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ORIGINAL ARTICLE

Prevalence of Pre-Diabetes, Diabetes and Associated Cardiovascular Risk Amongst Healthcare Workers in Ahmadu Bello University Teaching Hospital (ABUTH), Zaria using Glycated Haemoglobin

Prévalence du Prédiabète, du Diabète et des Risques Cardiovasculaires Associés chez les Travailleurs de la Santé de l'Hôpital Universitaire Ahmadu Bello (ABUTH), Zaria utilisant de l'Hémoglobine Glyquée

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ABSTRACT

BACKGROUND: **There is a global rise in the prevalence of diabetes mellitus and pre-diabetes is a fore-runner to type-2 diabetes. Pre-diabetes is reversible, therefore, measures should be taken to halt or slow down its progression to frank diabetes.**

AIM: **The study aimed to evaluate the prevalence of pre-diabetes and diabetes amongst staff of ABUTH, Zaria and identify some cardiovascular risks associated with them.**

METHODS: **A cross-sectional analytical study carried out on 377 healthcare workers who presented at the Medical out-patient department of ABUTH, Zaria in response to an invitation for the 2017 World Diabetes Day free medical screening. HbA1c was assessed via Immunofluorescence method. The difference in HbA1c amongst healthcare workers was determined by One-way Analysis of Variance with Post-hoc Bonferroni test. Cardiovascular risk associations were assessed via Multiple Binary Logistic Regression.**

RESULTS: **Pre-diabetes and diabetes prevalence were 19.4% and 6.5% respectively. There were 28.6% undiagnosed diabetic healthcare workers. There was no significant (p=0.35) difference in HbA1c between different categories of healthcare workers, however, random blood glucose was significantly (p=0.042) higher in other healthcare workers than doctors. There was a significant (p<0.01) association between systolic hypertension and risk of developing pre-diabetes and diabetes (OR, 4.11, CI 0.98–17.30).**

CONCLUSION: **There is a high prevalence of pre-diabetes and diabetes amongst healthcare workers in Zaria. The Odds of hypertensive healthcare workers developing pre-diabetes and diabetes is high. Efforts should be geared at intensifying health education, increased work physical activity and proper diet. WAJM 2020; 37(2): 91–99.**

Keywords: **Pre-diabetes, Diabetes, Cardiovascular Risk, HbA1c, Healthcare workers, Nigeria.**

RÉSUMÉ

CONTEXTE: La prévalence du diabète sucré est en hausse dans le monde entier et le prédiabète est un précurseur du diabète de type 2. Le pré-diabète est réversible, c'est pourquoi des mesures doivent être prises pour arrêter ou ralentir sa progression vers le diabète franc.

Objectif : L'étude visait à évaluer la prévalence du prédiabète et du diabète parmi le personnel d'ABUTH, Zaria et à identifier certains risques cardiovasculaires qui y sont associés.

MÉTHODES: Une étude analytique transversale réalisée sur 377 travailleurs de la santé qui se sont présentés au service médical ambulatoire d'ABUTH, Zaria, en réponse à une invitation pour le dépistage médical gratuit de la Journée mondiale du diabète 2017. L'HbA1c a été évaluée par la méthode d'immunofluorescence. La différence de taux d'HbA1c chez les travailleurs de la santé a été déterminée par une analyse de variance à sens unique avec le test post-hoc de Bonferroni. Les associations de risques cardiovasculaires ont été évaluées par régression logistique binaire multiple.

RÉSULTATS: La prévalence du pré-diabète et du diabète était de 19,4 % et 6,5 % respectivement. Il y avait 28,6 % de travailleurs de la santé diabétiques non diagnostiqués. Il n'y avait pas de différence significative (p=0.35) du taux d'HbA1c entre les différentes catégories de travailleurs de la santé, cependant, la glycémie aléatoire était significativement (p=0.042) plus élevée chez les autres travailleurs de la santé que chez les médecins. Il y avait une association significative (p<0,01) entre l'hypertension systolique et le risque de développer un pré-diabète et un diabète (OR, 4.11, IC 0.98-17.30).

CONCLUSION: Il existe une forte prévalence de prédiabète et de diabète chez les travailleurs de la santé à Zaria. La probabilité que les professionnels de la santé souffrant d'hypertension développent un prédiabète et un diabète est élevée. Les efforts doivent être axés sur l'intensification de l'éducation à la santé, l'augmentation de l'activité physique au travail et une alimentation adéquate. **WAJM 2020; 37(2): 91–99.**

Mots-clés: Pré-diabète, Diabète, Risque cardiovasculaire, HbA1c, Travailleurs de la santé, Nigeria.

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Abbreviations: **BMI,** Body Mass Index; **DBP,** Diastolic Blood Pressure; **DM,** Diabetes Mellitus; **HbA1c,** Glycated Haemoglobin; **IFG,** Impaired fasting glucose; **IGT,** Impaired glucose tolerance; **RBG,** Random Blood Glucose; **SBP,** Systolic Blood Pressure; **WC,** Waist Circumference.

INTRODUCTION

Diabetes mellitus (DM) is a chronic non-communicable disease often regarded as a "silent killer" with complications affecting almost all body organs.[1] Pre-diabetes, which is a fore-runner to diabetes, is defined by the American Diabetes Association (ADA) as presence of impaired fasting glucose (IFG) (100–125 mg/dL) and/or impaired glucose tolerance (IGT) (140–199 mg/dL) and or glycated haemoglobin (HbA1c) of 5.7–6.4% (39–47mmol/mol).[2] There is a global rise in the prevalence of DM rated at 8.8% with 424.9 million adults affected as at the year 2017 and this is projected to reach 9.9% with 628.6 million adults affected by 2045.[1] The proportion of adults with diabetes in sub-Saharan Africa has been projected to rise from 15.5 million in the year 2017 to 40.7 million by 2045 with 69.2% being undiagnosed.[1] In Nigeria, recent meta-analysis by Uloko *et al* rates it at 5.7%.[3] Similarly, pre-diabetes affects 7.3% (352.1 million) adults aged 20-79 years worldwide with an estimated rise to 8.3% (531.6 million) by 2045.[1] Likewise, about 7.7 million adult Nigerians were reported to have pre-diabetes in 2017 with an estimated projection of 17.9 million by 2045.[1]

This rising trend in the sub-Saharan Africa and Nigeria in particular can be attributed to early epidemiologic transition associated with "urbanization" and "westernisation".[4] This encompasses "morbidity and mortality aetiologic shifts" as the battle against non-communicable diseases is gradually replacing the scourge against communicable diseases, infections and malnutrition;[4] "nutritional transition" encompassing the adoption of western diets consisting of highly refined and processed foods, low fruits/vegetable content, low fibre and high cholesterol-containing foods.[1,4] There is also "risk factor transition" associated with lack of exercise, increased smoking and alcohol consumption[5] as well as "science and technological transition," resulting in long occupational sitting hours and sedentary positioning, consequently leading to obesity and type-2 DM.[4,6–9]

The economic burden of the disease is huge, [1,9] hence the need for studies to be focused on pre-diabetes, diabetes, associated cardiovascular (CV) risks and its prevention. Urgent measures should be taken to halt or slow down the progression of pre-diabetes to frank diabetes as well as prevent its CV complications.[1] More so, healthcare workers are particularly vulnerable to pre-diabetes, diabetes and CVD consequent to the long sitting hours, sedentary positioning, longer indoor activities, less exposure to sunshine as well as poor work dietary pattern.[6–10, 12–13]

Furthermore, previous studies done in other parts of Nigeria utilized fasting plasma glucose (FPG), 2 hours post-prandial and or oral glucose tolerance test with little or no study done on healthcare workers using glycated haemoglobin (HbA1c).[9,11,14] HbA1c is more advantageous than other blood glucose tests viz-a-viz better convenience and greater pre-analytical stability.[15–16] The day to day within subjects variation is <2% compared to 12–15% for FPG.[17,18] It can also determine blood glucose control over a three months period[19–20] and better relates to risks of micro- and macro-vascular complications.[21] It can be performed at any time of the day without need for patient preparation or an overnight fast.[15] HbA1c levels also represent post-prandial glucose intolerance in addition to impaired fasting glucose unlike a simple fasting plasma glucose assess-ment, hence could be more effective in screening overweight pre-diabetes subjects with glucose abnormalities.[22]

Likewise, the traditional cardio-vascular risk factors have been shown from studies worldwide to be associated with pre-diabetes and diabetes.[23–26] Its impact on the development of pre-diabetes and diabetes amongst healthcare workers in the Northern part of the country, bearing in mind their unique socio-cultural and religious practices, may be important to evaluate. The study was therefore carried out to determine the prevalence of pre-diabetes and diabetes amongst healthcare workers in Ahmadu Bello University Teaching Hospital (ABUTH), Zaria and evaluate some cardiovascular risks associated with it.

METHODS

Study Location and Research Design

It was a cross-sectional analytical study carried out among 377 healthcare workers who responded to an invitation for the 2017 World Diabetes Day celebration at the Medical Out-patient Department (MOPD) of ABUTH, Zaria. The study was carried out in accordance with the amended Helsinki's declaration and all participants gave written informed consent.

Inclusion criteria were adult healthcare workers above 20 years with willingness to participate. Exclusion criteria included healthcare workers with historical and clinical evidence of sickle cell disease, pregnancy or lactation, acute febrile illness and incomplete glycated haemoglobin data.

Screening Evaluation and Data Collection

There was a total of 377 healthcare workers who presented at the MOPD of ABUTH, Zaria, Nigeria on November 14, 2017. This was in response to an office-by-office/department-by-department invitation for free medical check-up and diabetes screening by 15 trained research assistants. Posters were another means of advertisement. A standard well-structured questionnaire was self-administered by each eligible study participant.

Anthropometric measurements {Waist circumference (WC), weight, height, body mass index (BMI) and blood pressure} were determined according to standard protocol approved by the World Health Organisation (WHO).[27,28] The cut-off points for WC was 80 cm for females and 94 cm for males.[27] The weight was measured in kilogram (kg) with the subject standing motionless on a weighing scale while height was measured in meters with the subject in erect posture against a vertical scale stadiometer.[27] The BMI was determined as weight (kg)/ height^2 in kg/m^2. Blood pressures were measured using Accoson mercury sphygmo-manometer, twice in the left arm of seated subjects previously rested for 5 minutes and by standard protocol and the mean of the two readings was used.[28] Hypertension was defined from self-reported history and or systolic or diastolic blood pressure $\geq$140/90 mmHg

or current use of anti-hypertensives.[28] The new hypertension guideline for re-definition of hypertension with partition limits of 130/80 mmHg was additionally applied.[29]

Preliminary random blood glucose was additionally assessed for all subjects using accu-check glucometer which had been previously standardized with the Chemray 120 automated clinical chemistry auto-analyser in the Chemical pathology laboratory of ABUTH, Zaria. Partition limits for RBG was ≥ 200 mg/dL or ≥ 11.1 mmol/L for diabetes and 140–199 mg/dL or 7.8-11.0 mmol/L for pre-diabetes.[1]

Blood Sample Collection

Blood samples for glycated haemoglobin were obtained from the ante-cubital vein of either arm. The whole blood was divided into two 5 ml aliquots and placed into labelled potassium EDTA-containing plastic lavender vacutainer tubes. The test tubes were taken to the Chemical pathology laboratory of the ABUTH, Zaria within 4 hours of collection for HbA1c assay.

Measurement of HbA1c

The Fine care HbA1c rapid quantitative test cartridge by Guangzhou Wondfo Biotech Company Ltd. with Lot No: F20711C0E AD was used for the *in-vitro* quantitative determination of glycated haemoglobin in whole blood in accordance with the manufacturer's manual and based on the Sandwich Immunofluorescence detection method.[30] Glycated haemoglobin was classified based on the ADA criteria as normal (<5.7 mmol/L); pre-diabetes (5.7–6.4 mmol/L) and diabetes (≥6.5).[1]

Data Analysis

Data were validated on excel and analysed by SPSS version-22 software (SPSS Inc., Chicago, IL, USA). The continuous variables were presented as Mean ± SD and the difference between each category of healthcare worker was determined by One Way Analysis of Variance (ANOVA) with Post-hoc Bonferroni test. Categorical variables were presented as frequencies and percentages with difference determined by Chi-square (χ^2). Descriptive statistics was done to estimate the prevalence of pre-diabetes and diabetes. The health-care workers were grouped into three classes viz: Doctors, Nurses and Other healthcare workers consisting of pharmacists, clerical staff, administrative staff, laboratory technicians, secretaries, health information staff, medical record staff, physiotherapists, estate managerial staff, health attendants and social healthcare workers. Categorical variables were recoded into other variables with 'Yes' being regarded as 1 and 'No' as 2. Numerical variables such as blood pressure (systolic and diastolic), BMI and WC were recoded into other variables as well as glycated haemoglobin.

The association between some cardiovascular indices and pre-diabetes/diabetes via recoded glycated haemoglobin was determined by Multiple Binary Logistic Regression analysis. The level of significance was assumed to be $p \leq 0.05$ at 95% Confidence Interval.

RESULTS

Study Participants

There were 217 healthcare workers randomly selected from a sample frame of 377 healthcare workers by random number allocation. These subjects met eligibility criteria, were enrolled and had complete data collected and analyzed. The remaining 160 subjects were excluded on account of incomplete data (Figure 1).

Socio-Demographic and Clinical Characteristics of the Study Population

There were 82 (37.3%) of the healthcare workers aged less than 40 years while greater proportions, 135 (62.2%) were between 40–65 years of age with the middle age being more represented (Table 1). There was a female preponderance (Table 1). The nurses constituted the highest proportion of healthcare workers followed by other healthcare workers then doctors (Table 1). Only 4.6% and 1.4% of the health-care workers took alcohol and cigarettes respectively. There were 63 (29%) of the subjects who attested to the fact that they were hypertensive while 10 (4.6%) were aware that they had diabetes (Table 1). There was a positive family history of hypertension and diabetes in over half and a third of the healthcare workers respectively (Table 1). Only 10 (4.6%) of the subjects had history of osmotic symptoms {polyuria (passage of ≥ 3 litres of urine in 24 hours); polydipsia (intake of ≥ 3 litres of water in 24 hours); and polyphagia (excessive food intake)}. More of the healthcare workers were overweight and obese totalling 145 (66.8%) (Table 1).

The prevalence of pre-diabetes by glycated haemoglobin was 42 (19.4%) while that of diabetes was 14 (6.5%) (Table 2). Out of the 6.5% diabetes healthcare workers, 4 (28.6%) were undiagnosed while 10 (71.4%) were aware that they had diabetes. None of the diabetes healthcare workers had glycaemic control <6.5%.

The mean HbA1c of the study population was 5.42 ± 0.76 % with highest levels among the diabetes subjects (Table 2). There was a significant (p<0.001) difference in HbA1c levels between normal, pre-diabetes and diabetes healthcare workers by One-way Analysis of Variance (ANOVA). The actual difference (p<0.001) with Post-hoc

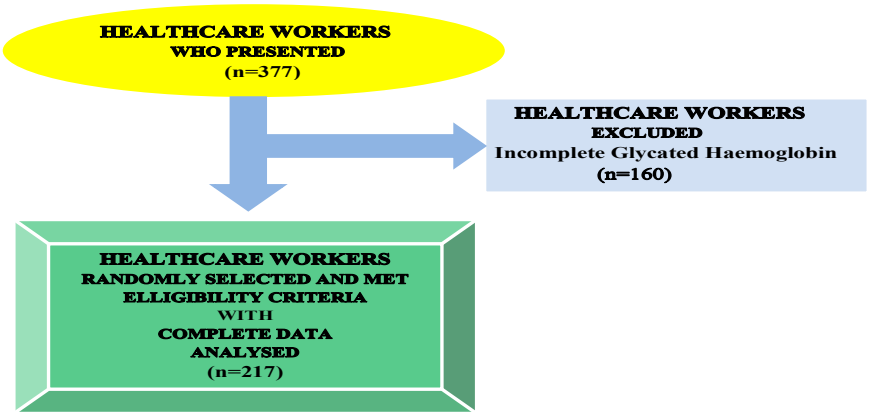

Fig. 1: Subject Participation at the 2017 World Diabetes Day at Ahmadu Bello University Teaching Hospital, Zaria, Nigeria.

Table 1: Socio-Demographic and Historical Characteristics of the Healthcare Workers

Variables	Complete Data (n=217)	Percentage (%) (n=217)	Incomplete Data (n=160)	Percentage (%) (n=160)
Age (Years)				
Young (< 40 years)	82	37.8	73	45.6
Middle age/Elderly (40–65)	135	62.2	87	54.4
21–30	23	10.6	34	21.3
31–40	59	27.2	39	24.4
41–50	61	28.1	49	30.6
51–60	72	33.2	36	22.5
61–70	2	0.01	2	0.01
Sex				
Female	144	66.4	94	58.8
Male	73	33.6	66	41.3
Profession				
Doctors	53	24.4		
Nurses	99	45.6		
Others	65	30.0		
Alcohol				
Yes	10	4.6		
No	207	95.4		
Cigarette Use				
Yes	3	1.4		
No	214	98.6		
Hypertension History				
Yes	63	29.0		
No	154	71.0		
Family History Hypertension				
Yes	114	52.5		
No	103	47.5		
Diabetes History				
Yes	10	4.6		
No	207	95.4		
Family History ofDiabetes				
Yes	70	32.3		
No	147	67.7		
Osmotic Symptoms				
Yes	10	4.6		
No	207	95.4		
BMI (kg/m^2)				
Underweight (< 18.5)	3	1.4		
Normal (18.5–24.9)	69	31.8		
Overweight (25–29.9)	75	34.6		
Obesity (>30)	70	32.3		

Data presented in Proportions and Percentages. n, total number of subjects; BMI, Body Mass Index.

Bonferroni test was the higher levels of glycated haemoglobin in pre-diabetes than normal healthcare workers; diabetes than pre-diabetes health-workers as well as diabetes than pre-diabetes healthcare workers respectively (Table 2).

Out of the 42 (19.4%) pre-diabetes healthcare workers, 10 (23.8%) were doctors, 13 (31.0%) nurses and 19 (45.2%), other healthcare workers (Figure 2). Likewise, out of the 6.5% diabetes healthcare workers, 4 (28.6%) were doctors, 7(50.0%) nurses and 3 (21.4%) other healthcare workers (Figure 2).

Clinical and Laboratory Parameters of the Healthcare Workers according to Professional Category

There was a significant difference between the RBG (p=0.04), SBP (p=0.001), weight (p<0.001), height (p<0.001), waist circumference (WC) (p<0.001) and BMI (p<0.001) amongst the different categories of healthcare workers using One-way ANOVA (Table 3). There was however no significant difference between the HbA1c (p=0.35) and DBP (p=0.13) amongst the different categories of healthcare workers respectively (Table 3).

The actual difference by Post-hoc Bonferroni test was as follows: the mean RBG of other healthcare workers was significantly (p=0.042) higher than that of doctors, however there was no significant (p=0.14 and p=1.00) difference in RBG between the doctors and nurses as well as the nurses and other healthcare workers respectively (Table 3).

The mean SBP was significantly (p=0.003) higher in nurses than doctors as well as nurses when compared to other healthcare workers (p=0.009) (Table 3). There were 69 (31.8%) of the healthcare workers with SBP/DBP $\geq$140/90 mmHg. Also, 118 (54.4%) had SBP/DBP between 130–139/80–89 mmHg, increasing the proportion of healthcare workers with hypertension by the new definition of hypertension to 2.7 times its initial proportion, totalling 187 (86.2%) (Data not shown).

The nurses had higher mean BMI in comparison to the doctors (p=0.001) and other healthcare workers (p=0.004). The BMI of the doctors did not however differ significantly (p=1.00) from that of other healthcare workers (Table 3). Likewise, central obesity by WC was significantly higher in nurses than doctors (p=0.03) as well as other healthcare workers (p<0.001) (Table 3).

Association of Pre-diabetes & Diabetes with Cardiovascular and Cardio-metabolic Risk Factors

There was a significant association between pre-diabetes and diabetes with increasing age (p=0.03); history of diabetes (p=0.02) and hypertension (p=0.001) respectively; long duration of

Table 2: Sex Distribution of Pre-diabetes and Diabetes among Healthcare Workers and Respective Mean Glycated Haemoglobin Levels

Class	Proportion (n=217)	%	Male (%) n=73	Female (%) n=144	Mean ± SD HbA1c (%)	P-Value
Normal	161	74.2	28.6 (46)	71.4 (115)	5.11 ± 0.40^{a}	<0.001
Pre-Diabetes	42	19.4	54.8 (23)	45.2 (19)	6.03 ± 0.19^{b}	
Diabetes	14	6.5	28.6 (4)	71.4 (10)	7.39 ± 0.83^{c}	
Total	**217**	**100.0**	**100 (73)**	**100 (144)**	**5.42 ± 0.76**	

Data presented in frequency and percentages. Numerical variables as Mean ± SD. Difference between mean HbA1c among normal, pre-diabetes and diabetes subjects by One-way ANOVA with Post-hoc Bonferroni. Means in a row without a common superscript letter differ with p-value < 0.001; n: total sample size.

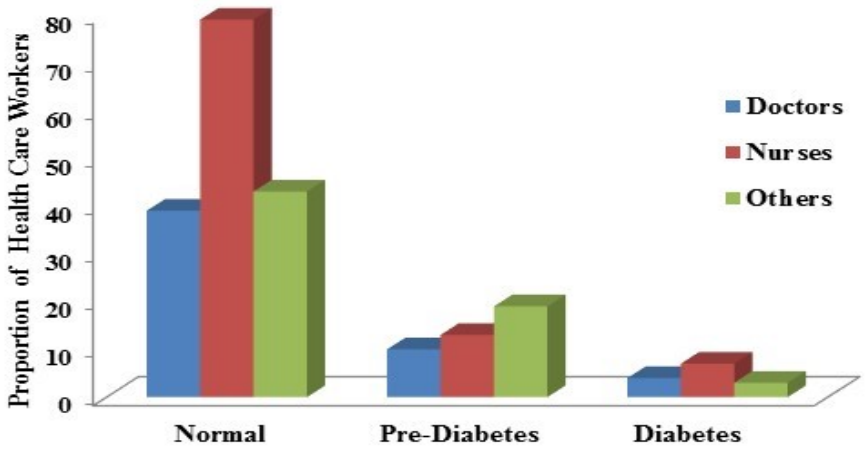

Fig. 2: Distribution of Categories of Healthcare Workers in Relation to Pre-Diabetes and Diabetes by Glycated Haemoglobin

hypertension (p=0.01); history of osmotic symptoms (p=0.02); central obesity by WC (p=0.02) and systolic hypertension (p=0.05) (Table 4).

DISCUSSION

This study showed a high prevalence of pre-diabetes among the study population similar to previous reports in Nigeria,[9,14,31–32] albeit with higher rates in the previous in the range of 22.3%, 25%, 33.1% and 38.9% respectively.[9,14,31–32] The difference may be attributed to the hypertensive cohort studied in the latter three studies as hypertension has been shown to be a risk factor for pre-diabetes and diabetes.[1,3,14,23–24] Studies outside Nigeria also showed higher rates such as studies from Ethiopia (20.3%),[33] Uganda (20.2 %)[34] and among Hispanics (47.4%).[24] Recent meta-analysis of population-based studies in England showed an increased trend from 11.6% in 2003 to 35.3% in 2011.[35] The strikingly higher prevalence rates in the latter two studies may be attributed to the older age group studied, study cohorts, larger sample size, population-based studies, ethnic, genetic and geographical differences worldwide.[34–35]

Contrary reports however exist, documenting lower prevalence of pre-diabetes in public service workers in Akure, Ondo of 11.7%;[11] 6% in Oke-Ogun residents of Oyo;[13] 4.9% in a rural and urban population survey in Delta as well

Table 3: Clinical and Laboratory Parameters of the Healthcare Workers according to Professional Category

Parameters	Doctors (n=53)	Nurses (n=99)	Others (n=65)	Overall Mean (n=217)	P-Value
Random Blood Glucose (mmol/L)	5.60 ± 0.70^{a}	6.10 ± 1.70^{ac}	6.20 ± 1.10^{bc}	6.00 ± 1.40	0.04*
Glycated Haemoglobin (%)	5.47 ± 0.70^{a}	5.33 ± 0.70^{a}	5.49 ± 0.80^{a}	5.42 ± 0.76	0.35
Blood Pressure (mmHg)					
– Systolic (mmHg)	115.30 ± 12.70^{a}	124.00 ± 15.40^{b}	116.60 ± 17.50^{c}	119.70 ± 15.90	0.001**
– Diastolic (mmHg)	74.20 ± 11.30^{a}	78.00 ± 10.00^{a}	77.30 ± 12.10^{a}	76.80 ± 11.00	0.125
Height (m)	1.70 ± 0.10^{a}	1.60 ± 0.10^{ab}	1.60 ± 0.10^{ab}	1.60 ± 0.10	<0.001***
Weight (kg)	74.70 ± 11.60^{a}	78.50 ± 16.00^{ab}	68.90 ± 13.70^{ac}	74.70 ± 14.90	<0.001***
Waist Circumference (cm)	87.80 ± 9.80^{a}	93.70 ± 15.70^{bc}	83.70 ± 13.05^{d}	89.30 ± 14.30	<0.001***
WC, Males (n = 73)	86.08 ± 8.09^{a}	91.80 ± 18.10^{ab}	83.62 ± 11.98^{b}	89.03 ± 15.08	0.19
WC, Females (n = 144)	89.24 ± 10.90^{a}	92.98 ± 13.93^{ac}	81.60 ± 14.98^{bd}	89.41 ± 13.88	0.001***
Body Mass Index (kg/m^2)	25.90 ± 3.70^{a}	29.80 ± 6.00^{b}	26.40 ± 8.80^{ac}	27.80 ± 6.80	<0.001***

*Data presented as Mean ± SD. Difference between mean HbA1c of Health Workers by One-way Analysis of Variance with Post-hoc Bonferroni test. Difference between mean WC of males and females Healthcare Workers by One-way Analysis of Variance. $^{a-b,\ b-c,\ a-c,\ c-d}$ Means in a row without a common superscript letter differ. $^{a-a,\ b-b,\ c-c}$ Means in a row with a common superscript letter do not differ.*Level of significance at p<0.05. ** Level of significance at p≤0.01. ***Level of significance at p≤0.001. BP, Blood Pressure; SD: Standard Deviation.*

Table 4: Association of Pre-Diabetes and Diabetes using Glycated Haemoglobin with Cardiovascular and Cardio-metabolic Risk Factors

Dependent Variable {HbA1c} for Pre-diabetes (n=42) and Diabetes (n=14)]	Odds Ratio (OR)	P-Value	95% Confidence Interval (CI)	
Age				
Middle Age/Elderly	2.40	0.03*	1.11	4.96
Sex	3.03	0.10	0.82	11.21
‡ Male	1.92	0.09	0.80	4.60
‡ Female	0.63	0.09	0.40	1.00
Profession	0.63	0.25	0.29	1.37
‡ Alcohol				
Yes	0.95	0.41	0.89	1.02
‡ Cigarette Use				
Yes	0.95	0.41	0.89	1.02
History of Hypertension				
Yes	0.06	0.001***	0.01	0.31
Family History Hypertension				
Yes	0.33	0.10	0.09	1.22
History of Diabetes				
Yes	0.14	0.02*	0.03	0.69
Family History of Diabetes				
Yes	0.90	0.87	0.25	3.20
Osmotic Symptoms				
Yes	0.06	0.02*	0.006	0.61
‡ Duration of Diabetes				
5 years	1.50	0.51	0.67	3.34
‡ Duration of Hypertension				
> 10 years	0.29	0.01**	0.09	0.92
Overweight/Obese	3.73	0.10	0.79	17.68
Waist Circumference (cm)	0.15	0.02*	0.03	0.76
Blood Pressure				
Systolic (mmHg)	4.11	0.05*	0.98	17.30
Diastolic (mmHg)	0.59	0.46	0.15	2.37

*Multiple Binary Logistic Regression Analysis. ‡, Relative Risk Assessment with Pearson's Chi-Square analysis. OR, Odds Ratio; CI, Confidence Interval; *Level of significance at p ≤ 0.05; **Level of significance at p ≤ 0.01; ***Level of significance at p ≤ 0.001.*

as population-based study in Chinese adults;[36–37] 3.3% in an urban setting in Ibadan[12] and 3.8% in a rural community in Ekiti, South-West Nigeria.[13] The reason for the disparity may be attributed to the difference in study population, method of blood glucose assay, diagnostic criteria used, geographical and racial disparity.

Over decades, there has been a paradigm shift in prevalence of diabetes in Nigeria with very low prevalence as far back as the nineties in the range of 0.8% to 2.8% in Ibadan,[38–39] 1.4% in Ilorin[40] and 1.5% in Lagos,[41] to the very high prevalence over the recent past cutting across all geopolitical zones and ranging from 6.5% in Calabar similar to that of this study;[42] 5.4% in rural-urban indigenes of Delta;[37] 4.7% in a large population-based study among workers in Oyo;[12] 4.8% in rural-semi-urban indigenes of Ekiti State;[13] 10.5% in South-East Nigeria;[43] 22.2% among hypertensive urban residents in Zaria[32] as well as 26.3% in Port Harcourt oil workers.[44]

The high prevalence of pre-diabetes and diabetes amongst healthcare workers in this study may be attributed to the following: Firstly, the higher hypertension prevalence simulating that in the United States in which 46% of the population are affected as against 32% with the previous definition of 140/90 mmHg.[29,32] This is a cause for concern especially as a large proportion of the healthcare workers were unaware of their high blood pressure status coupled with their 4 times odds of pre-diabetes and diabetes. The link between hypertension and type-2 diabetes has been shown from studies worldwide as 80% of type-2 diabetes patients have hypertension while 50% of hypertensive patients have hyper-insulinaemia or glucose intolerance.[1-4,14,23-24,32,45–46] Mechanisms include insulin resistance (IR) resulting in selective impairment of insulin-induced nitric oxide (NO) pathway as well as compensatory hyperinsulinaemia resulting in mitogen-activated protein kinase (MAPK) induction and resultant vasoconstriction, pro-inflammation, sodium/water retention and consequently, raised blood pressure.[45,47–49] Hypertension via the renin-angiotensin pathway is associated with angiotensin-II and aldosterone mediated water retention, pro-inflammatory effects and IR leading to diabetes and metabolic diseases.[45,48]

Secondly, the healthcare workers had other traditional cardiometabolic risk factors such as positive family history of hypertension and diabetes in more than half and a third of subjects respectively as well as the trend towards overweight and obesity in two thirds of the subjects. The tendency towards obesity may be attributed to what has been termed the "Sitting syndrome."[6–8,48] Healthcare workers are vulnerable to pre-diabetes and diabetes possibly because of longer sitting hours and sedentary positioning while attending to administrative duties, similar to the reason adduced in another study done in South-West Nigeria on administrative staff.[9] The disparity however, is the heterogeneous nature of the healthcare workers studied here and the fact that it cannot be said categorically that doctors and nurses are exactly sedentary given the long hours of standing-ward rounds and physical activities to save lives. Other healthcare workers like pharmacists sit to dispense drugs for long hours. Clerical, secretarial and administrative staff sit for long behind their desk and have long sitting board meetings. Further buttressing this point was the mean RBG of other healthcare workers shown to be higher than that of the doctors but not nurses. However, this may not suffice as the glycated haemoglobin, which reliably

determines blood glucose control over a longer duration of time showed no difference between other healthcare workers and doctors/nurses respectively.

Studies have shown that sitting greater than 4 hours a day is associated with increased risk of obesity, CVD, metabolic syndrome and CV mortality more attributed to type-2 diabetes.[6–8,45,47–49] Mechanisms include reduced muscle mass utility and basal metabolic rate as well as decreased fuel generation for adenosine triphosphate (ATP) consumption, consequently leading to central obesity, IR, IGT and diabetes.[6–8,45,47–49] Central obesity also causes the release of myriads of anti-insulinic hormones such as ghrelin, tumor necrosis factor-alpha (TNF-α), resistin, IL-6, plasminogen activator inhibitor-1 (PAI-1), retinol binding protein (RBP), C-reactive protein (CRP), toll-like receptor-4 (TLR-4) and low levels of adiponectin, all resulting in IR, IGT and diabetes.[32,45,47,49] Furthermore, it is worthwhile to note that the nurses had higher BMI, weight, central obesity and systolic hypertension than doctors and other healthcare workers. There is therefore, a need to determine in further studies, whether the recent trend of nurses sitting behind their desks, filling in nursing records for hours, may be putting them at risk for pre-diabetes and diabetes. Although female doctors demonstrated higher levels of central obesity than other female healthcare workers, perhaps attributable to lack of physical activity and exercise following delivery among female doctors with consequent fat build up.

Other cardiovascular risks which could explain the high prevalence of pre-diabetes and diabetes include: Increasing age >40 years, which was positively associated with pre-diabetes and diabetes with high Odds. Alcohol and smoking could however, not account for the high prevalence in this study as very few of the healthcare workers smoked or indulged in alcohol. This may be due to the sociocultural/religious practice in the North. Studies have reported that alcohol and smoking cause endothelial dysfunction and IR.[5,23–24,34] Smoking additionally induces inflammation and oxidative stress with resultant toxicity to β-cell function.[37,50]

Thirdly, the long in-door habits of healthcare workers, the wearing of "covering clothing" and reduced exposure to early morning sunshine may predispose them to vitamin D deficiency, which has been shown from studies worldwide to be associated with IGT and diabetes.[10,25–26] However, this study may be limited by lack of assessment of vitamin D levels as well as hours of sunlight exposure/day.

Lastly, the healthcare workers may have a high prevalence of pre-diabetes and diabetes due to poor dietary habits. Studies have shown that intake of "junk" foods, soft-drinks and lack of balanced diet increase risk of CVD and type-2 diabetes.[1–4,23–24] Healthcare workers, due to very busy schedule, hardly find time to eat proper healthy diets, hence rely on fast meals and "junk." This study might be however limited, as 24–72 hour dietary recall and office dietary record of the subjects were not assessed to determine objectively their dietary pattern at work.

Consistent with previous reports, increasing age and systolic hypertension were adversely associated with pre-diabetes and diabetes with high Odds ratio.[3,9,23,24,32] The hypertensive healthcare workers being aware of the fact that they had hypertension, diabetes and or osmotic symptoms was protective, as the Odd ratio was less than 1. Being aware may have caused them to seek medical attention, commence medication and lifestyle modification on time so as to prevent complications unlike the undiagnosed who are at greater risk for CV mortality.[1]

Limitations

Further limitation was the lack of preliminary blood glucose assessment by the glucose oxidase method. However, the glucometer used was previously standardized by the autoanalyzer in the chemical pathology laboratory bearing in mind that the study focused on glycated haemoglobin assay. Furthermore, the lack of assessment of lipid profile as a cardiovascular risk index in all the subjects was a limitation as it was only assessed in a few subjects (Unpublished Data).

Conclusion

There is a high prevalence of pre-diabetes and diabetes amongst healthcare workers in Zaria. The Odds of hypertensive healthcare workers developing pre-diabetes and diabetes is high.

Recommendation

Efforts should be geared at intensifying health education, increased work physical activity and proper diet. Healthcare workers especially administrative staff should be encouraged to organize "stand-up" meetings.[8,49] Thread-mill exercise kits should be put in each office so that during office breaks, healthcare workers can do 10 to 15 minutes walks on the thread-mill.[8,49] They should be advised to do regular medical check-ups, take walks to canteens or eateries during their break periods rather than drive and avoid intake of "junks." Also, hospital cafeterias should be made to provide balanced diets as against unhealthy meals commonly found.

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Authors' Contributions

The conceptualisation, study design and data collection were done by all authors. The data analysis was by Global data analysis centre, Nigeria and writing of the manuscript was by OUO with contributions from all authors up to the final version of the manuscript.

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