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Knowledge, attitude and practice of physical activity among diabetic patients in Kilimanjaro region, northern Tanzania: a descriptive cross-sectional study

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ABSTRACT

Introduction: To assess the knowledge, attitude and practices of physical activity among diabetic patients in Kilimanjaro region, Northern Tanzania

Design: Cross-sectional study design.

Setting: Two diabetic clinics in the Kilimanjaro region, northern Tanzania

Participants: 315 diabetic patients who were ≥18 years of age attending the diabetic clinic.

Methods: A systematic random sampling technique was used to select study participants who were interviewed using a modified version of the WHO Steps Survey for non-communicable diseases. Data were analyzed using SPSS version 20. Categorical variables were summarized using frequencies and percentages, and continuous variables using means and standard deviations. The Chi-square test was used to compare the proportion of PA across participant characteristics.

Results: The vast majority (94.3%) of the participants were physically active, mostly contributed by work and transport-related activities. Participants had high levels of knowledge (98.4%) and positive attitudes (95.6%) towards PA. These were mainly contributed by health care provider or doctors' advice on the benefits of PA to diabetic patients. There was a strong statistical association ($p<0.001$) between good knowledge and attitude towards PA with PA practice.

Conclusion: The vast majority of the participants were physically active. High levels of PA were associated with a high level of knowledge and positive attitudes towards PA. Health care provider or doctors' advice during diabetic clinics is essential in promoting PA practice in this population as well as diabetes management.

Keywords: Knowledge; Attitude; Practice; Physical activity; Tanzania

Strength and limitations of this study

- Self-reported measures could have overestimated the respondents' physical activity levels.
- MET values of some activities, which involve high breathing, have not been derived from actual oxygen consumption, hence increasing the risk of overestimation.
- Some individuals might have incorrectly reported the information collected in minutes of physical activity due to the inherent difficulty of recalling the number of minutes spent in one week doing any particular activity.
- Being an institutional based study, desirability bias could have occurred.

BACKGROUND

Diabetes is a serious chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces[1] The number of people with diabetes is steadily rising, with the World Health Organization (WHO) estimating 422 million adults with diabetes worldwide in 2014 compared to 108 million in 1980 [1]. The greatest rise is in low- and middle-income countries. Without interventions to halt this increase, there will be at least 629 million people living with diabetes by 2045 [2]). Tanzania is not an exception to the ever-increasing prevalence of diabetes. A 2012 Tanzanian national survey estimated diabetes prevalence at 9.1% among adults aged 25–64 years, a significant increase of 4% compared to a study conducted in two regions of Tanzania which showed a prevalence of 5% among adults aged >15 years [3,4]. Also, the International Diabetic Federation (IDF) showed that there was a total of 897,000 cases of diabetes in adults aged 20-79 years in 2017, with a prevalence of 3.6% in Tanzania [5].

Weight control is key to the control of diabetes and the prevention of related negative consequences. Regular and adequate levels of physical activity (PA) in adults reduce the risk of hypertension, coronary heart disease, stroke, diabetes, breast and colon cancer, depression and the risk of falls, improve bone and functional health [6]. PA is also a key determinant of energy expenditure, and thus fundamental to energy balance and body weight control [7]. Several studies have shown that PA is protective against developing diabetes and related complications such as diabetic neuropathy, retinopathy, CVD, mortality, stroke, hypertension, cancers (colon, breast) and depression and enhances skeletal muscle mass, drop in blood glucose, for weight loss and regulation of blood pressure.[8–11]

PA is also crucial among diabetic patients because it has been associated with improvement in genomic stability, reduction in mortality rate and effective in lowering the susceptibility to oxidative DNA damage and the lipid peroxidation levels [12–14]. Yet, the practice of PA is still low among diabetic patients in different countries across the globe. For instance, the prevalence in North America ranged from 32.8% in the United States of America to 39.5% in Canada [15]. In Asian countries, it ranged from 10% in Kuwait to 28% in Nepal [16–18] while in Africa, it ranged from 27.4% in Nigeria to 81% in Senegal [9,19–21]. It is reported that the high prevalence of physical activity in Senegal has been highly motivated by doctor's advice on PA. The practice of PA in East African countries is between 31.4% in Rwanda to 41% in Kenya [21,22] compared to 33% in Tanzania [23]. These findings indicate significant variations in the practice of PA among diabetic patients between and within countries.

Sufficient knowledge and a good attitude towards physical activities are crucial for diabetes management. Limited knowledge of the duration and type of physical activity has been associated with poor adherence to physical activity among diabetic patients [20,24,25] Also, negative attitude towards physical activity such as PA has no much advantage in managing diabetes, is associated to poor adherence to PA among diabetic patients [19,26].

In Tanzania, studies have shown that sufficient knowledge on physical activity in diabetes management is very minimal [27], which contributes to the high rate of physical inactivity among diabetic patients in the country [3,23]. Thus, this study will determine knowledge, attitude, and practice of physical activity among diabetic patients in the Kilimanjaro region.

METHODS

Study design and setting

We carried out a cross-sectional study from August to September 2020 among diabetic patients attending two diabetic clinics in the Kilimanjaro region, northern Tanzania. Kilimanjaro region has seven administrative districts, 20 hospitals, 41 health centres and 335 dispensaries. The health facilities are owned by either the government, religious or private sectors. There are five diabetic clinics in the region, namely KCMC referral hospital, Mawenzi regional hospital, Kilema, Rombo, and Kibosho district hospitals. Data collection was conducted in the KCMC referral hospital and Mawenzi regional hospital due to the high-volume of diabetic patients relative to other facilities in the region.

Study population, sample size and sampling

The study population were diabetic patients aged 18 years and above attending diabetic clinics in the Kilimanjaro region. We used a single proportion formula to estimate the minimum required sample size given as $[N=(Z_{a/2})^2 \times p(1-p)/e^2]$. Where *N* is the minimum required sample size, *p* is the estimated prevalence of PA among diabetic patients (27.5%) based on a study conducted in Nigeria [19]. Furthermore, *e* is the margin of error or precision (5%), and Z is the standard normal value (1.96) corresponding to a 95% confidence interval. After adding a 15% proportion of non-response, the estimated sample size was 353. A systematic random sampling technique was used to select study participants until the desired number was reached.

Data collection methods and procedures

Trained doctor of medicine students at the Kilimanjaro Christian Medical University College (KCMUCo) collected data using a modified version of the WHO-STEPS questionnaire for non-communicable diseases [28]. The questionnaire was designed in English language then translated and administered in Swahili (local) language. It contained information on behavioral characteristics (smoking, alcohol intake, and diet), PA practices, history of raised blood pressure, history of raised cholesterol, and physical measurements like blood pressure, weight and height. The tool was modified to include questions on knowledge and attitudes towards PA.

Participants were provided with clear information about the study purpose, benefits for participation, anticipated harm, and what was expected of their involvement. After addressing all participant questions, informed consent was administered. Those who refused to participate

continued with routine care. All consenting participants were interviewed in a quiet and secure room or place within the clinic to ensure confidentiality. Interviews took approximately 20-30 minutes to complete. Immediately after data collection, the researchers assessed the patterns and completeness of the collected data.

Study variables

The variables in this study were knowledge, attitude, and PA practices. Knowledge of PA was assessed using 12 yes/no items [29] It was scored by summing the scores of all items of the domain with a higher score (≥75%) indicating good PA knowledge.

The attitude towards PA was measured using 10-items on a 3-point scale, i.e., disagree, neutral, and agree [29]. Items 1 to 3, 9, and 10 were, reverse-coded because of the negative meanings of the items. Then, attitudes on PA was scored by summing all the scores of all items with a higher score (≥75%), suggesting a favorable attitude toward PA.

The PA questions were adapted from the WHO Global Physical Activity Questionnaire [30]. The PA practice questions were divided into three sections: work-related PA, transport-related PA (related to walking or cycling), and leisure-related PA. Time spent on all PA types was summed to obtain the time spent per week doing each PA type. Frequency, duration, and intensity for each type of PA were coded into metabolic equivalent tables (METs). One MET is defined as the energy expenditure while sitting quietly for one hour, which for the average adult is approximately 3.5 ml of oxygen/kg body weight/min with MET values obtained from the Compendium of PA [31]

Vigorous-intensity work-related PA was assigned a value of 8.0METs while moderate-intensity work-related PA was assigned a value of 4.0METs. Transport-related PA was assigned a value of 4.0METs. Vigorous-intensity leisure-related PA was assigned a value of 8.0METs, and moderate-intensity leisure-related PA was assigned a value of 4.0METs (WHO, 2020c). The total METs per week for all PA was calculated by multiplying the duration (minutes) of activity per week by its corresponding METs and summed for each type of PA. Sufficient METS was defined as ≥600 METS per week [30]

Other study variables included age (<40, 40-59, 60+), sex (male, female), marital status (married, not married), education level (primary, secondary, tertiary), employment status (employed, self-employed, unemployed), BMI (normal weight, overweight, obese) and behavioral characteristics such as smoking, alcohol consumption and diet

Data analysis

We performed data cleaning and analysis using SPSS version 20 software. Categorical variables were summarized using frequencies and percentages, and continuous variables using means and standard deviations. The Chi-square test was used to compare the proportion of PA across participant characteristics, and a p-value of <0.05 was considered statistically significant association.

Patient and public involvement.

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Participants background characteristics

A total of 353 diabetic patients met the inclusion criteria and were invited to participate in the study. Of these, 315 consented to participate in making a response rate of 89% since the rest (11%) were not comfortable to complete the questionnaire. The mean age of 315 respondents was 58.62 ± 10.8 years, and almost half (47.3%) were >60 years. Females accounted for 58.4% of all study participants, 54% had primary education level, and three-quarters (75.6%) were married. Only 3% were current smokers, and 54.9% ever consumed alcohol. Of those who ever consumed alcohol (n=173), a quarter (24.9%) consumed in the past year, and 73.4% stopped drinking due to health reasons. About 20% of all add salt when eating, 35.6% when cooking (Table **1**).

Table 1: Participants background characteristics (N=315)

Variable	Frequency	Percentage
Age in years		
<40	20	6.3
40-59	146	46.3
60+	149	47.3
Mean (SD)	58.6 (10.8)	
Sex		
Male	131	41.6
Female	184	58.4
Education level		
Primary	170	54.0
Secondary	93	29.5
Tertiary	52	16.5
Marital status		
Married	238	75.6
Not married	77	24.4
Employment status		
Employed	74	23.5
Self employed	124	39.4
Unemployed	117	37.1
BMI		
Normal weight	67	21.3

Overweight	186	59.0
Obese	62	19.7
Currently smoke?		
Yes	9	2.9
No	306	97.1
Ever smoked in the past (n=306)*		
Yes	40	13.1
No	266	86.9
Ever consumed alcohol		
Yes	173	54.9
No	142	45.1
Consumed alcohol within the past 12 months (n=173)*		
Yes	43	24.9
No	130	75.1
Stopped drinking due to health reasons (n=173)*		
Yes	127	73.4
No	46	26.6
Add salt when eating		
Frequently	64	20.3
Rarely/never	251	79.7
Add salt when cooking		
Frequently	112	35.6
Rarely/never	203	64.6

*Variables containing missing values

Knowledge on physical activities

The vast majority (95.6%) of participants reported knowing that PA is any form of bodily movement, included dancing and going up and down the stair (99.7%), safe PA in diabetes increased breath moderately (91.7%) and would make them sweat mildly (93.7%). Also, nearly all (99%) reported that PA included leisure walking in the neighborhood (99%), riding mobile or stationary bicycle (97.8%), PA could be incorporated into leisure time (96.8%), and PA includes recreational activities (95.2%). Overall, 98.4% of all participants had good knowledge of PA (Table **2**).

Table 2: Knowledge on physical activities (N=315)

Variable	Frequency*	Percentage*
Knowledge on PA		
PA is any form of bodily movement	301	95.6
Safe PA increases breathing rate moderately	289	91.7
Safe PA will make you sweat mildly	295	93.7
PA includes housework and working in the garden	314	99.7
PA includes dancing or going up and down the stair	314	99.7
PA includes leisure walking in the neighbourhood	312	99.0
PA includes riding mobile or stationary bicycle	308	97.8
PA benefits overall health	315	100
PA does not have to be expensive	315	100
PA does not have to be hard	313	99.4
PA can be incorporated into leisure time	305	96.8
PA includes recreational activities	300	95.2
Overall knowledge on PA		
Good	310	98.4
Poor	5	1.6

*Frequencies and percentages among those who answered 'Yes'.

Attitude towards Physical Activity

The majority of participants were always concerned about their PA level (63.3%), considered engagement in regular PA as not being fanatical (68.9%), and that extra PA outside normal daily activities is necessary for diabetes (72.7). Furthermore, PA behaviour made respondents feel well (88.6%), derive a lot of pleasure in PA practice as diabetic patients (83.8%), believed the practice would be beneficial to them (99.4%). The majority (97.1%) also believed that PA was not risky in diabetes and that regular PA reduced blood sugar (99.4%). Nearly all participants (99%) would encourage regular PA behaviour in individuals with diabetes. Overall, the vast majority (95.6%) of all study participants in this study had positive attitudes on PA (Table **3**).

Table 3: Attitude towards physical activity (N=315)

Variable	Disagree n (%)	Neutral n (%)	Agree n (%)
Attitude towards PA			
Always concerned about PA level	64 (20.3)	51 (16.2)	200 (63.3)
Consider engagement in regular PA as being fanatical	217 (68.9)	94 (29.8)	1 (1.3)
Extra PA outside normal daily activities is unnecessary in diabetes	229 (72.7)	27 (8.6)	59 (18.7)
Need to be physically active enough to reduce my blood sugar	8 (2.5)	2 (0.6)	305 (96.8)
PA behaviour makes me feel well	11 (3.5)	25 (7.9)	279 (88.6)
Would encourage regular PA behaviour in individuals with diabetes.	1 (0.3)	2 (0.6)	312 (99)

I derive pleasure in PA behaviour as a diabetic patient	12 (3.8)	39 (12.4)	264 (83.8)
I believe PA behaviour will be beneficial to me as a diabetic patient	2 (0.6)	0 (0)	313 (99.4)
PA is risky in diabetes	306 (97.1)	8 (2.5)	1 (0.3)
Regular PA does not reduce blood sugar	313 (99.4)	1 (0.3)	1 (0.3)
The overall attitude towards physical activities			
Positive	301 (95.6)		
Negative	14 (4.4)		

Physical activity practices among diabetic patients

Overall, 94.3% of respondents had sufficient levels of PA (≥600 METs). Work-related activities were the largest contributor (70%) to the total PA, specifically the moderate-intensity work-related activities, which accounted for 86% of all work-related PA. Walking for the travel was found to be the second major contributor (20%) to the total PA in this study (Table **4**).

Table 4: Participants different levels of PA (N=315)

Variable	Frequency	Percentage
Work-related		
Vigorous-intensity		
Sufficient	29	9.2
Insufficient	286	90.8
Moderate Intensity		
Sufficient	235	74.6
Insufficient	80	25.4
Total work-related		
Sufficient	236	74.9
Insufficient	79	25.1
Transport related		
Sufficient	175	55.6
Insufficient	140	44.4
Leisure related		
Vigorous-intensity		
Sufficient	15	4.8
Insufficient	300	95.2
Moderate-intensity		
Sufficient	62	19.7
Insufficient	253	80.3
Total leisure-related PA		
Sufficient	66	21
Insufficient	249	79
Overall, PA level		
Sufficient	297	94.3

Insufficient	18	5.7

Note: Sufficient levels of PA are equivalent to ≥600 METs

PA by participant characteristics

There were statistically significant differences in the proportions of PA by marital status, employment, knowledge and attitudes on PA, and being hypertensive (Table **5**). Higher prevalence of PA (95.8%) was among those who were married, employed (100%), self-employed (98.4%), with good knowledge (94.8%), and positive attitudes (96.3%) towards PA. Most (98.4%) of the non-hypertensive patients had sufficient PA to (91.6%) among those with self-reported hypertension (Table **5**).

Table 5: PA by participant characteristics (N=315)

Variable	Insufficient PA n (%)	Sufficient PA n (%)	P-value
Gender			0.47
Male	9 (6.9)	122 (93.1)	
Female	9 (4.9)	175 (95.1)	
Marital status			0.042
Married	10 (4.2)	228 (95.8)	
Unmarried	8 (10.4)	69 (89.6)	
BMI			0.9
Normal weight	4 (6)	63 (94)	
Overweight	10 (5.4)	176 (94.6)	
Obese	4 (6.5)	58 (93.5)	
Employment status			<0.001
Employed	0 (0)	74 (100)	
Self employed	2 (1.6)	122 (98.4)	
Unemployed	16 (13.7)	101 (86.3)	
Knowledge on PA			<0.001
Good	16 (5.2)	294 (94.8)	
Poor	2 (40)	3 (60)	
Attitude towards PA			<0.001
Positive	11 (3.7)	290 (96.3)	
Negative	7 (50)	7 (50)	
Education level			0.372
Primary	12 (7)	158 (93)	
Secondary	5 (5.4)	88 (94.6)	
Tertiary	1(2)	51(98)	
Have hypertension			0.012
Yes	16(8.4)	174(91.6)	
No	2(1.6)	123(98.4)	

Note: Sufficient levels of PA are equivalent to ≥600 METs

DISCUSSION

The study aimed to assess knowledge, attitude, practices of physical activities among diabetic patients in the Kilimanjaro region, northern Tanzania. The findings show that 98.4% of all participants had good knowledge, and 95.6% had positive attitudes towards PA. The vast majority (94.3%) of participants had sufficient (≥600 METs) PA.

The diabetic patients in this study met the WHO recommendations for sufficient (≥600 METs) PA which is way higher than that observed in various sub-Saharan Africa countries, with estimates ranging from 27.4% in Nigeria to 33% in Dar es Salaam, Tanzania [9,19,20,23]. The higher proportion of PA in our study might be explained by a high level of good knowledge, positive attitudes on PA and employment status. As also reported in Senegal, doctors' advice on the importance of PA is critical to diabetes management. On the other hand, findings from a population-based cross-sectional study in Mwanza, North-western Tanzania, revealed that 96% of adults (aged 15 years and older) had sufficient PA [33]. The authors indicated that high prevalence of PA was explained by the fact that the population sampled were; working-class, residing in a rural area, and involved in farming activities [33].

Participation in PA is likely to differ depending on the study population and context-specific factors. Work-related moderate-intensity activities accounted for 57.5% of the total PA in this study. These activities included household chores and agriculture-related activities. The results are similar to those found in Rwanda [21]. In this study, 62.9% of all participants were employed and engaged in agricultural activities. Leisure activity participation was found to be lower (10%) than other activities. Our results are consistent with a study done in Nepal and Rwanda [18,21]. These might be because participants thought it was enough to engage in agricultural activities.

The knowledge and attitudes to PA were significantly associated with PA practice as also reported in other studies [18,19,21,34]. The knowledge on PA in this study is high (98.4%) as also reported in other studies [20,24,25]. Our findings are, however, very high compared to those reported elsewhere [22,26,34]. This signifies that being knowledgeable about PA translates to participation in PA [19]. The high proportion of knowledge on PA among diabetic patients in our study might have been contributed by the healthcare provider or doctor's advice on the importance of maintaining healthy body weight or weight loss in managing diabetes and regular attendance to diabetic clinics. Indeed, healthcare provider or doctor's advice is vital in encouraging diabetic patients to engage in frequent PA for blood sugar, body weight control, and most importantly diabetic control in this population [20]. Patients attending routine diabetic

clinics should frequently and consistently be advised and reminded about the importance of PA in the management of diabetes.

The vast majority (95.6%) of diabetic patients in this study had a positive attitude towards PA, which is consistent to other studies [20,34]. These results are contrary to a similar study in Nigeria, whereby 90% of the study participants had a negative attitude towards PA [19]. As earlier indicated, the high proportion of positive attitudes towards PA in this study may have been contributed to the consistent and frequent advice from the healthcare provider or doctors concerning the benefits of PA in diabetic management. The poor attitude reported in Nigeria can be attributed to inadequate health education on the importance of PA and reliance on drugs as the main treatment approach for regulation of plasma blood glucose [19]. The positive attitude on PA is an integral part of diabetes treatment and can potentially translate to participation in PA [9]. Positive attitude towards PA are likely to translate to participation in PA practice [34].

Strengths and limitations of the study

Our findings provided evidence for good knowledge, positive attitudes, and sufficient PA practices in this population. Also, the study potentially helps further the research in physical activity among people with diabetes. However, the study does have some shortcomings. Self-reported measures could have overestimated the respondents' physical activity levels. MET values of some activities, which involve high breathing, have not been derived from actual oxygen consumption, hence increasing the risk of overestimation. Some individuals might have incorrectly reported the information collected in minutes of physical activity due to the inherent difficulty of recalling the number of minutes spent in one week doing any particular activity. Being an institutional based study, desirability bias could have occurred.

Conclusion and recommendations

The vast majority of diabetic patients were physically active. High levels of PA were associated with a high level of knowledge and positive attitudes towards PA. Health care provider or doctors' advice during diabetic clinics is essential in promoting PA practice in this population as well as diabetes management.

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Foot notes

- **Contributors** JM carried out the design of the study and drafted the manuscript; IM gave advice and reviewed the manuscript from a medical perspective; SS, BL, CA and EM helped to draft the manuscript. All authors read and approved the final manuscript.
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- **Patient consent for publication** Not required.
- **Ethics approval** The Kilimanjaro Christian Medical University College Research and Ethics Review Committee (KCMU-CRERC) with approval number (UG/085/2020) approved the study.
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Knowledge, attitude and practice of physical activity among diabetic patients in Kilimanjaro region, northern Tanzania: a descriptive cross-sectional study

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ABSTRACT

Introduction: Diabetes mellitus is one of the most common non-communicable diseases and is the fifth leading cause of death in most developing countries. Regular physical activity is strongly recommended for individuals with diabetes for its beneficial effects in improving blood glucose control and insulin sensitivity, prevention and reduction of morbidities and complications, and its cardiovascular benefits.

Objective: To assess the knowledge, attitude and practices of physical activity among diabetic patients in the Kilimanjaro region, Northern Tanzania

Research design and methods: A cross-sectional study was conducted from June to September 2020 among 315 diabetic patients aged 18 years and above receiving care from diabetic clinics in the Kilimanjaro region, northern Tanzania. A systematic random sampling technique was used to select study participants who were interviewed using a modified version of the WHO Steps Survey for non-communicable diseases. Data were analysed using SPSS version 20. Categorical variables were summarised using frequencies and percentages, and continuous variables using means and standard deviations. The Chi-square test was used to compare the proportion of Physical activity (PA) across participant characteristics.

Results: The vast majority (94.3%) of the participants were physically active, and from our findings, most of it was contributed by work (70%) and transport-related (20%) activities. Participants had high levels of knowledge (98.4%) and positive attitudes (95.6%) towards PA. These were mainly contributed by a health care provider or doctors' advice (96%) on PA benefits to diabetic patients. There was a strong statistical association ($p<0.001$) between knowledge and attitude towards PA with PA practice.

Conclusion: The vast majority of the participants were physically active. High levels of PA were associated with a high level of knowledge and positive attitudes towards PA. Health care provider or doctors' advice during diabetic clinics is essential in promoting PA practice in this population and diabetes management.

Keywords: Knowledge; Attitude; Practice; Physical activity; Tanzania

Strengths and Limitations of the Study.

- This study provides evidence for good knowledge, positive attitudes, and sufficient PA practices in this population.
- This study potentially helps further the research in physical activity among people with diabetes.
- Self-reported measures could have overestimated the respondents' physical activity levels, as demonstrated in this study.
- Inability to assess the temporal relationship, since it's a cross sectional study
- Since it was a hospital based study, it may have affected the generalizability of this study's findings

BACKGROUND

Diabetes is a serious chronic disease that occurs when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces [1]. The number of people with diabetes is steadily rising, with the World Health Organization (WHO) estimating that 6% of the world's population has diabetes, four times the number in 1980 [1]. The greatest rise is in low- and middle-income countries. Without interventions to halt this increase, there will be at least 629 million people living with diabetes by 2045 [2]). Tanzania is not an exception to the ever-increasing prevalence of diabetes. A 2012 Tanzanian national survey estimated diabetes prevalence at 9.1% among adults aged 25–64 years, a significant increase of 4% compared to a study conducted in two regions of Tanzania in the year 2000, which showed a prevalence of 5% among adults aged >15 years [3,4]. Also, the International Diabetic Federation (IDF) showed a total of 897,000 prevalent cases of diabetes in adults aged 20-79 years in 2017, with a prevalence of 3.6% in Tanzania [5].

Weight control is key to the control of diabetes and the prevention of related negative consequences. Regular and adequate physical activity levels (PA) in adults reduce the risk of hypertension, coronary heart disease, stroke, diabetes, breast and colon cancer, depression, and the risk of falls, improving bone and functional health [6]. PA is also a key determinant of energy expenditure and thus fundamental to energy balance and body weight control [7]. Several studies show PA is protective against diabetes and related complications such as diabetic neuropathy, retinopathy, cardiovascular disease (CVD), mortality, stroke, hypertension, cancers (colon, breast), depression, enhances skeletal muscle mass, drop in blood glucose, contribute to weight loss, and regulation of blood pressure [8–11].

PA is also crucial among diabetic patients because it has been associated with improved genomic stability, reduction in mortality rate and effective in lowering the susceptibility to oxidative DNA damage and the lipid peroxidation levels [12–14]. Yet, the practice of PA is still low among diabetic patients in different countries across the globe. For instance, the proportion in North America ranged from 32.8% in the United States of America to 39.5% in Canada [15]. In Asian countries, it ranged from 10% in Kuwait to 28% in Nepal [16–18], while in Africa, it ranged from 27.4% in Nigeria to 81% in Senegal [11,19–21]. It is reported that the high proportion of physical activity in Senegal has been highly motivated by doctor's advice on PA. PA practice in East African countries is between 31.4% in Rwanda to 41% in Kenya [21,22] compared to 33% in Tanzania [23]. These findings indicate significant variations in the practice of PA among diabetic patients between and within countries.

Sufficient knowledge and a good attitude towards physical activities are crucial for diabetes management. Limited knowledge of the duration and type of physical activity has been associated with poor adherence to physical activity among diabetic patients [20,24,25]. Also, a negative attitude towards physical activity such as PA has no significant advantage in managing diabetes and is associated with poor adherence to PA among type 2 diabetic patients [19,26].

In Tanzania, studies have shown that sufficient knowledge on physical activity in diabetes management is very minimal [27], which contributes to the high rate of physical inactivity among diabetic patients in the country [3,23]. Thus, this study will determine knowledge, attitude, and practice of physical activity among diabetic patients in the Kilimanjaro region.

METHODS

Study design and setting

We carried out a cross-sectional study from August to September 2020 among diabetic patients attending two diabetic clinics in the Kilimanjaro region, northern Tanzania. Kilimanjaro region has seven administrative districts, 20 hospitals, 41 health centres and 335 dispensaries. The health facilities are owned by either the government, religious or private sectors. There are five diabetic clinics in the region, namely Kilimanjaro Christian Medical Centre (KCMC) referral hospital, Mawenzi regional hospital, Kilema, Rombo, and Kibosho district hospitals. Data collection was conducted in the KCMC referral hospital and Mawenzi regional hospital due to the high volume of diabetic patients relative to other facilities in the region. KCMC is a zonal referral hospital serving over 15 million people in Northern Tanzania. Mawenzi hospital is the regional hospital for the Kilimanjaro region serving around 1.7 million people.

Study population, sample size and sampling

The study population were type 2 diabetic patients aged 18 years and above attending diabetic clinics in the Kilimanjaro region. We used a single proportion formula to estimate the minimum required sample size given as $[N=(Z_{a/2})^2 \times p(1-p)/e^2]$. Where *N* is the minimum required sample size, *p* is the estimated proportion of PA among diabetic patients (27.5%) based on a study conducted in Nigeria [19]. Furthermore, *e* is the margin of error or precision (5%), and Z is the standard normal value (1.96) corresponding to a 95% confidence interval. After adding a 15% proportion of non-response, the estimated sample size was 353. A systematic random sampling technique was used to select study participants until the desired number was reached.

Data collection methods and procedures

Trained doctor of medicine students at the Kilimanjaro Christian Medical University College (KCMUCo) collected data using a modified version of the WHO-STEPS questionnaire for non-communicable diseases [28]. The WHO-STEPS questionnaire for non-communicable diseases is a tool that measures risk factors for chronic non communicable diseases (NCDs) such as hypertension, diabetes etc.The questionnaire was designed in English and then translated by the study team and administered in Swahili (local). It contained information on behavioural characteristics (smoking, alcohol intake, and diet), PA practices, history of raised blood pressure, history of raised cholesterol, and physical measurements like blood pressure,

weight and height.[29]. The tool was modified to include questions on knowledge and attitudes towards PA, whereby 12 added questions assessed PA knowledge and ten questions assessed attitude towards PA. The questions on knowledge and attitude were adapted from a study in Nigeria [30]

Participants were provided with clear information about the study purpose, benefits for participation, anticipated harm, and what was expected of their involvement. After addressing all participant questions, informed consent was administered. Those who refused to participate continued with routine care. All consenting participants were interviewed by trained medical students in a quiet and secure room or place within the clinic to ensure confidentiality. Interviews took approximately 20-30 minutes to complete and there after the participants continued with routine care. Immediately after data collection, the researchers assessed the patterns and completeness of the collected data.

Study variables

The outcome variables in this study were knowledge, attitude, and PA practices. Knowledge of PA was assessed using 12 questions with Yes (1) and No (0) responses [30]. Knowledge was scored by summing the scores of all questions of the domain. The scores were then converted to percentages, and a higher percentage score (≥75%) indicated good PA knowledge.

The attitude towards PA was measured using 10-items on a 3-point scale, i.e., disagree, neutral, and agree [30]. Items 1 to 3, 9, and 10 were reverse-coded because of the negative meanings of the items. Then, attitudes on PA was scored by summing all the scores of all items with a higher score (≥75%), suggesting a favourable attitude toward PA.

PA practice was measured using questions from the WHO Global Physical Activity Questionnaire [31]. The PA practice questions were divided into three sections: work-related PA, transport-related PA (related to walking or cycling), and leisure-related PA. Time spent on all PA types was summed to obtain each PA type's time spent per week. Frequency, duration, and intensity for each PA type were coded into metabolic equivalent tables (METs). One MET is defined as the energy expenditure while sitting quietly for one hour, which for the average adult is approximately 3.5 ml of oxygen/kg body weight/min with MET values obtained from the Compendium of PA [32].

Vigorous-intensity work-related PA was assigned a value of 8.0METs while moderate-intensity work-related PA was assigned a value of 4.0METs. Transport-related PA was

assigned a value of 4.0METs. Vigorous-intensity leisure-related PA was assigned a value of 8.0METs, and moderate-intensity leisure-related PA was assigned a value of 4.0METs [33]. The total METs per week for all PA was calculated by multiplying the duration (minutes) of activity per week by its corresponding METs and summed for each PA type. Sufficient METS was defined as ≥600 METS per week [31].Other study variables included age (<40, 40-59, 60+), sex (male, female), marital status (married, not married), education level (primary, secondary, tertiary), employment status (employed, self-employed, unemployed), BMI (normal weight, overweight, obese) and behavioural characteristics such as smoking, alcohol consumption and diet.

Data analysis

We performed data analysis using SPSS version 20 software. Categorical variables were summarised using frequencies and percentages, and continuous variables using means and standard deviations. The Chi-square test was used to compare the proportion of PA across participant characteristics, and a p-value of <0.05 was considered a statistically significant association.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Participants demographic characteristics

A total of 353 diabetic patients met the inclusion criteria and were invited to participate in the study. Of these, 315 consented to participate in making a response rate of 89% since the rest (11%) were not comfortable completing the questionnaire. The mean age of 315 respondents was 58.62 ± 10.8 years, and almost half (47.3%) were >60 years. Females accounted for 58.4% of all study participants, 54% had primary education level, and three-quarters (75.6%) were married (Table **1**).

Table 1: Participants background characteristics (N=315)

Variable	Frequency	Percentage
Age in years		
<40	20	6.3
40-59	146	46.3
60+	149	47.3

Mean (SD)	58.6 (10.8)	
Sex		
Male	131	41.6
Female	184	58.4
Education level		
Primary	170	54.0
Secondary	93	29.5
Tertiary	52	16.5
Marital status		
Married	238	75.6
Not married	77	24.4
Employment status		
Employed	74	23.5
Self employed	124	39.4
Unemployed	117	37.1
BMI		
Normal weight	67	21.3
Overweight	186	59.0
Obese	62	19.7

Behavioural characteristics

Among all respondents, only 3% were current smokers, and 54.9% ever consumed alcohol. Of those who ever consumed alcohol (n=173), a quarter (24.9%) consumed in the past year, and 73.4% stopped drinking due to health reasons. About 20% of all add salt when eating, 35.6% when cooking, and 16.8% consume processed food high in salt (Table **2**).

Table 2: Participants behavioural characteristics (N=315)

Variable	Frequency	Percentage
Currently smoking		
Yes	9	2.9
No	306	97.1
Ever smoked in the past (n=306)*		
Yes	40	13.1
No	266	86.9
Ever consumed alcohol		
Yes	173	54.9
No	142	45.1
Consumed alcohol within the past 12 months (n=173)*		
Yes	43	24.9
No	130	75.1
Stopped drinking due to health reasons (n=173)*		
Yes	127	73.4
No	46	26.6
Add salt when eating		

Frequently	64	20.3
Rarely/never	251	79.7
Add salt when cooking		
Frequently	112	35.6
Rarely/never	203	64.6
Consume processed food high in salt		
Frequently	51	16.8
Rarely/never	264	83.2

*Variables containing missing values

Knowledge of physical activities

The vast majority (95.6%) of participants reported knowing that PA is any form of bodily movement, included dancing and going up and down the stair (99.7%), safe PA in diabetes increased breath moderately (91.7%) and would make them sweat mildly (93.7%). Also, nearly all (99%) reported that PA included leisure walking in the neighbourhood (99%), riding mobile or stationary bicycle (97.8%), PA could be incorporated into leisure time (96.8%), and PA includes recreational activities (95.2%). Overall, 98.4% of all participants had good knowledge of PA (Table **3**).

Table 3: Knowledge of physical activities (N=315)

Variable	Frequency*	Percentage*
Knowledge on PA		
PA is any form of bodily movement	301	95.6
Safe PA increases breathing rate moderately	289	91.7
Safe PA will make you sweat mildly	295	93.7
PA includes housework and working in the garden	314	99.7
PA includes dancing or going up and down the stair	314	99.7
PA includes leisure walking in the neighbourhood	312	99.0
PA includes riding a mobile or stationary bicycle	308	97.8
PA benefits overall health	315	100
PA does not have to be expensive	315	100
PA does not have to be hard	313	99.4
PA can be incorporated into leisure time	305	96.8
PA includes recreational activities	300	95.2
Overall knowledge of PA		
Good	310	98.4
Poor	5	1.6

*Frequencies and percentages among those who answered 'Yes'.

Attitude towards Physical Activity

The majority of participants were always concerned about their PA level (63.3%), considered engagement in regular PA as not being fanatical (68.9%), and extra PA outside normal daily activities is necessary for diabetes (72.7). Furthermore, PA behaviour made respondents feel

well (88.6%), derive a lot of pleasure in PA practice as diabetic patients (83.8%), believed the practice would be beneficial to them (99.4%). The majority (97.1%) also believed that PA was not risky in diabetes and that regular PA reduced blood sugar (99.4%). Nearly all participants (99%) would encourage regular PA behaviour in individuals with diabetes. Overall, the vast majority (95.6%) of all study participants in this study had positive attitudes on PA (Table **4**).

Table 4: Attitude towards physical activity (N=315)

Variable	Disagree n (%)	Neutral n (%)	Agree n (%)
Attitude towards PA			
Always concerned about PA level	64 (20.3)	51 (16.2)	200 (63.3)
Consider engagement in regular PA as being fanatical	217 (68.9)	94 (29.8)	1 (1.3)
Extra PA outside normal daily activities is unnecessary in diabetes	229 (72.7)	27 (8.6)	59 (18.7)
Need to be physically active enough to reduce my blood sugar	8 (2.5)	2 (0.6)	305 (96.8)
PA behaviour makes me feel well	11 (3.5)	25 (7.9)	279 (88.6)
Would encourage regular PA behaviour in individuals with diabetes.	1 (0.3)	2 (0.6)	312 (99)
I derive pleasure in PA behaviour as a diabetic patient	12 (3.8)	39 (12.4)	264 (83.8)
I believe PA behaviour will be beneficial to me as a diabetic patient	2 (0.6)	0 (0)	313 (99.4)
PA is risky in diabetes	306 (97.1)	8 (2.5)	1 (0.3)
Regular PA does not reduce blood sugar	313 (99.4)	1 (0.3)	1 (0.3)
The overall attitude towards physical activities			
Positive	301 (95.6)		
Negative	14 (4.4)		

Physical activity practices among diabetic patients

Overall, 94.3% of respondents had sufficient levels of PA (≥600 METs). Work-related activities were the largest contributor (70%) to the total PA, specifically the moderate-intensity work-related activities, which accounted for 86% of all work-related PA. Walking for travel was the second major contributor (20%) to the total PA in this study (Table **5**).

Table 5: Participants different levels of PA (N=315)

Variable	Frequency	Percentage
Work-related		
Vigorous-intensity		
Sufficient	29	9.2
Insufficient	286	90.8
Moderate Intensity		

Sufficient	235	74.6
Insufficient	80	25.4
Total work-related		
Sufficient	236	74.9
Insufficient	79	25.1
Transport related		
Sufficient	175	55.6
Insufficient	140	44.4
Leisure related		
Vigorous-intensity		
Sufficient	15	4.8
Insufficient	300	95.2
Moderate-intensity		
Sufficient	62	19.7
Insufficient	253	80.3
Total leisure-related PA		
Sufficient	66	21
Insufficient	249	79
Overall PA level		
Sufficient	297	94.3
Insufficient	18	5.7

Note: Sufficient levels of PA are equivalent to ≥600 METs

PA by participant characteristics

There were statistically significant differences in the proportions of PA by marital status, employment, knowledge and attitudes on PA, and being hypertensive (Table **6**). A higher proportion of sufficient PA was among diabetic patients who were married (95.8%), employed (100%), self-employed (98.4%), with good knowledge (94.8%), and positive attitudes (96.3%) towards PA. Most (98.4%) of the non-hypertensive patients had sufficient PA compared to (91.6%) among those with self-reported hypertension (Table **6**).

Table 6: PA by participant characteristics (N=315)

Variable	Insufficient PA n (%)	Sufficient PA n (%)	P-value
Gender			0.47
Male	9 (6.9)	122 (93.1)	
Female	9 (4.9)	175 (95.1)	
Marital status			0.042
Married	10 (4.2)	228 (95.8)	
Unmarried	8 (10.4)	69 (89.6)	
BMI			0.9
Normal weight	4 (6)	63 (94)	
Overweight	10 (5.4)	176 (94.6)	
Obese	4 (6.5)	58 (93.5)	
Employment status			<0.001
Employed	0 (0)	74 (100)	

Self employed	2 (1.6)	122 (98.4)	
Unemployed	16 (13.7)	101 (86.3)	
Knowledge on PA			<0.001
Good	16 (5.2)	294 (94.8)	
Poor	2 (40)	3 (60)	
Attitude towards PA			<0.001
Positive	11 (3.7)	290 (96.3)	
Negative	7 (50)	7 (50)	
Education level			0.372
Primary	12 (7)	158 (93)	
Secondary	5 (5.4)	88 (94.6)	
Tertiary	1 (2)	51 (98)	
Have hypertension			0.012
Yes	16 (8.4)	174 (91.6)	
No	2 (1.6)	123 (98.4)	

Note: Sufficient levels of PA are equivalent to ≥600 METs

DISCUSSION

The study aimed to assess knowledge, attitude, practices of physical activities among diabetic patients in the Kilimanjaro region, northern Tanzania. The findings show that 98.4% of all participants had good knowledge, and 95.6% had positive attitudes towards PA. The vast majority (94.3%) of participants had sufficient (≥600 METs) PA.

The diabetic patients in this study met the WHO recommendations for sufficient (≥600 METs) PA, which is way higher than that observed in various sub-Saharan Africa countries, with estimates ranging from 27.4% in Nigeria to 33% in Dar es Salaam, Tanzania [11,19,20,23]. The higher proportion of PA in our study might be explained by a high level of good knowledge, positive attitudes on PA, and employment status. As also reported in Senegal, doctors' advice on the importance of PA is critical to diabetes management. On the other hand, findings from a population-based cross-sectional study in Mwanza, North-western Tanzania, revealed that 96% of adults (aged 15 years and older) had sufficient PA [34]. The authors indicated that the high prevalence of PA was explained by the fact that the population sampled were; working-class, residing in a rural area, and involved in farming activities [34].

Participation in PA is likely to differ depending on the study population and context-specific factors. Work-related moderate-intensity activities accounted for 57.5% of the total PA in this study. These activities included household chores and agriculture-related activities. The results are similar to those found in Rwanda [21]. In this study, 62.9% of all participants were employed and engaged in agricultural activities. Leisure activity participation was lower (10%) than other activities. Again, our results are consistent with a study done in Nepal and Rwanda

[18,21]. This might be because participants thought it was enough to engage in agricultural activities.

The knowledge and attitudes to PA were significantly associated with PA practice, as also reported in other studies [18,19,21,35]. The knowledge on PA in this study is high (98.4%), as also reported in other studies [20,24,25]. Our findings are, however, very high compared to those reported elsewhere [22,26,35]. The regular counselling might have contributed to the high proportion of knowledge on PA among diabetic patients in our study on the importance of maintaining healthy body weight or weight loss in managing diabetes and regular attendance to diabetic clinics. Such an intervention is crucial to encouraging diabetic patients to engage in frequent PA for blood sugar, body weight control, and diabetic control [20]. Patients attending routine diabetic clinics should frequently and consistently be advised and reminded about the importance of PA in the management of diabetes.

The vast majority (95.6%) of diabetic patients in this study had a positive attitude towards PA, consistent with other studies [20,35]. These results are contrary to a similar study in Nigeria, whereby 90% of the study participants had a negative attitude towards PA [19].. The poor attitude reported in Nigeria can be attributed to inadequate health education on the importance of PA and reliance on drugs as the main treatment approach for the regulation of plasma blood glucose [19]. The positive attitude on PA is an integral part of diabetes treatment and can potentially translate to participation in PA [11]. A positive attitude towards PA is likely to translate to participation in PA practice [35].

Strengths and limitations of the study

Our findings provided evidence for good knowledge, positive attitudes, and sufficient PA practices in this population. Also, the study potentially helps further the research in physical activity among people with diabetes. However, the study does have some shortcomings. First, self-reported measures could have overestimated the respondents' physical activity levels, as demonstrated in this study. MET values of some activities, which involve high breathing, have not been derived from actual oxygen consumption, hence increasing the risk of overestimation. Second, some individuals might have incorrectly reported the information collected in minutes of physical activity due to the inherent difficulty of recalling the number of minutes spent in one week doing any particular activity. The study was hospital-based which affects the generalizability of this study's findings. Finally, an inherent limitation of cross-sectional studies is the inability to assess the temporal relationship.

Conclusion and recommendations

The vast majority of diabetic patients were physically active. High levels of PA were associated with a high level of knowledge and positive attitudes towards PA. Health care provider or doctors' advice during diabetic clinics is essential in promoting PA practice in this population and diabetes management.

Contributorship statement.

All authors made a substantial contribution to this study. JLM, SS, EM and IBM designed the study. JLM, SS, EM collected and analysed the data. IBM, CA and BJL commented on the manuscript. JLM drafted the manuscript and had the primary responsibility for the final content. All authors reviewed the drafts of this manuscript and approved the final version for submission.

Competing interests.

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Data Availability statement.

Data will be available from corresponding author upon a reasonable request.

Ethics statement

Patient consent for publication

Not required

Ethical considerations

The study was approved by the Kilimanjaro Christian Medical University College Research and Ethics Review Committee (KCMU-CRERC), with the ethical approval number being UG/085/2020. Permission to conduct the study was sought from the Kilimanjaro region medical officer (for Mawenzi Hospital) and the KCMC hospital director. Participants provided oral informed consent, and participation was voluntary. Participants were also informed that they were free to withdraw from the study any time they felt so without affecting their care process. To protect the privacy and confidentiality of the participant information, we used unique identification numbers.

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Knowledge, attitude and practice of physical activity among diabetic patients in Kilimanjaro region, northern Tanzania: a descriptive cross-sectional study

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ABSTRACT

Introduction: Diabetes mellitus is one of the most common non-communicable diseases and is the fifth leading cause of death in most developing countries. Regular physical activity is strongly recommended for individuals with diabetes for its beneficial effects in improving blood glucose control and insulin sensitivity, prevention and reduction of morbidities and complications, and its cardiovascular benefits.

Objective: To assess the knowledge, attitude and practices of physical activity among diabetic patients in the Kilimanjaro region, Northern Tanzania.

Research design and methods: A cross-sectional study was conducted from June to September 2020 among 315 diabetic patients aged 18 years and above receiving care from diabetic clinics in the Kilimanjaro region, northern Tanzania. A systematic random sampling technique was used to select study participants who were interviewed using a modified version of the WHO Steps Survey for non-communicable diseases. Data were analysed using SPSS version 20. Categorical variables were summarised using frequencies and percentages, and continuous variables using means and standard deviations. The Chi-square test was used to compare the proportion of Physical activity (PA) across participant characteristics.

Results: The vast majority (94.3%) of the participants were physically active, and from our findings, most of it was contributed by work (70%) and transport-related (20%) activities. Participants had high levels of knowledge (98.4%) and positive attitudes (95.6%) towards PA. These were mainly contributed by a health care provider or doctors' advice (96%) on PA benefits to diabetic patients. There was a strong statistical association ($p<0.001$) between knowledge and attitude towards PA with PA practice.

Conclusion: The vast majority of the participants were physically active. High levels of PA were associated with a high level of knowledge and positive attitudes towards PA. Health care provider or doctors' advice during diabetic clinics is essential in promoting PA practice in this population and diabetes management.

Keywords: Knowledge; Attitude; Practice; Physical activity; Tanzania

Strengths and Limitations of the Study.

- This study provides evidence for good knowledge, positive attitudes, and sufficient PA practices in this population.
- This study potentially helps further the research in physical activity among people with diabetes.
- Self-reported measures could have overestimated the respondents' physical activity levels, as demonstrated in this study.
- Inability to assess the temporal relationship, since it's a cross sectional study
- Since it was a hospital based study, it may have affected the generalizability of this study's findings

BACKGROUND

Diabetes is a serious chronic disease that occurs when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces [1]. The number of people with diabetes is steadily rising, with the World Health Organization (WHO) estimating that 6% of the world's population has diabetes, four times the number in 1980 [1]. The greatest rise is in low- and middle-income countries. Without interventions to halt this increase, there will be at least 629 million people living with diabetes by 2045 [2]). Tanzania is not an exception to the ever-increasing prevalence of diabetes. A 2012 Tanzanian national survey estimated diabetes prevalence at 9.1% among adults aged 25–64 years, a significant increase of 4% compared to a study conducted in two regions of Tanzania in the year 2000, which showed a prevalence of 5% among adults aged >15 years [3,4]. Also, the International Diabetic Federation (IDF) showed a total of 897,000 prevalent cases of diabetes in adults aged 20-79 years in 2017, with a prevalence of 3.6% in Tanzania [5].

Weight control is key to the control of diabetes and the prevention of related negative consequences. Regular and adequate physical activity levels (PA) in adults reduce the risk of hypertension, coronary heart disease, stroke, diabetes, breast and colon cancer, depression, and the risk of falls, improving bone and functional health [6]. PA is also a key determinant of energy expenditure and thus fundamental to energy balance and body weight control [7]. Several studies show PA is protective against diabetes and related complications such as diabetic neuropathy, retinopathy, cardiovascular disease (CVD), mortality, stroke, hypertension, cancers (colon, breast), depression, enhances skeletal muscle mass, drop in blood glucose, contribute to weight loss, and regulation of blood pressure [8–11].

PA is also crucial among diabetic patients because it has been associated with improved genomic stability, reduction in mortality rate and effective in lowering the susceptibility to oxidative DNA damage and the lipid peroxidation levels [12–14]. Yet, the practice of PA is still low among diabetic patients in different countries across the globe. For instance, the proportion in North America ranged from 32.8% in the United States of America to 39.5% in Canada [15]. In Asian countries, it ranged from 10% in Kuwait to 28% in Nepal [16–18], while in Africa, it ranged from 27.4% in Nigeria to 81% in Senegal [11,19–21]. It is reported that the high proportion of physical activity in Senegal has been highly motivated by doctor's advice on PA. PA practice in East African countries is between 31.4% in Rwanda to 41% in Kenya [21,22] compared to 33% in Tanzania [23]. These findings indicate significant variations in the practice of PA among diabetic patients between and within countries.

Sufficient knowledge and a good attitude towards physical activities are crucial for diabetes management. Limited knowledge of the duration and type of physical activity has been associated with poor adherence to physical activity among diabetic patients [20,24,25]. Also, a negative attitude towards physical activity such as PA has no significant advantage in managing diabetes and is associated with poor adherence to PA among type 2 diabetic patients [19,26].

In Tanzania, studies have shown that sufficient knowledge on physical activity in diabetes management is very minimal [27], which contributes to the high rate of physical inactivity among diabetic patients in the country [3,23]. Nationally and regionally, there have been very few literatures addressing the issue of PA among diabetic patients where by the last similar study was conducted in the year 1996 and 1997 in Dar es salaam and Kilimanjaro regions. [3]. Thus, this study will determine knowledge, attitude, and practice of physical activity among diabetic patients in the Kilimanjaro region.

METHODS

Study design and setting

We carried out a cross-sectional study from August to September 2020 among diabetic patients attending two diabetic clinics in the Kilimanjaro region, northern Tanzania. Kilimanjaro region has seven administrative districts, 20 hospitals, 41 health centres and 335 dispensaries. The health facilities are owned by either the government, religious or private sectors. There are five diabetic clinics in the region, namely Kilimanjaro Christian Medical Centre (KCMC) referral hospital, Mawenzi regional hospital, Kilema, Rombo, and Kibosho district hospitals. Data collection was conducted in the KCMC referral hospital and Mawenzi regional hospital due to the high volume of diabetic patients relative to other facilities in the region. KCMC is a zonal referral hospital serving over 15 million people in Northern Tanzania. Mawenzi hospital is the regional hospital for the Kilimanjaro region serving around 1.7 million people.

Study population, sample size and sampling

The study population were type 2 diabetic patients aged 18 years and above attending diabetic clinics in the Kilimanjaro region. We used a single proportion formula to estimate the minimum required sample size given as $[N=(Z_{a/2})^2 \times p(1-p)/e^2]$. Where *N* is the minimum required sample size, *p* is the estimated proportion of PA among diabetic patients (27.5%) based on a study conducted in Nigeria [19]. Furthermore, *e* is the margin of error or precision (5%), and Z is the standard normal value (1.96) corresponding to a 95% confidence interval. After adding a 15% proportion of non-response, the estimated sample size was 353. A systematic random sampling technique was used to select study participants until the desired number was reached.

Data collection methods and procedures

Trained doctor of medicine students at the Kilimanjaro Christian Medical University College (KCMUCo) collected data using a modified version of the WHO-STEPS questionnaire for non-communicable diseases [28]. The WHO-STEPS questionnaire for non-communicable diseases is a tool that measures risk factors for chronic non communicable diseases (NCDs) such as hypertension, diabetes etc. The questionnaire was designed in English and then translated by the study team and administered in Swahili, the local language in Tanzania. The team members translated one question after another and where there was a disagreement on the Swahili translation, the supervisor was consulted, and if consensus was not reached, other

experts within the college environment were consulted. The tool contained information on behavioural characteristics (smoking, alcohol intake, and diet), PA practices, history of raised blood pressure, history of raised cholesterol, and physical measurements like blood pressure, weight and height.[29]. The tool was modified that is; removed questions about diabetes because the study was among diabetic patients and added questions on knowledge and attitudes towards PA. A total of 12 questions assessed the knowledge and ten (10) questions assessed the attitude towards PA. These questions on knowledge and attitude were adapted from a study in Nigeria [30].

Participants were provided with clear information about the study purpose, benefits for participation, anticipated harm, and what was expected of their involvement. After addressing all participant questions, informed consent was administered. Those who refused to participate continued with routine care. All consenting participants were interviewed by trained medical students in a quiet and secure room or place within the clinic to ensure confidentiality. Interviews took approximately 20-30 minutes to complete and there after the participants continued with routine care. Immediately after data collection, the researchers assessed the patterns and completeness of the collected data.

Study variables

The outcome variables in this study were knowledge, attitude, and PA practices. Knowledge of PA was assessed using 12 questions with Yes (1) and No (0) responses [30]. Knowledge was scored by summing the scores of all questions of the domain. The scores were then converted to percentages, and a higher percentage score (≥75%) indicated good PA knowledge.

The attitude towards PA was measured using 10-items on a 3-point scale, i.e., disagree, neutral, and agree [30]. Items 1 to 3, 9, and 10 were reverse-coded because of the negative meanings of the items. Then, attitudes on PA was scored by summing all the scores of all items with a higher score (≥75%), suggesting a favourable attitude toward PA.

PA practice was measured using questions from the WHO Global Physical Activity Questionnaire [31]. The PA practice questions were divided into three sections: work-related PA, transport-related PA (related to walking or cycling), and leisure-related PA. Time spent on all PA types was summed to obtain each PA type's time spent per week. Frequency, duration, and intensity for each PA type were coded into metabolic equivalent tables (METs). One MET is defined as the energy expenditure while sitting quietly for one hour, which for the average

adult is approximately 3.5 ml of oxygen/kg body weight/min with MET values obtained from the Compendium of PA [32].

Vigorous-intensity work-related PA was assigned a value of 8.0METs while moderate-intensity work-related PA was assigned a value of 4.0METs. Transport-related PA was assigned a value of 4.0METs. Vigorous-intensity leisure-related PA was assigned a value of 8.0METs, and moderate-intensity leisure-related PA was assigned a value of 4.0METs [33]. The total METs per week for all PA was calculated by multiplying the duration (minutes) of activity per week by its corresponding METs and summed for each PA type. Sufficient METS was defined as ≥600 METS per week [31].Other study variables included age (<40, 40-59, 60+), sex (male, female), marital status (married, not married), education level (primary, secondary, tertiary), employment status (employed, self-employed, unemployed), BMI (normal weight, overweight, obese) and behavioural characteristics such as smoking, alcohol consumption and diet.

Data analysis

We performed data analysis using SPSS version 20 software. Categorical variables were summarised using frequencies and percentages, and continuous variables using means and standard deviations. The Chi-square test was used to compare the proportion of PA across participant characteristics, and a p-value of <0.05 was considered a statistically significant association.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Participants demographic characteristics

A total of 353 diabetic patients met the inclusion criteria and were invited to participate in the study. Of these, 315 consented to participate in making a response rate of 89% since the rest (11%) were not comfortable completing the questionnaire. The mean age of 315 respondents was 58.62 ± 10.8 years, and almost half (47.3%) were >60 years. Females accounted for 58.4% of all study participants, 54% had primary education level, and three-quarters (75.6%) were married (Table **1**).

Table 1: Participants background characteristics (N=315)

Variable	Frequency	Percentage
Age in years		
<40	20	6.3
40-59	146	46.3
60+	149	47.3
Mean (SD)	58.6 (10.8)	
Sex		
Male	131	41.6
Female	184	58.4
Education level		
Primary	170	54.0
Secondary	93	29.5
Tertiary	52	16.5
Marital status		
Married	238	75.6
Not married	77	24.4
Employment status		
Employed	74	23.5
Self employed	124	39.4
Unemployed	117	37.1
BMI		
Normal weight	67	21.3
Overweight	186	59.0
Obese	62	19.7

Behavioural characteristics

Among all respondents, only 3% were current smokers, and 54.9% ever consumed alcohol. Of those who ever consumed alcohol (n=173), a quarter (24.9%) consumed in the past year, and 73.4% stopped drinking due to health reasons. About 20% of all add salt when eating, 35.6% when cooking, and 16.8% consume processed food high in salt (Table **2**).

Table 2: Participants behavioural characteristics (N=315)

Variable	Frequency	Percentage
Currently smoking		
Yes	9	2.9
No	306	97.1
Ever smoked in the past (n=306)*		
Yes	40	13.1
No	266	86.9
Ever consumed alcohol		
Yes	173	54.9
No	142	45.1
Consumed alcohol within the past 12 months (n=173)*		
Yes	43	24.9
No	130	75.1
Stopped drinking due to health reasons (n=173)*		
Yes	127	73.4
No	46	26.6
Add salt when eating		
Frequently	64	20.3
Rarely/never	251	79.7
Add salt when cooking		
Frequently	112	35.6
Rarely/never	203	64.6
Consume processed food high in salt		
Frequently	51	16.8
Rarely/never	264	83.2

*Variables containing missing values

Knowledge of physical activities

The vast majority (95.6%) of participants reported knowing that PA is any form of bodily movement, included dancing and going up and down the stair (99.7%), safe PA in diabetes increased breath moderately (91.7%) and would make them sweat mildly (93.7%). Also, nearly all (99%) reported that PA included leisure walking in the neighbourhood (99%), riding mobile or stationary bicycle (97.8%), PA could be incorporated into leisure time (96.8%), and PA includes recreational activities (95.2%). Overall, 98.4% of all participants had good knowledge of PA (Table **3**).

Table 3: Knowledge of physical activities (N=315)

Variable	Frequency*	Percentage*
Knowledge on PA		
PA is any form of bodily movement	301	95.6
Safe PA increases breathing rate moderately	289	91.7
Safe PA will make you sweat mildly	295	93.7

PA includes housework and working in the garden	314	99.7
PA includes dancing or going up and down the stair	314	99.7
PA includes leisure walking in the neighbourhood	312	99.0
PA includes riding a mobile or stationary bicycle	308	97.8
PA benefits overall health	315	100
PA does not have to be expensive	315	100
PA does not have to be hard	313	99.4
PA can be incorporated into leisure time	305	96.8
PA includes recreational activities	300	95.2
Overall knowledge of PA		
Good	310	98.4
Poor	5	1.6

*Frequencies and percentages among those who answered 'Yes'.

Attitude towards Physical Activity

The majority of participants were always concerned about their PA level (63.3%), considered engagement in regular PA as not being fanatical (68.9%), and extra PA outside normal daily activities is necessary for diabetes (72.7). Furthermore, PA behaviour made respondents feel well (88.6%), derive a lot of pleasure in PA practice as diabetic patients (83.8%), believed the practice would be beneficial to them (99.4%). The majority (97.1%) also believed that PA was not risky in diabetes and that regular PA reduced blood sugar (99.4%). Nearly all participants (99%) would encourage regular PA behaviour in individuals with diabetes. Overall, the vast majority (95.6%) of all study participants in this study had positive attitudes on PA (Table **4**).

Table 4: Attitude towards physical activity (N=315)

Variable	Disagree n (%)	Neutral n (%)	Agree n (%)
Attitude towards PA			
Always concerned about PA level	64 (20.3)	51 (16.2)	200 (63.3)
Consider engagement in regular PA as being fanatical	217 (68.9)	94 (29.8)	1 (1.3)
Extra PA outside normal daily activities is unnecessary in diabetes	229 (72.7)	27 (8.6)	59 (18.7)
Need to be physically active enough to reduce my blood sugar	8 (2.5)	2 (0.6)	305 (96.8)
PA behaviour makes me feel well	11 (3.5)	25 (7.9)	279 (88.6)
Would encourage regular PA behaviour in individuals with diabetes.	1 (0.3)	2 (0.6)	312 (99)
I derive pleasure in PA behaviour as a diabetic patient	12 (3.8)	39 (12.4)	264 (83.8)
I believe PA behaviour will be beneficial to me as a diabetic patient	2 (0.6)	0 (0)	313 (99.4)
PA is risky in diabetes	306 (97.1)	8 (2.5)	1 (0.3)
Regular PA does not reduce blood sugar	313 (99.4)	1 (0.3)	1 (0.3)
The overall attitude towards physical activities			

Positive	301 (95.6)
Negative	14 (4.4)

Physical activity practices among diabetic patients

Overall, 94.3% of respondents had sufficient levels of PA (≥600 METs). Work-related activities were the largest contributor (70%) to the total PA, specifically the moderate-intensity work-related activities, which accounted for 86% of all work-related PA. Walking for travel was the second major contributor (20%) to the total PA in this study (Table **5**).

Table 5: Participants different levels of PA (N=315)

Variable	Frequency	Percentage
Work-related		
Vigorous-intensity		
Sufficient	29	9.2
Insufficient	286	90.8
Moderate Intensity		
Sufficient	235	74.6
Insufficient	80	25.4
Total work-related		
Sufficient	236	74.9
Insufficient	79	25.1
Transport related		
Sufficient	175	55.6
Insufficient	140	44.4
Leisure related		
Vigorous-intensity		
Sufficient	15	4.8
Insufficient	300	95.2
Moderate-intensity		
Sufficient	62	19.7
Insufficient	253	80.3
Total leisure-related PA		
Sufficient	66	21
Insufficient	249	79
Overall PA level		
Sufficient	297	94.3
Insufficient	18	5.7

Note: Sufficient levels of PA are equivalent to ≥600 METs

PA by participant characteristics

There were statistically significant differences in the proportions of PA by marital status, employment, knowledge and attitudes on PA, and being hypertensive (Table **6**). A higher proportion of sufficient PA was among diabetic patients who were married (95.8%), employed

(100%), self-employed (98.4%), with good knowledge (94.8%), and positive attitudes (96.3%) towards PA. Most (98.4%) of the non-hypertensive patients had sufficient PA compared to (91.6%) among those with self-reported hypertension (Table **6**).

Table 6: PA by participant characteristics (N=315)

Variable	Insufficient PA n (%)	Sufficient PA n (%)	P-value
Gender			0.47
Male	9 (6.9)	122 (93.1)	
Female	9 (4.9)	175 (95.1)	
Marital status			0.042
Married	10 (4.2)	228 (95.8)	
Unmarried	8 (10.4)	69 (89.6)	
BMI			0.9
Normal weight	4 (6)	63 (94)	
Overweight	10 (5.4)	176 (94.6)	
Obese	4 (6.5)	58 (93.5)	
Employment status			<0.001
Employed	0 (0)	74 (100)	
Self employed	2 (1.6)	122 (98.4)	
Unemployed	16 (13.7)	101 (86.3)	
Knowledge on PA			<0.001
Good	16 (5.2)	294 (94.8)	
Poor	2 (40)	3 (60)	
Attitude towards PA			<0.001
Positive	11 (3.7)	290 (96.3)	
Negative	7 (50)	7 (50)	
Education level			0.372
Primary	12 (7)	158 (93)	
Secondary	5 (5.4)	88 (94.6)	
Tertiary	1 (2)	51 (98)	
Have hypertension			0.012
Yes	16 (8.4)	174 (91.6)	
No	2 (1.6)	123 (98.4)	

Note: Sufficient levels of PA are equivalent to ≥600 METs

DISCUSSION

The study aimed to assess knowledge, attitude, practices of physical activities among diabetic patients in the Kilimanjaro region, northern Tanzania. The findings show that 98.4% of all participants had good knowledge, and 95.6% had positive attitudes towards PA. The vast majority (94.3%) of participants had sufficient (≥600 METs) PA.

The diabetic patients in this study met the WHO recommendations for sufficient (≥600 METs) PA, which is way higher than that observed in various sub-Saharan Africa countries, with

estimates ranging from 27.4% in Nigeria to 33% in Dar es Salaam, Tanzania [11,19,20,23]. The higher proportion of PA in our study might be explained by a high level of good knowledge, positive attitudes on PA, and employment status. As also reported in Senegal, doctors' advice on the importance of PA is critical to diabetes management. On the other hand, findings from a population-based cross-sectional study in Mwanza, North-western Tanzania, revealed that 96% of adults (aged 15 years and older) had sufficient PA [34]. The authors indicated that the high prevalence of PA was explained by the fact that the population sampled were; working-class, residing in a rural area, and involved in farming activities [34].

Participation in PA is likely to differ depending on the study population and context-specific factors. Work-related moderate-intensity activities accounted for 57.5% of the total PA in this study. These activities included household chores and agriculture-related activities. The results are similar to those found in Rwanda [21]. In this study, 62.9% of all participants were employed and engaged in agricultural activities. Leisure activity participation was lower (10%) than other activities. Again, our results are consistent with a study done in Nepal and Rwanda [18,21]. This might be because participants thought it was enough to engage in agricultural activities.

The knowledge and attitudes to PA were significantly associated with PA practice, as also reported in other studies [18,19,21,35]. The knowledge on PA in this study is high (98.4%), as also reported in other studies [20,24,25]. Our findings are, however, very high compared to those reported elsewhere [22,26,35]. The regular counselling might have contributed to the high proportion of knowledge on PA among diabetic patients in our study on the importance of maintaining healthy body weight or weight loss in managing diabetes and regular attendance to diabetic clinics. Such an intervention is crucial to encouraging diabetic patients to engage in frequent PA for blood sugar, body weight control, and diabetic control [20]. Patients attending routine diabetic clinics should frequently and consistently be advised and reminded about the importance of PA in the management of diabetes.

The vast majority (95.6%) of diabetic patients in this study had a positive attitude towards PA, consistent with other studies [20,35]. These results are contrary to a similar study in Nigeria, whereby 90% of the study participants had a negative attitude towards PA [19]. The poor attitude reported in Nigeria can be attributed to inadequate health education on the importance of PA and reliance on drugs as the main treatment approach for the regulation of plasma blood glucose [19]. The positive attitude on PA is an integral part of diabetes treatment and can

potentially translate to participation in PA [11]. A positive attitude towards PA is likely to translate to participation in PA practice [35].

Strengths and limitations of the study

Our findings provided evidence for good knowledge, positive attitudes, and sufficient PA practices in this population. Also, the study potentially helps further the research in physical activity among people with diabetes. However, the study does have some shortcomings. First, self-reported measures could have overestimated the respondents' physical activity levels, as demonstrated in this study. MET values of some activities, which involve high breathing, have not been derived from actual oxygen consumption, hence increasing the risk of overestimation. In addition, higher proportion of PA knowledge, attitude, and practice in this study might reflect limited applicability of the WHO STEP tool among diabetic patients in this setting. As earlier indicated, work-related moderate-intensity activities accounted for nearly sixty percent of the total PA in this study. The 600 METS per day could be achieved by just walking from one point to another also given the mountainous terrain of most parts of Kilimanjaro region. All these does not necessarily translate to adequate diabetes care or management. Secondly, some individuals might have incorrectly reported the information collected in minutes of physical activity due to the inherent difficulty of recalling the number of minutes spent in one week doing any activity. The study was hospital-based which affects the generalizability of this study's findings. Finally, an inherent limitation of cross-sectional studies is the inability to assess the temporal relationship.

Conclusion and recommendations

The vast majority of diabetic patients were physically active. High levels of PA were associated with a high level of knowledge and positive attitudes towards PA. Health care provider or doctors' advice during diabetic clinics is essential in promoting PA practice in this population and diabetes management.

Contributors

All authors made a substantial contribution to this study. JLM, SS, EM and IBM designed the study. JLM, SS, EM collected and analysed the data. IBM, CA and BJL commented on the manuscript. JLM drafted the manuscript and had the primary responsibility for the final content. All authors reviewed the drafts of this manuscript and approved the final version for submission.

Competing interests

None declared.

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Data Availability statement

Data will be available from corresponding author upon a reasonable request.

Ethics statement

The study was approved by the Kilimanjaro Christian Medical University College Research and Ethics Review Committee (KCMU-CRERC), with the ethical approval number being UG/085/2020. Permission to conduct the study was sought from the Kilimanjaro region medical officer (for Mawenzi Hospital) and the KCMC hospital director. Participants provided oral informed consent, and participation was voluntary. Participants were also informed that they were free to withdraw from the study any time they felt so without affecting their care process. To protect the privacy and confidentiality of the participant information, we used unique identification numbers.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper.	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6 &7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7 &8
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed.	8
		(b) Give reasons for non-participation at each stage.	8
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	10
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-12

		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives.	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.