

# Diabetes awareness and control among urban dwellers of Kinondoni District, Dar es Salaam, Tanzania:

## A population-based study.

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## **Abstract**

**Background:** Diabetes is a major endocrine disorder of global health importance associated with high morbidity, mortality and cost of care. It is estimated that about 90% of persons with prediabetes and 46.5% with diabetes in sub-Saharan Africa are unaware of their status and as a result not on treatment. We conducted this population-based screening to explore the prevalence, awareness and control rates of prediabetes and diabetes among urban dwellers residing in Kinondoni district, Dar es Salaam.

**Methods:** We recruited and screened 1374 persons for diabetes mellitus in this population-based cross-sectional study. Diabetes was diagnosed using a random blood glucose (RBG)  $\geq 11.1$  mmol/L and/or fasting blood glucose (FBG)  $\geq 7$  mmol/L. Prediabetes was defined as a FBG of 5.6-6.9 mmol/L and/or RBG of 7.8-11.0 mmol/L. Potential factors associated with prediabetes and diabetes were assessed by univariate analyses and significant factors were then put in a logistic regression model to control for confounders. Odd ratios with 95% confidence intervals and p-values are reported.

**Results:** The mean age was 42.9 years, women constituted 64.3% of participants and 68.9% were overweight or obese. The crude prevalence of prediabetes and diabetes was 15% and 13.6% respectively. 21.9% of persons with diabetes were aware of their diabetes status and 46.3% of these had their blood sugar controlled. Obesity (OR 1.5, 95%CI 1.1-2.0,  $p < 0.01$ ), female sex (OR 1.6, 95%CI 1.1-2.1,  $p < 0.01$ ) and age  $\geq 55$  (OR 1.9, 95%CI 1.4-2.5,  $p < 0.001$ ) proved to be the strongest factors associated with new diagnosis of prediabetes and diabetes.

**Conclusion:** The prevalence of prediabetes and diabetes is increasing rapidly in urban Tanzania while the awareness and control rates remain low. Parallel to this, the rates of obesity are also rising exponentially and it proved to be the strongest modifiable risk factor associated with prediabetes and diabetes.

**Key words:** diabetes, prediabetes, excess body weight, obesity, awareness, control

## Background

Diabetes mellitus is a global epidemic of major public health importance that disproportionately affect minority populations.<sup>1-4</sup> In a span of 20 years, diabetes burden has had one of the steepest rise for any disease making it the biggest endocrine contributor to the global burden of disease.<sup>5</sup> The global prevalence in 2015 was estimated to be 9% with some countries reporting prevalence of up-to 37.5%.<sup>6</sup> About 75%<sup>6</sup> of all persons with diabetes live in low- and middle-income countries which also carry an over 80%<sup>7</sup> of global mortalities attributable to it. Moreover, diabetes accounted for about 12% of health expenditures worldwide in 2015, making it a significant financial threat especially to the developing nations.<sup>6,8-11</sup>

Early detection and appropriate intervention of prediabetes has the potential to change the natural history by preventing or rather delaying its progression to a full blown diabetes.<sup>12,13</sup> Furthermore, good glycemic control is known to reduce the risk of microvascular and neurological complications of diabetes.<sup>14-18</sup> Despite this knowledge, nearly 90% of persons with prediabetes and 46.5% with diabetes in sub-Saharan Africa are unaware of their status.<sup>6,19-21</sup> Given the rising prevalence of obesity in Tanzania<sup>22</sup>, it is likely that the prevalence of diabetes particularly among the urban settlers is on a rapid rise. We conducted this population-based screening to explore the prevalence, awareness and control rates of prediabetes and diabetes among urban dwellers residing in Kinondoni district, Dar es Salaam.

## Methods

### Study Oversight & Definition of Terms

This population-based screening was conducted in Kinondoni district, Dar es Salaam, Tanzania in January 2016. We recruited and screened 1374 persons for diabetes mellitus. Participants of this study were a subset of a 3-day cardiovascular diseases screening sample. All participants in the larger screening were given a registration number on a random basis and those assigned an odd number were offered diabetes screening on top of the cardiovascular diseases screening. Socio-demographic data was gathered through interviews utilizing a structured questionnaire. Physical activity vital sign (PAVS) scale<sup>23</sup> was used to assess for physical activity where scores of 0 minutes/week, 1 - <150 minutes/week and  $\geq 150$  minutes/week signified physical inactivity, underactivity and activeness respectively. Body Mass index (BMI) was a ratio of weight to height squared. For participants aged less than twenty years, a CDC BMI online calculator<sup>24</sup> for children and teens was used. We used the WHO BMI cut-off values to define underweight, normal, overweight and obese.<sup>25</sup> A duration of 6 months without smoking or a self-report of smoking cessation was used to label one a past smoker. Those who presently smoke were regarded as current smokers, while non-smokers living with smokers were grouped as passive smokers. Persons with a current history of alcohol consumption were assessed for alcohol dependence using the CAGE questionnaire<sup>26</sup>, a total score of at least 2 was used to define alcohol dependence. Diabetes was diagnosed using a random blood glucose (RBG)  $\geq 11.1$  mmol/L and/or fasting blood glucose (FBG)  $\geq 7$  mmol/L.<sup>27</sup> Prediabetes was defined as FBG of 5.6-6.9 mmol/L and/or RBG of 7.8-11.0 mmol/L.<sup>27</sup> Glucose levels of 3.9 mmol/L and 2.8 mmol/L

were used to define hypoglycemia among diabetics and non-diabetics respectively.<sup>28</sup> Diabetes awareness was defined as prior knowledge of diabetes status established in a health facility and/or use of oral hypoglycemic and/or insulin. Controlled diabetes was defined as awareness of diabetes associated with a RBG < 11.1 mmol/L or FBG < 7 mmol/L. All screening staff underwent a one day training to familiarize themselves with study aims and methods.

### **Statistical analysis**

STATA v11.0 software was employed in all statistical analyses. Continuous and categorical variables are summarized and presented as means ( $\pm$  SD) and frequencies (percentages) respectively. Categorical variables were compared using the Chi square tests while Student's T-test was used in comparison of continuous variables. Factors associated with prediabetes and diabetes were assessed by bivariate analyses and significant factors were then put in a logistic regression model to control for confounders. Odd ratios with 95% confidence intervals and p-values are reported. All analyses were two-sided and  $p < 0.05$  was used to denote significance.

## Results

**Table 1: Socio-Demographic Characteristics of Study Participants (N = 1374)**

<b>Characteristic</b>	<b>n (%)</b>
<b>Age: mean (SD), years</b>	42.9 (13.8)
<b>Age groups</b>	
18-39	421 (30.6%)
40-54	509 (37.0%)
≥55	444 (32.3%)
<b>Sex</b>	
Female	883 (64.3%)
Male	491 (35.7%)
<b>Education level</b>	
None	98 (07.1%)
Primary	801 (58.3%)
Secondary	385 (28.0%)
University	90 (06.6%)
<b>Marital status</b>	
Single	250 (18.2%)
Married	837 (60.9%)
Divorced	109 (07.9%)
Widowed	178 (13.0%)
<b>Physical Activity</b>	
Inactive	904 (65.8%)
Underactive	267 (19.4%)
Active	203 (14.8%)
<b>Smoking status</b>	
Non-smoker	1238 (90.1%)
Current smoker	14 (01.0%)
Past smoker	73 (05.3%)
Passive Smoker	49 (03.6%)
<b>Alcohol dependence</b>	
Yes	74 (05.4%)
No	1300 (94.6%)
<b>BMI: mean (SD), kg/m<sup>2</sup></b>	27.9 (6.6)
<b>BMI category, kg/m<sup>2</sup></b>	
<18.5	36 (02.6%)
18.5-24.9	392 (28.5%)
25-29.9	404 (29.4%)
≥30.0	543 (39.5%)

## Study Population

The mean age was 42.9 years and women constituted 64.3% of all participants. 58.3% of individuals had primary education knowledge, 60.9% were married, 5.4% had alcohol dependence, and 9.9% were either current, past or passive smoker. About two-thirds were physically inactive and 68.9% of all individuals had excess body weight, Table 1.

**Table 2: Blood Sugar Range of Participants with Negative History of Diabetes (N = 1330)**

Characteristic	Blood Sugar Range		
	normoglycemia	prediabetes	diabetes
<b>Overall</b>	984 (74.0%)	200 (15.0%)	146 (11.0%)
<b>Age group</b>			
18-39 ∞	331 (80.9%)	47 (11.5%)	31 (07.6%)
40-54	361 (73.5%)	69 (14.1%)	61 (12.4%)*
≥55	292 (67.9%)	84 (19.5%)**	54 (12.6%)*
<b>Sex</b>			
Female	605 (70.8%)	141 (16.5%)*	109 (12.7%)**
Male	379 (79.8%)	59 (12.4%)	37 (07.8%)
<b>BMI Category</b>			
<18.5	32 (94.1%)	2 (05.9%)	0 (00.0%)
18.5-24.9 ∞	316 (83.4%)	40 (10.6%)	23 (06.0%)
25.0-29.9	289 (73.5%)	57 (14.5%)	47 (12.0%)**
≥30.0	347 (66.2%)	101 (19.3%)***	76 (14.5%)***

persons with hypoglycemia (n = 3) are not featured in this table ; ∞: reference group ; \*: p<0.05 ; \*\*: p<0.01 ; \*\*\*: p<0.001

## Diabetes Awareness and Control

The crude prevalence of diabetes was 13.6% (187/1374) and 21.9% (41/187) had awareness of their diabetic status. 46.3% (19/41) of persons with diabetes awareness had their blood sugar controlled. Table 2 displays blood sugar range of 1330 participants who had a negative diabetes history. The age adjusted prevalence of newly diagnosed prediabetes and diabetes was 11.8% and 7.3% among males and 16.0% and 12.4% among female participants respectively. The elderly subgroup (i.e. age ≥55) displayed a higher likelihood of having prediabetes and diabetes compared to age groups, (p<0.01 & p<0.05 respectively compared to 18-39 years). Females displayed higher diabetes rates compared to males i.e. 12.7% vs 7.8%, p<0.01. Diabetes rates increased with increasing body weight ranging from 0% among underweight participants to 14.5% in the obese subgroup. Table 3 displays results of logistic regression analyses of factors associated with prediabetes and diabetes. After multivariate analyses; those aged 55 years and above had a 90% increased rate of prediabetes and diabetes compared to those aged less than

55 years, ( $p < 0.001$ ). Female sex and obesity displayed a 60% and 50% increased likelihood for prediabetes and diabetes compared to male sex and non-obese individuals respectively, (both  $p < 0.01$ ).

**Table 3: Logistic regression analyses of potential factors associated with a new diagnosis of prediabetes and diabetes**

Test Group	Comparative	OR	95% CI	P-value	Adj.OR	95% CI	P-value
Age $\geq 55$	Age $< 55$	1.8	1.4-2.4	$< 0.001$	1.9	1.4-2.5	$< 0.001$
Female	Male	1.7	1.3-2.3	$< 0.001$	1.6	1.1-2.1	$< 0.01$
BMI $\geq 30$	BMI $< 30$	1.8	1.4-2.4	$< 0.001$	1.5	1.1-2.0	$< 0.01$
Inactive	Active/Underactive	0.8	0.6-1.1	0.17	-	-	-
Ever smoker	Never smoker	0.9	0.5-1.6	0.81	-	-	-
Alcohol dependent	Not dependent	0.6	0.3-1.3	0.19	-	-	-

## Discussion

Increasing urbanization, rapid lifestyle changes, and improved medical care have led to longevity of human life coupled with increased incidence of obesity and diabetes among other comorbidities. This present study has demonstrated a high prevalence of prediabetes and diabetes of 15% and 13.6% respectively. A study conducted by Ruhembe et al<sup>29</sup> in Mwanza region, another major city in Tanzania revealed near similar rates of diabetes (11.9%). These findings are way above the 2015 national prevalence of 3.5%<sup>30</sup> and should raise a serious concern among policy makers and medical practitioners in Tanzania. Recent population-based studies in nearby countries including Kenya, Nigeria and South Africa have also documented an increasing trend of diabetes with prevalence rates ranging from 5.1%-16%.<sup>31-34</sup> Less than a quarter of all persons with diabetes in this study were aware of their diabetes status. Awareness rates in developing nations, sub-Saharan Africa in particular is reportedly very low.<sup>35</sup> For instance, studies from Ethiopia, Kenya and Tunisia have produced awareness rates of 25%-47%.<sup>34,36,37</sup> Additionally, diabetes control rates are uniformly low among studies and we found that less than a half of participants with diabetes awareness in this study had their blood glucose controlled.

We observed that females displayed significantly higher rates of diabetes compared to males. Existing literature is enriched with inconsistent findings regarding sex differences and diabetes. While some studies<sup>29,38-40</sup> have revealed results in unison with our findings, others<sup>33,41-44</sup> have found higher rates among males and some<sup>45-49</sup> have produced similar rates of diabetes between

males and females. Association between sex and diabetes indeed needs further exploration. Unlike sex, old age is a well-established factor associated with diabetes. Participants in the age group  $\geq 55$  years displayed higher diabetes rates compared to age groups 18-39 and 40-54 years. Numerous other studies have shown the association between aging and increased risk of diabetes.<sup>29,33, 50-56</sup> Furthermore, our findings displayed an increased likelihood of diabetes with increasing weight i.e. obese subgroup had the highest diabetes rate. Multivariate analysis of our data found obesity to be the strongest modifiable risk factor for diabetes, findings which are in keeping with previous work.<sup>57</sup> Excess body weight has been shown to increase the risk of diabetes by up-to seven-fold compared to those with a healthy weight.<sup>58</sup> Moreover, previous studies<sup>29,33-35</sup> have consistently shown higher rates of obesity amongst females compared to males, findings which have been replicated in this present study.

This study had limitations largely due to its observational nature including selection bias and non-differential bias. Moreover, our assessment of diabetes apart from relying on a single measure it also relied on rapid glucose measurement instead of glycated hemoglobin which has the potential to give a reliable estimate of one's blood sugar concentration. Nevertheless, our study has numerous strengths including; recruiting a good number of participants suitable for subgroup analyses, use of standard definitions and cut-off points which will make comparison among studies practicable, produced findings which are consistent to previous work and the observed high rates of prediabetes and diabetes are noteworthy.

## **Conclusion**

This study has revealed that the prevalence of diabetes is rising at a fast pace in urban Tanzania. Parallel to this, the rates of obesity are also rising exponentially and it proved to be the strongest modifiable risk factor associated with prediabetes and diabetes. Furthermore, the rates of diabetes awareness and control are low thus warranting concrete measures to cultivate and stimulate the health seeking behavior and exercising culture especially in low- and middle-income nations.

**Ethical Consideration**

Ethical clearance was obtained from the Unit of Research of the Jakaya Kikwete Cardiac Institute (JKCI) and the Office of the Kinondoni District Commissioner granted the permission to conduct the study. All participants gave informed consent prior to recruitment into the study.

**Availability of Data Materials**

The final version of data set supporting the findings of this paper may be found in the Jakaya Kikwete Cardiac Institute website ([www.jkci.or.tz](http://www.jkci.or.tz)). The corresponding author will be more than willing to email the data set to the editorial committee whenever it's needed.

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**Conflict of interest**

The authors have no conflict of interest to disclose

**Authors Contributions**

MJ, PK, and PP conceived and designed the study. Analysis and development of the manuscript was done by PP and PN. PK, EU, LS, and MJ made revisions of the initial draft. All authors have made contribution and approved the present version.

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