activity, but not every day	n =79	n =3	n =95	n =28	13.320
I do light physical activity every day	n =78	n =1	n =104	n =19	10.845
I do physical activity to improve muscle strength, such as lifting weights	n =78	n =1	n =120	n =3	0.341
I do flexibility exercises only, such as stretching and yoga	n =79	n =0	n =120	n =3	1.956
I do cardio exercises only, such as running/walking	n =78	n =1	n =112	n =11	5.074
I do both cardio and strength exercises	n =78	n =1	n =120	n =3	0.341

Table 13. Physical activity engagement of participants.

Characteristics	M						F						Chi-square
	0 day	1 day	2 days	3 days	4 days	+5 days	0 day	1 day	2 days	3 days	4 days	+5 days	
Over the last 7 days, did you engage in moderate/strenuous physical activities?	n =71	n =3	n =1	n =4	n =0	n =0	n =99	n =10	n =2	n =8	n =3	n =1	4.686
Days per week of moderate to strenuous activities	n =72	n =2	n =1	n =0	n =1	n =3	n =106	n =4	n =4	n =4	n =0	n =5	5.120

Table 14. Average minutes of exercise.

Characteristics	M			F			Chi-square
	10-15 minutes	20-30 minutes	45-60 minutes	10-15 minutes	20-30 minutes	45-60 minutes	
On average, how many minutes of exercise do you complete?	n =71	n =4	n =4	n =101	n =11	n =11	2.290

Table 15. Challenges of engaging in physical activities.

Characteristics	M				F				Chi-square
	Very unlikely	Somewhat unlikely	Somewhat likely	Very likely	Very unlikely	Somewhat unlikely	Somewhat likely	Very likely	
None of my family members or friends like to do physical activities, so I don't have a chance to exercise	n =0	n =0	n =0	n =79	n =0	n =1	n =13	n =109	9.661
I'm too tired after work to get any exercise	n =0	n =3	n =7	n =69	n =4	n =9	n =29	n =81	12.409
I've been thinking about getting more exercise, but I just can't seem to get started	n =7	n =13	n =8	n =51	n =33	n =12	n =20	n =58	13.593
I'm getting older, so exercise can be risky	n =1	n =1	n =22	n =55	n =14	n =29	n =38	n =42	35.510
I don't get enough exercise because I never learned the skills for any sport	n =0	n =8	n =10	n =61	n =12	n =13	n =37	n =61	20.069
I don't have access to jogging trails, swimming pools, bike paths, *etc*.	n =50	n =19	n =8	n =2	n =36	n =53	n =24	n =10	23.184
Physical activity takes too much time away from other commitments, *e.g.*, time, work, family, *etc*.	n =0	n =4	n =62	n =13	n =10	n =22	n =25	n =66	67.366
I'm embarrassed about how I will look when I exercise with others	n =16	n =5	n =54	n =4	n =58	n =43	n =12	n =10	77.303
I don't get enough sleep as it is. I just couldn't get up early or stay up late to get some exercise	n =16	n =12	n =44	n =7	n =50	n =26	n =20	n =27	35.540
It's easier for me to find excuses not to exercise than to do something	n =5	n =2	n =57	n =15	n =15	n =11	n =50	n =47	19.548
I know of too many people who hurt themselves by overdoing it with exercise	n =29	n =50	n =0	n =0	n =92	n =17	n =7	n =7	56.135
I really can't see learning a new sport at my age	n =18	n =6	n =41	n =14	n =55	n =18	n =7	n =43	56.697
It's just too expensive. You have to take a class, join a club, or buy the right equipment	n =59	n =17	n =2	n =1	n =62	n =34	n =20	n =7	16.150
My free time during the day is too short to include exercise	n =2	n =12	n =6	n =59	n =10	n =14	n =26	n =73	10.380
My usual social activities with family/friends do not include physical activity	n =0	n =0	n =5	n =74	n =7	n =4	n =13	n =99	9.012
I'm too tired during the week, and I need the weekend to catch up on my rest	n =2	n =2	n =7	n =68	n =6	n =14	n =18	n =85	8.550
I want to get more exercise, but I just can't seem to make myself stick to anything	n =0	n =8	n =58	n =13	n =15	n =16	n =31	n =61	49.770
I'm afraid I might injure myself/have a heart attack	n =12	n =53	n =10	n =4	n =44	n =24	n =28	n =27	47.467
I'm not good enough at any physical activity to make it fun	n =1	n =4	n =4	n =70	n =10	n =2	n =33	n =78	22.685
If we had exercise facilities and showers at work, then I would be more likely to exercise	n =0	n =4	n =9	n =66	n =0	n =0	n =59	n =64	32.766

4. DISCUSSION

The current study used a quantitative descriptive cross-sectional design. The aim of this study was to determine the health status and physical activity levels of patients with T2DM in the Elias Motsoaledi Municipality, Limpopo Province, South Africa. The objectives of this study were to investigate the association between gender, health status, and physical activity levels of T2DM patients. Both genders were included in this study. Females were the majority of participants aged 18 years and older in this study. According to South African national statistics, females constitute a larger proportion of the population, possibly explaining the majority representation in this study [49, 50].

The results of this study reported that participants had health issues that ranged from diabetes to additional

forms of non-communicable diseases. This has dire consequences, as reported in the results, wherein the overall health of the participants was severely physically impaired. This was aligned with a report by the World Health Organization, which indicated a staggering 422 million adults since 1980, and the number is on an upward trajectory, expecting to reach 693 million adults by 2045 [44]. Additionally, Nowakowska *et al*. reported that diabetes affects one in eleven adults aged 20 to 79 years old [51]. The results of this study are concerning, as diabetes is considered a world-leading cause of death, with an estimated 1.6 million reported cases [44]. Studies by Mayosi *et al*. and Muthuri *et al*. reported that non-communicable diseases, such as diabetes, are highly prevalent and linked to physical inactivity [52, 53]. Brazil introduced a National Health System to promote universal access and coverage of healthcare services [54]. This type of approach can be beneficial to South African society, which provides citizens with free services that range from inpatient care, maternity care, mental health services, preventative services, primary care, outpatient care, pharmaceuticals, dental care, vision care, and physical therapy [54]. A well-run health system, such as the one from Brazil, can complement health educational forums that promote physical activity programs to combat increasing sedentary lifestyles. The cases can be reduced, and diabetes can be managed through recognized interventions, which include physical activities.

Despite the overwhelming benefits of participating in physical activities, the results of this study reported that participants did not engage in any form of activity. This lack of physical activity was concerning as they would not be able to reverse or manage their health conditions. According to Kanaley *et al*., aerobic exercise training can improve insulin sensitivity in adults with T2DM for up to 2-72 hours [55]. The benefits of engaging in physical activities include both short- and long-term outcomes and can help reduce the death rates associated with T2DM [55]. Mlangeni *et al*. reported that despite the known benefits of physical activity, the prevalence of physical inactivity is significantly higher [56]. Unfortunately, participants in the current study did not experience both short- and long-term benefits associated with physical activity and exercise.

The results of this study demonstrated various challenges and barriers that hinder their ability to engage in physical activities. Based on the results, participants in this study did not have a challenge- and barrier-free environment to become fully engaged in physical activities. The challenges reported in this study can be regarded as a lack of effort and interest from the participants. The challenges can be overpowered if and when participants become aware of the consequences of T2DM. Therefore, it seems relevant to consider self-management and education about T2DM. Frantz and Rhoda indicated that self-management incorporates essential skills that integrate behavior modeling, decision-making, planning, social persuasions, locating, accessing, and using resources to help people forge collaboration between themselves and healthcare professionals in overcoming a health issue [57]. Self-management becomes important, particularly in the current study, to help participants take the initiative in managing their T2DM.

Therefore, it can be concluded that there is a lack of awareness, accountability, and understanding about engaging in physical activity in T2DM. The inability of the participants in this study to engage in physical activities has dire consequences, particularly in relation to managing T2DM. Diabetes is considered an expensive disease to manage, even more so when considering the medical costs [58]. Therefore, promoting physical activities and exercise could help to reduce the cost implications for participants in the current study. Therefore, the results of this study can be generalized in the context of physical activity and the health status of people living with diabetes.

4.1. Implications and Recommendations

The current study lays a good foundation for determining health issues and physical activity levels of people diagnosed with T2DM in Limpopo province. The results of this study have valuable and meaningful implications for the healthcare sectors in Limpopo Province and the residents in the area. The healthcare sector should promote its health campaigns and make them more meaningful and specifically directed toward people with T2DM. This will raise more awareness and practical perceptions relating to the importance of physical activity, particularly for people with T2DM. It is, therefore, recommended that people with T2DM embrace self-management so they can manage T2DM. Furthermore, interventions related to physical activity need to be promoted, particularly in areas similar to Elias Motsoaledi municipality in Limpopo province.

CONCLUSION

The present study concludes that collaborative efforts between health professionals and people diagnosed with diabetes must be encouraged to make sure all affected parties and stakeholders are included in all awareness campaigns. More interventions aimed at the target population are encouraged to ensure that the relevant people receive information and necessary support.

AUTHORS' CONTRIBUTION

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to its submission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

LIST OF ABBREVIATIONS

T2DM	=	Type 2 Diabetes Mellitus
IDF	=	International Diabetes Federation
AI	=	Artificial Intelligence

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study received ethics approval from the University of the Western Cape's Biomedical Research Ethics Committee, South Africa (Reference BM22/6/41).

HUMAN AND ANIMAL RIGHTS

All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

All participants provided written consent to participate in the study.

STANDARDS OF REPORTING

STROBE and SAGER guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data from manuscript is available on resonable request to corresponding author [M.M.].

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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