Prevalence of prediabetes and associated factors among community members in Rural Isingiro district

Isaac Petit Ampeire (rweyeshera@gmail.com)
Mbarara University of Science and Technology
Peter Chris Kawugezi
Mbarara University of Science and Technology
Edgar Mugema Mulogo
Mbarara University of Science and Technology

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Abstract

Background

In rural Uganda many people are either pre-diabetic or diabetic, however they do not know that these conditions afflict them. The burden of pre-diabetes in rural Isingiro had not previously been determined. The study examined the prevalence of pre-diabetes and associated factors.

Methods

A cross-sectional survey that enrolled 370 participants aged between 18 and 70 years was conducted in the Kabuyanda sub-county, rural Isingiro district in March 2021. Multistage sampling and systematic random sampling was conducted to select eligible households and data was collected using a pretested WHO STEP-wise protocol questionnaire. The primary outcome was Prediabetes (FBG=6.1mmol/l to 6.9mmol/l), calculated as a proportion. Chi-square tests and multivariate logistic regression models were performed for data analysis using STATA.

Results;The prevalence of Prediabetes was 9.19% (95% CI 6.23-12.14). Factors independently associated with pre-diabetes were; advancing age [AOR=5.771 95% CI=1.031-32.306, P=0.046], moderate-intensity work [AOR=2.637 95%CI=1.233-5.636, P=0.012], high level of consumption of diet categorized as protective [AOR=5.657 95%CI=1.679-19.054, P=0.005] and body mass index [AOR=3.608 95% CI=1.414-9.206, P=0.007] were significantly associated with Prediabetes.

Conclusion; Prediabetes is prevalent among adult community members in rural Isingiro, southwestern Uganda. Age and lifestyle factors predict Prediabetes in this rural population, suggesting a need for targeted health promotion interventions.

Background

Diabetes is a chronic condition that occurs when there are raised levels of glucose in blood because the body cannot produce any or enough of the hormone insulin or use insulin effectively [35]. Diabetes is an insidious disease. Patients usually go through the stage of Prediabetes for some years before they develop Diabetes disease [2]. Diabetes mellitus is a major public health challenge of the 21st century [23]. It is one of the four major Non-Communicable Diseases(NCD). Diabetes kills and disables, striking people at their most productive age, impoverishing families, or reducing the life expectancy of older people. The burden of Diabetes drains national healthcare budgets and slows economic growth. It is a major cause of catastrophic expenditure for vulnerable households. The global prevalence of Diabetes has grown from 4.7% in 1980 to 8.5% in 2014. By 2017, the estimated number of adults aged 18–79 years old with Diabetes worldwide had risen to 451 million. About 79% of these live in low and middle-income countries. If this trend continues, by 2045 it is estimated that the number of adults who have Diabetes will be 693 million [14]. The regional prevalence of Diabetes in Africa has been estimated at 3.3% about

25.5 million adults aged 20–79 years and 69.2% of these are undiagnosed. A high number of undiagnosed Diabetes cases have costly public health implications in Africa.

Undiagnosed Diabetes contributes to a high burden of morbidity and mortality occurring at a younger age. This seems to have been underestimated because most of the Diabetic patients in Africa are undiagnosed. A high Diabetes prevalence in these Low and Middle-Income Countries (LMIC) will have an additional cost implication for households who are already overburdened with communicable diseases [16]. There is therefore a need to increase screening efforts, especially in Africa so as to prevent the burden of Diabetes on these communities.

Prediabetes is a stage of intermediate raised blood glucose between normal glucose tolerance and Type 2 Diabetes. Prediabetes is also called intermediate hyperglycemia which is defined by two conditions; Impaired Glucose Tolerance (IGT) or Impaired Fasting Glucose (IFG) as per WHO 2006 definition [14]. It is a gradually developing condition which starts with a state of Insulin resistance, then progresses to Prediabetic state and finally to full blown Type 2 Diabetes. Prediabetes is defined by glycemic plasma levels (fasting plasma glucose of 6.1mmol/l to 6.9 mmol/l) that are higher than normal but lower than Diabetes thresholds. The majority of people, that is, 72.3% with prediabetes according to Impaired Glucose Intolerance live in low and Middle Income Countries in Sub Saharan Africa [14]. It is projected that more than 470 million people globally will have Prediabetes by 2030[19].The international Diabetes federation estimated the number of adults aged 20–79 with IGT in Africa to be 40.1 million and projected to increase to 102 million in 2045.

In a case control study among over weight adults with Prediabetes, it was shown that the incidence of diabetes was 2.5 times higher among those who were on the control arm compared to those on the intervention arm of dietary change and lifestyle change. About 6% of Prediabetes individuals progressed to Diabetes annually as compared to 3% in the intervention arm [15].The first and only previous population based study in urban and rural Uganda in 2014, showed the overall prevalence of Impaired Fasting Glucose (IFG) as 2.0% with higher proportion in urban areas at 2.6% and the prevalence of IFG was highest in the western region at 3.3% and lowest in the eastern region at 0.8% [10]. However, another study in rural eastern Uganda in 2013 had found the prevalence of IFG at 8.6% [18].

Subjects with Prediabetes have an increased risk of Type 2 Diabetes[17] and therefore form an important target group for interventions aimed at preventing Diabetes[30].Prediabetes was shown to be associated with an increased risk of composite cardiovascular disease (CVD),Coronary Heart Disease(CHD) and Stroke[13].Observational studies have shown the association between Prediabetes and each form of Nephropathy, small fiber Neuropathy ,Diabetic Retinopathy and an increased risk of macrovascular disease [29].

The early diagnosis of Prediabetes can significantly help individuals and communities at large to prevent themselves from developing overt Diabetes and its debilitating complications. The burden of pre-diabetes in rural Isingiro had not previously been determined. The study examined the prevalence of pre-diabetes and associated factors to inform Diabetes and Prediabetes control programs in this region.

Methods

Design and study setting

A cross sectional survey was conducted in Kabuyanda sub- county, Isingiro district between September 2020 and March 2021. The sub-county has 7864 households with a total population of 37,569 of which 19722 are female. The sub-county is comprised of 8 parishes with 60 villages. Most of the community members derive their livelihood from subsistence farming.

Sample size and sampling procedure

One half of the total parishes were randomly selected. Villages were randomly selected by probability proportionate to the parish. The list of households in the selected villages were obtained and used as a sampling frame. A sampling interval was calculated and systematic random sampling was then done. The number of households to be included from each village was selected randomly and determined by probability proportionate to the size of the village. In each household, participants aged 18 years and above, and not more than seventy years, were selected with one participant per household. The sample size estimate was based on a formula for cross sectional surveys. A “p” prevalence of pre-diabetes of 13.8% was assumed. A sample size of 370 was calculated.

Instrument and variables

Data was collected by trained nurses using a structured pretested questionnaire adapted from the WHO STEP wise approach for risk factors surveillance of Non-Communicable Diseases. A standing height was measured to the nearest 0.1 cm using a portable Stadiometer (Fazzini S225) and recorded as the maximum distance from the floor base of the Stadiometer to the highest part on the head with participant standing barefooted in fully extended standing position. Weight was measured using a portable well calibrated mechanical weighing scale (Fazzini S758) to the nearest 0.1kg and adjusted to zero before each reading.

The body mass index (BMI) was calculated as weight in kilograms over height in meters squared and was categorized as normal (BMI < 25 kg/m^2), overweight (25kg/m^2 $\leq$ BMI $<$ 30kg/m^2), and Obesity (BMI $\geq$ 30kg/m^2). Waist circumference was measured using a constant tension tape placed on the skin of the waist across the mid-point between the lower margin of the least palpable rib and the top of the iliac crest with participant standing with feet close together, arm at the side and back straight. Blood pressure measurements were taken according to the European society of cardiology and hypertension 2018 guidelines of management of hypertension [8]

Participants were requested to have their last meal at a time not more than 10:00pm in the night to achieve 8 hours of fasting. Fasting Blood Glucose was tested by taking participants capillary blood sample from a ring finger of the non-dominant hand according to the WHO guidelines on drawing blood 2010[31].The level of blood Glucose was measured using a validated digital Glucometer (Free Style Optium neo, Abbott). Prediabetes was defined as fasting blood glucose of 6.1mmol/l to $<$ 7mmol/l.

Physical activity was categorized as vigorous intensity work, moderate intensity work, active transport, vigorous recreation and moderate recreation according to WHO recommendations on physical activity[32].Dietary patterns were categorized as low, medium or high according to participants' consumption of diabetogenic foods or protecting foods as recommended by WHO and the International Diabetes Federation (IDF). Diabetogenic foods included; meat, milk, sugary beverages, factory cooking oil and bolted grain flour breads. Protective diet included; fruits, vegetables, whole grains, nuts and seeds.

Data analysis

Data was entered into Access to create a data base that was transferred to Stata version 12 (College Station, Tx 77845) for analysis. Proportions were calculated for categorical variables while Prediabetes was computed as a proportion. Bivariate analysis was conducted to assess the association between explanatory variables, and Prediabetes. Logistic regression was performed to determine variables that were independently associated with prediabetes.

This study was approved by Faculty of Medicine Research committee (FRC) and the Mbarara University of Science and Technology Research Ethics Committee (MUST-REC)

Results

Table 1. Prevalence of Prediabetes

Status	n (%)
Prediabetes	34 (9.19)
Normal	336 (90.81)
Total	370 (100)

Table 1 shows the prevalence of prediabetes.The prevalence of Prediabetes was found to be 9.19% 95% CI (6.23-12.14). The mean fasting plasma glucose(FPG) for the participants was 4.5 mmol/l, Range (2.6-12.3) SD =1.02

Table 2. Socio-demographic characteristics of the respondents.

Characteristic	Total n (%) N=370	No prediabetes n (%) N= 336	Prediabetes n (%) N=34	P-value
Age (mean, SD)		42, SD=14.3		
Age groups				0.012**
18-30	93 (25.1)	91 (27.08)	2 (5.88)	
31-45	123 (33.2)	113 (33.63)	10 (29.41)	
46-60	111 (30.0)	94 (27.98)	17 (50)	
61-70	43 (11.6)	38 (11.31)	5 (14.71)	
Gender				0.129
Male	119 (32.16)	112 (33.33)	7 (20.59)	
Female	251 (67.84)	224 (66.67)	27 (79.41)	
Marital status				0.767
Married/Cohabiting	285 (77.0)	259 (77.08)	26 (76.47)	
Separated/Divorced	23 (6.22)	21 (6.25)	2 (5.88)	
Widowed	38 (10.27)	33 (9.82)	5 (14.71)	
Never Married	24 (6.29)	23 (6.85)	1 (2.94)	
Level of education				0.018**
No formal education	78 (21.1)	69 (20.5)	9 (26.47)	
Primary level completed	207 (56.0)	191 (56.84)	16 (4.76)	
Secondary level completed	57 (15.4)	54 (16.07)	3 (0.89)	
College /university completed	17 (4.6)	15 (4.46)	2 (5.88)	
Refused	11 (3.0)	7 (2.08)	4 (11.76)	
Monthly income (UGX)				0.069
<50,000	218 (58.92)	198 (58.93)	20 (58.82)	
50,000-100,000	113 (30.54)	99 (29.46)	14 (41.18)	
100,000-500,000	39 (10.54)	39 (11.61)	0	

Employment				0.378
Self Employed	346 (93.51)	313 (93.15)	23 (67.65)	
No formal employment	24 (6.49)	23 (6.85)	1 (2.94)	
Family history of diabetes				0.084
Yes	86 (23.3)	81 (24.11)	5 (14.7)	
No	259 (70)	230 (68.45)	29 (85.29)	
Don't know	25 (6.8)	25 (7.44)	0	

** statistically significant at p< 0.05.

Table 2 shows the social demographic characteristics of the participants. A total of 378 eligible participants were contacted, out of which 370(97.8%) were enrolled and participated in the study. A total of 5 participants missed in the early morning of day two for testing for blood sugar and 3 failed to achieve fasting status in the morning. Of the 370 participants 119 (32.2% were males and 251(67.84%) were females. The overall mean age was 42 (SD=14.3), and the mean age for males was 41 (SD=13.7) while for females was 42 (SD=14.5). More than half of the participants had primary level education, Family history of diabetes was reported in only 23.4% of the participants. Among the social demographic factors, Age and level of Education were found to have a significant association with Prediabetes(p<0.05) at the chi square test analysis. Monthly income and family history of diabetes were only marginally associated with Prediabetes. (p<0.1).

Table 3. Bivariate test results showing the association between Prediabetes across the social demographic variables

Characteristic		Prediabetes n (%)		COR	95% CI	P-value
		No Prediabetes N=336	Has Prediabetes N=34			
Age	18-30	91 (27.08)	2 (5.88)	1.000*		
	31-45	113 (33.63)	10 (29.41)	4.027	0.859 -18.879	0.077
	46-60	94 (27.98)	17 (50.00)	8.229	1.845 -36.704	0.006**
	61-70	38 (11.31)	5 (14.71)	5.987	1.11 - 32.291	0.037**
Education level	No formal education	69 (20.97)	9 (30.00)	1.000*		
	Primary level	191 (58.05)	16 (53.33)	0.642	0.271-1.52	0.314
	Secondary level	54 (16.41)	3 (10.00)	0.426	0.11-1.65	0.217
	college /university	15 (4.56)	2 (6.67)	1.022	0.2-5.221	0.979
	Refused	*11 respondents declined to mention their level of education.*				
Household income	<50,000	198 (58.93)	20 (58.82)	1.000*		
	50000-100000	99 (29.46)	14 (41.18)	1.4	0.678 -2.888	0.363
	100000-500000	39 (11.61)	0	1		
Family history of diabetes	No	230 (73.95)	29 (85.29)	1.000*		
	Yes	81 (26.05)	5 (14.71)	2.042	0.764-5.454	0.154

** statistically significant at p< 0.05.

1.000*- odds ratio of the referent category.

Table 3 shows the results of the bivariate test results between prediabetes and social demographic characteristics. Advancing age was significantly associated with prediabetes. The results show that the odds of prediabetes are 8 times higher with increasing age (COR=8.229 CI 1.845 - 36.704 p=0.006). Age was therefore included in the multivariate analysis, other social demographic factors, that is, education level, household income and family history of diabetes did not remain significantly associated with prediabetes and were therefore not included in the multivariate analysis model.

Table 4. Bivariate test results showing the association between Prediabetes and lifestyle variables

Characteristic		Prediabetes		COR	95 % CI	P value
		No prediabetes N=336	Prediabetes N=34			
Smoking	No	288 (85.71)	25 (73.53)	1.000*		
	Yes	48 (14.29)	9 (26.47)	2.16	0.950-4.908	0.066
Alcohol use	No	186 (55.36)	19 (55.88)	1.000*		
	Yes	150 (44.64)	15 (44.12)	0.978	0.481-1.991	0.953
Body mass Index	Normal	217 (64.58)	16 (47.06)	1.000		
	Overweight	83 (24.70)	8 (23.53)	1.307	0.539-3.169	0.553
	Obese	36 (10.71)	10 (29.41)	3.767	1.585-8.949	0.003**
Hypertension	Normal	229 (68.15)	17 (50.00)	1.000*		
	High	107 (31.85)	17 (50.00)	2.140	1.051-4.354	0.036**
Moderate intensity work.	No	225 (66.96)	15 (44.12)	1.000*		
	Yes	111 (33.04)	19 (55.88)	2.567	1.257-5.244	0.010**
Dietary Patterns						
	Low	105 (31.25)	4 (11.76)	1.000*		
Protective diet	Medium	177 (52.68)	18 (52.94)	2.669	0.879-8.100	0.083
	High	54 (16.07)	12 (35.29)	5.833	1.795-18.950	0.003**

** statistically significant at p< 0.05

1.000*- odds ratio of the referent category.

From Table 4,the results show that increasing body mass index, hypertension, moderate intensity level of work and diet categorized as protective were significantly associated with Prediabetes. Participants with higher BMI were 3 times likely to have Prediabetes (COR=3.767 CI=1.585-8.949 p=0.003). The odds of Prediabetes were two fold among those who were hypertensive (COR=2.140, CI=1.051-4.354 p=0.036). Participants with moderate intensity level of work were twice likely to have Prediabetes (COR=2.567, CI=1.257-5.244 p=0.010). The Odds of Prediabetes were 5 times higher among participants who consumed a high level of food categorized as protective (COR=5.833 CI=1.795-18.950 p=0.003). Smoking remained marginally associated with Prediabetes and alcohol use continued to have no significant association with Prediabetes they were not included in the multivariate analysis model. Increasing BMI, Hypertension, moderate level of work and protective diet were included in the multivariate analysis.

Table 5. Bivariate test results showing the association between Prediabetes and Medical and Health accesses variables

Characteristic		Prediabetes, n (%)		COR	95% CI	P Value
		No Prediabetes N=336	Prediabetes N=34			
Ever tested for diabetes						
	No	305 (91.87)	27 (8.13)	1.000		
	Yes	31 (81.58)	7 (18.42)	2.550	1.027-6.335	0.044**
Reported Available testing services at health facility						
	No	251 (91.27)	24 (8.73)	1.000		
	Yes	59 (85.51)	10 (14.49)	1.772	0.804-3.907	0.156
	Don’t know	26 (100)	0	1.000		
Steroid use	No	190 (56.55)	13 (38.24)	1.000*		
	Yes	146 (43.45)	21 (61.76)	2.102	1.018-4.338	0.044**

** statistically significant at p< 0.05.

In table 5, the results show that; ever testing for Diabetes and steroid use were significantly associated with Prediabetes. The results show that the odds of Prediabetes were twice as high among those who had ever tested for Diabetes (COR=2.550, CI=1.027-6.335 p=0.044). The participants who used steroids were twice as likely to have Prediabetes (COR=2.102, CI=1.018-4.338 p=0.044). Ever testing for diabetes and history of steroid use were therefore included in the multivariate analysis model. Report of availability of testing services at the health facility was not significantly associated with Prediabetes and was thus not included in the multivariate analysis model.

Table 6. Multivariate analysis results of factors inherently associated with Prediabetes

Characteristic		COR	P value	AOR	P value	95% CI
Age	18-30	1.000				
	31-45	4.027	0.077	3.540	0.115	0.736-17.03
	46-60	8.229	0.006	7.442	0.01	1.614-34.294
	61-70	5.987	0.037	5.771	0.046**	1.031-32.306
Moderate intensity work	No	1.000				
	Yes	2.567	0.010	2.637	0.012**	1.233-5.636
Protective diet	Low	1.000				
	Medium	2.669	0.083	2.421	0.13	0.771-7.6
	High	5.833	0.003	5.657	0.005**	1.679-19.054
BMI	Normal	1.000				
	overweight	1.307	0.553	1.049	0.918	0.416-2.644
	Obese	3.767	0.003	3.608	0.007**	1.414-9.206

** statistically significant at p< 0.05.

Table 6 shows the results from the multivariate analysis. From the multivariate analysis of significant factors identified at bivariate analysis, increasing age, moderate intensity level of work, consumption of a high level of diet categorized as protective and BMI remained statistically significant with P values <0.05. We adjusted for confounding factors based on biological relevance and significant associations found at the bivariate analysis. The final model was adjusted for family history of Diabetes, smoking, hypertension, ever testing for Diabetes and the use of steroids.

The multivariate analysis showed that the Odds of Prediabetes were 5.7 higher with increasing age (AOR 5.771, p=0.046, CI=1.031-32.306). And the Odds of Prediabetes remained twice as much for participants who had moderate intensity work (AOR=2.637, 0.012, CI=1.233-5.636). Participants who consumed a high level of diet categorized as protective were 5 times likely to have Prediabetes (AOR=5.657, p=0.005, CI=1.679-19.054). The Odds of Prediabetes were 3.6 times higher among the participants with a higher BMI (AOR=3.608, p=0.007, CI=1.414-9.206), see Table 6.

Discussion

In the present study we found an overall prevalence of Prediabetes of 9.19%. This was within the estimated global prevalence range of 4.8%-11.9% but slightly higher than that of sub-Saharan Africa alone[14].However another study that assessed the prevalence of Prediabetes based on correlation with HbA1c in sub Saharan Africa found a prevalence of 25% by the ADA criteria [12]. The ADA criteria on the other hand is known to estimate higher prevalence of Prediabetes than the WHO criteria that we used in the current study. In our current study we found a slightly higher prevalence of Prediabetes compared to another study that was conducted in rural eastern Uganda by Mayega et al & years ago. Mayega found a Prediabetes prevalence of 8.6% by the same WHO criteria as our study [18].

This study also revealed that the prevalence of Prediabetes was higher among women (10.7%) compared to men. Systematic reviews of community -based cross-sectional studies in sub-Saharan Africa that provided sex- specific prevalence, demonstrated a higher prevalence of Prediabetes in males than in females by the IFG but higher prevalence in women by IGT [11].A study in Kenya, East Africa however, also showed a higher prevalence of Prediabetes among females 3.3% compared to males 2.8% [19], this difference is similar to our study findings. The prevalence of Prediabetes by sex seems to vary with regions. In rural Isingiro our study has demonstrated higher prevalence of Prediabetes among females than males. Women in this region tend to have moderate level of work and no levels of physical exercise, they are also relatively more overweight and obese compared to the males. This could explain why they have a higher prevalence of Prediabetes.

The prevalence of Prediabetes in our study was highest among the age group of 46 to 69 years this is similar to other studies which have showed that the age group most affected by Prediabetes is 30–69 years[3][6].

This study has demonstrated like other studies that the prevalence of Prediabetes varies by regions in Uganda. And that in this predominantly rural south western region of Uganda, the prevalence of Prediabetes is high enough and comparable with global estimates and requires serious consideration and attention.

In our study, analysis of the social demographic factors, showed that advancing age was significantly associated with prediabetes. The odds of prediabetes were fivefold with advancing age. In this rural setting, we found that 1 in 6 adults more than 45 years of age may have Prediabetes. This finding confirms that in this rural population advancing age remains an inherently significant risk for prediabetes. Advancing age is well known to be independently associated with increase in insulin resistance. However, we also found that most of the adults in this region do not engage in any form of vigorous or even moderate intensity exercises. The high level of low physical activity and increased risk for insulin resistance with advancing age could explain the association of advancing age and prediabetes in our study.

In the current study, analysis of physical activity showed that the odds of Prediabetes were 2 fold among participants who engaged in moderate intensity work and this remained statistically significant even after controlling for other explanatory factors. Moderate intensity work was measured by participant reports on whether their activities at work increase breathing rates and heart rates for at least 10 minutes continuously. The lack of such activities was used as the referent group in the analysis. It is expected that when there are no moderate intensity work activities the odds of Prediabetes would be higher compared to if an individual has moderate intensity work, this was not the case in our findings. Moderate intensity activities may not provide any difference in insulin sensitivity and glucose utilization compared to low intensity activities, but studies have shown this to be the case for vigorous intensity work. Conrad Earnest in his hypothesis paper demonstrated from various studies, how higher intensity of physical activity or work is more protective than moderate physical activity or work [7].However our results can be explained by the fact that moderate intensity activities may induce a feeling of hunger and an urge to eat in a short time as compared to low intensity work activities. Moderate intensity work may not increase the level of utilization and metabolism of glucose as much as does vigorous exercise and vigorous work. Most of the easily available diet in this rural setting is carbohydrate dense foods. Therefore, a routine exposure of excess glucose from these carbohydrate dense foods despite moderate intensity work will eventually increase the risk of Prediabetes.

In our study we found that consumption of a higher level of diet categorized as protective as per the IDF was not protective as such. We found that, the odds of Prediabetes in individuals who consumed such diet at least twice a week or more than 3 times in a week was 5 fold contrary to our expectation and this remained statistically significant even after controlling for other explanatory variables. This finding is also in contrast to a study that found that plant based diet was protective for Prediabetes when compared to animal based diet[5].However a study that compared fruits and vegetable consumption in Prediabetic individuals demonstrated that higher intake of dark yellow vegetables was significantly associated with a higher chance of Prediabetes [26].Our study findings have showed that dietary foods traditionally considered protective and consumed extensively by most of the people in this rural area may not be very protective .This can be explained by the fact that most of the diet in this rural area is food with high fiber and high carbohydrate content. This means that unless the glucose content of these foods is taken into consideration, consumption of such foods in large quantities may increase the risk of Prediabetes contrary to the expectation. The preparation of such foods considered as protective may also have a significant effect on the protective value of such foods. Most households in this rural area may not be aware of how to properly prepare such foods to retain their nutritive and protective value. The implication of our findings is that, care need to be taken on dietary counselling and recommendations to these community members on diet and prevention of Prediabetes or Diabetes. Riccardi et al in the review of diet on Diabetes demonstrated that the effect of diet on Prediabetes and Diabetes depends on the glycemic index or glycemic load of food items [25].In a randomized pilot trial by Laura R Saslow and colleagues it was shown that very low carbohydrate ketogenic diet was more favorable in reducing the risk of Prediabetes than moderate carbohydrate diets[27].This like in our study findings shows that diet recommendation as protective for prediabetes may need to go beyond the categorization as per the IDF to take into consideration the glycemic index and ketogenic effects of individual local food items.

Increasing level of BMI was found to be independently associated with Prediabetes. Obese individuals were 3 times likely to have Prediabetes. This association was also found in a study among adult teachers in urban Iran [1] and in a comparative study among Adult Chinese and the Swedish [33].Several other studies have further demonstrated that a high BMI is a significant risk factor for Prediabetes [34][24][22].Our current study confirms the significance of a high BMI as an inherent independent predictor of Prediabetes. Our study is the first one in Uganda to find a significant association between BMI and prediabetes in a predominantly rural population. This challenges the notion that rural people are at a reduced risk of the obesity pandemic and the rise in its poor health outcomes like diabetes and hypertension.

Due to low prevalence rates of hypertension among the Prediabetic respondents, our study may have failed to detect an independent significant association between hypertension and prediabetes. However, at the bivariate analysis the association was statistically significant. Several studies have found statistically significant associations findings [28][9][21][20].Prediabetes is among the major elements of metabolic syndrome together with hypertension and dyslipidemias. Some of the significant risk factors that our study have demonstrated as inherent to prediabetes, like advancing age and BMI are also known risk factors for hypertension [4].Therefore hypertension remains an important risk factor for prediabetes.

Whereas prediabetes may not cause an individual to seek for medical attention it is a major stage towards development of Type 2 diabetes. Prediabetic individuals have a higher risk of progressing to Type 2 diabetes in a year. Jaakko and colleagues in a case control study conducted in 2001 found that 6% prediabetic individuals under the control arm progressed to Diabetes as compared to 3% in the other arm who received intensive life style modification intervention[15]. Prediabetes therefore is a stage that presents the best opportunity to initiate interventions for prevention of diabetes at community and individual level.

Limitations

One limitation to our study was the use of participants self-reports to assess physical activity and dietary patterns. Self-reports are subjective and prone to misreporting and thus may result in false associations. We took great care to clearly define levels of physical activity and provide elaborate demonstrations of physical activity categories. While for dietary food intakes local examples in the local language were provided to minimize recall bias. Another limitation of the study was ensuring fasting status of the participants in the early morning. The study involved taking finger capillary blood samples for Fasting Blood Glucose test early in the morning of day 2. In the rural setting and the timing of the study, participants wake up very early and eat a meal before going for work, as is their routine. Some of the participants could have forgotten and taken a meal and refuse to divulge the information because of their interest to know their blood Glucose status. We ensured fasting status by cross examination every morning and making sure that the team reaches households very early to test for blood Glucose before participants leave for work or take any kind of food or drink.

Conclusion

Prediabetes is prevalent among community members in rural Uganda. The prevalence is slightly higher but comparable with global estimates. It has been found that prediabetes affects women more than men and community members of older age especially those above 40 years. Advancing age and high body mass index are independent predictors of Prediabetes in rural Isingiro in south western Uganda. Moderate intensity level of work was associated with prediabetes and a diet categorized as protective was not protective as such for Prediabetes.

Given the level of prediabetes in this rural population, it is recommended that routine screening for prediabetes should be emphasized. This should be so especially among adults with a high BMI.An in-depth study is also recommended to fully understand the causal relationship between the commonly consumed foods and prediabetes in rural communities in Uganda.

Declarations

We here by declare that this research report is the result of our original research work and inputs. No part of this report has ever been published in any journal. The research was solely undertaken as part of academic qualification requirement at Mbarara University of science and Technology and all methods and procedures were done according to the relevant guidelines and regulations.

Consent to publication

This is not applicable since our manuscript contains no images or information that could lead to the identification of the participants.

Ethics approval and consent to participate

Ethical approval for this study was sought and obtained from the Research Ethics Committee at Mbarara University of Science and Technology. Written informed consent was also obtained from the individual subjects.

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author at the email; rweyshera@gmail.com

Competing interests

The authors declare that they have no competing interests.

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Authors Contributions

AIP participated in the study conception and design, data acquisition, analysis and interpretation, manuscript drafting and revising the version for publication.

PCK participated in study conception and design and drafting of the manuscript.

EMM participated in the study conception, and design, and interpretation, manuscript drafting and approval of the final version for publication.

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