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A Pilot Study on Pre-diabetes and Associated Central Obesity among Students of University of Guyana, Guyana

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AA, DS and DJ oversaw study design, data collection and initial data analysis. Authors RK and CB participated in study design and final data analysis and interpretation. In addition, authors RK and CB revised the manuscript and approved final version.

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ABSTRACT

Objective: The purpose of this study was to examine the incidence of pre-diabetes and associated central obesity among sampled University of Guyana students.
Methods: The study was a cross sectional study where a questionnaire was distributed to each participant to assess predisposing risk factors. Anthropometric measurements like BMI and HbA1c were used to ascertain if the participant was overweight or obese. Nycocard® HbA1c test kit was used for collecting HbA1c. Data was analyzed using SPSS 20.0 to calculate descriptive statistics and analysis of variance were used to investigate the research questions. A p value of <0.05 was considered to be significant for all analysis.
Results: A total of seventy-four students were randomly selected for the study. The findings of this study revealed pre-diabetes incidence of 40.5% and a weak positive correlation between central obesity and pre-diabetes, with r-values of 0.25 (males), 0.27 (females) & 0.26 (overall).

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Conclusion: There was a weak association between central obesity and pre-diabetes incidence. Therefore, a large follow up study would be important to understand association between pre-diabetes and central obesity and to create nationwide awareness or development of an operational policy/strategy/action plan to reduce overweight.

Keywords: Incidence; pre-diabetes; central obesity; type 2 diabetes.

1. INTRODUCTION

The epidemic of type 2 diabetes continues to pose a challenge to both developed and developing countries, accounting for 95% of all diabetes cases [1]. The morbidity, mortality and the cost of care associated with type 2 diabetes makes it an important global public health concern. Globally, the number of people with diabetes is expected to almost double in the next two decades, increasing from 415 million in 2015 to 642 million in 2040 [2]. Moreover, given the burden of type 2 diabetes and its complications, much attention has been given to prevention, beginning with identifying at risk individuals. This has led to the designation of the term "pre-diabetes." Pre-diabetes characterizes an individual having blood glucose levels higher than normal but not high enough to be classified as diabetes. Without weight loss measures, healthy eating and moderate physical activity many people living with pre-diabetes will go on to develop diabetes [3].

Approximately 5-10% of people per year with pre-diabetes progress to diabetes; with similar proportion converting back to normoglycemia [4]. Observational evidence suggests an association between pre-diabetes and several adverse health outcomes, which includes: early forms of nephropathy, small fiber neuropathy, diabetic retinopathy, chronic kidney disease and increased risk of macrovascular disease [4]. Pre-diabetes is also associated with being overweight or obese and carries an excess risk for Cardiovascular Disease (CVD) and death. This is of tremendous public health concern as the global burden of obesity has significantly increased. The most recent analysis by the World Health Organization (WHO) reports that the number of adults globally who are overweight or obese is 1.9 billion and 650 million, respectively [5]. The Pan American Health Organization has also estimate that more than half the population in Latin America and the Caribbean is overweight, with 58% or 360 million people being overweight and 23% or 140 million people are estimated to be obese. Obesity in women is 10% higher than in men [6]. Due to this increase in the epidemic of obesity; understanding body fat distribution and its clinical implications is critical to a timely intervention. Adipose tissue is a special type of loose connective tissue in which adipose cells (adipocytes) predominates. Primitively, it was considered simply as storage organ for triacylglycerol, however, over the last decade there has been considerable experimental data about the biology and biochemistry of adipose tissue that it is no longer considered to be an inert tissue that just stores fat. It is a metabolically dynamic organ that is not only the primary site of storage for excess energy, but also serves as an endocrine organ capable of synthesizing a number of biologically active compounds that regulate metabolic homeostasis [7].

Diabetes continues to be a major health issue in Guyana; since it's a relatively small population and continues to be a burden on the healthcare system. To date, no study was conducted to evaluate and assess the incidence of pre-diabetes among the Guyanese population and therefore combat the rate of progression to diabetes.

2. MATERIALS AND METHODS

The study was a cross sectional study where University of Guyana (UG) students ≥18 years old, who were overweight or obese or had waist circumferences exceeding 80 cm (females) and 90 cm (males) were randomly selected for the study. All participants were told about the study and an informed consent form was obtained before the study. The study was conducted during March 2018. A total of 92 participants were enrolled in the study of which 74 participants completed the study. Others were excluded due to various reasons like incomplete information, reluctance to perform tests.

Inclusion criteria: Students enrolled at UG with an identification card, no known disease condition, willingness to enroll in the study.

Instrument for weight assessment: Portable electronic weighing scale.

Instrument for height and waist assessment: Constant tension tape, for waist circumference measurement was taken 2.5 cm above the umbilicus.

Criteria for Prediabetes: Patients with prediabetes are defined by the presence of impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT) and/or A1C 5.7–6.4% (39–47 mmol/mol).

Measurement of blood pressure: Digital blood pressure monitor was used. Normal blood pressure was considered measured if systolic under 140 mmHg and diastolic under 90 mmHg.

A questionnaire was distributed to each participant to assess predisposing risk factors. BMI was used to ascertain if the participant was overweight or obese by measuring the height in cm and weight in kg. Nycocard® HbA1c test kit was used to assess the HbA1c levels of each participant. Data was analyzed using SPSS version 20.0 software for frequencies, descriptive statistics, and analysis of variance. A p value of ≤0.05 was considered to be significant for all analysis.

Ministry of Public Health, Institutional Review Board (IRB) gave approval for conducting the study, Medical Arts Laboratory and the University of Guyana (UG) to carry out this study.

3. RESULTS

Of the 92 students participated in the study, 74 met the inclusion criteria, with 80% participation rate. A higher percentage of participants (67.6%) were females and 32.4% were males (Table 1).

Table 1 shows the baseline characteristics and anthropometric indices of the study population. Mean ± SD height and weight were 167.7±1.1 cm and 88.9±3.9 kg respectively, with the mean BMI being 31.4±1.1 kg/m2. The incidence of overweight and obesity was estimated to be 40.5% and 44.6% respectively. The mean waist circumference for men and women were 101.4± 2.3 cm and 96.4±1.6 cm, respectively.

Out of a total of 74 participants, 30 (40.5%) were considered pre-diabetic, 6 (8.1%) were considered diabetic and 38 (51.3%) were considered non-diabetic/pre-diabetic (Table 2). A weak positive correlation was recorded between central obesity and pre-diabetes (r=0.25 for males, r=0.27 for females and r=0.26 for total participants). Among female participants, 21 (42.0%) were pre-diabetic and 4 (8.0%) were diabetic. However, for males 9 (37.7%) were pre-diabetic and 2 (8.3%) were diabetic. Females accounted for the highest number of pre-diabetes person in the study. The mean HbA1c was 5.8±0.1%. Correlation of HbA1c among male students were r=0.25 (p≥0.05), for females r=0.27 (≥0.05) and for total participants r=0.26 (≤0.005).

Only 16 (21.6%) participants indicated that they engage in high level of physical activity, 24 (32.4%) in a low level of physical activity, while 34 (45.9%) reported a moderate level of physical activity. Only three participants indicated that they are smokers. Interestingly, a significant proportion (66.3%) of persons reported that they have a family history of diabetes. Overall, 30 (40.5%) participants were classified as having pre-diabetes and 6 (8.1%) as being diabetic. Amerindian ethnic group had higher risk of being pre-diabetic compared to African ethnic group (Odds ratio=2.9). In addition, the odd of someone being pre-diabetic is 2.86 for the Amerindian ethnicity compared to the African ethnicity.

Overall there was a strong positive correlation (r=0.8) between family history and pre-diabetes and weak positive correlation (r=0.4) between physical activity and the development of pre-diabetes.

4. DISCUSSION

This is the first cross-sectional study that has examined the incidence of pre-diabetes among a sampled Guyanese population and its association with central/abdominal obesity. Several important findings were observed in this study. Firstly, incidence of pre-diabetes was estimated at 30 (40.5%) within the sample. Similarly, a study from Iran, also a country with a high prevalence of diabetes (11.4%) [8], showed that pre-diabetes had an incidence of 40.6 per 1000-person years of those aged 20 and above [9]. Within this study females (28.3%) had the highest incidence of pre-diabetes as compared to males (12.1%). This was mainly due to the larger portion of our study population constituted by females, (i.e., 67.6%). Moreover, this may be a good representation of the large number of women at risk of developing future diabetes in Guyana, a country with a high prevalence of diabetes among women (10.9%) [5]. The incidence of central obesity was higher than

overall obesity, which indicates a significant portion of the population, may not be classified as obese by BMI level. Overall the incidence of central obesity was found higher among the study participants. These finding are consistent with studies conducted in China and the United States of America [10,11]. The association of central obesity and the incidence of pre-diabetes were weakly correlated and overall were statistically significant.

Table 1. Shows the baseline characteristics and anthropometric indices

Variable	% (n)
Sex:	
Female	67.6 (50)
Male	32.4 (24)
Faculty:	
FHS	16.2 (12)
FNS	16.2 (12)
FSS	10.8 (8)
FEES	13.5 (10)
FOA	13.5(10)
FOT	16.2 (12)
FEH	13.5 (10)
Ethnicity:	
African	51.4 (38)
East Indian	18.9 (14)
Amerindian	4.1 (3)
Mixed	25.7 (19)
BMI Group:	
Underweight (<18.5)	0.0 (0)
Normal (18.5 - 24.9)	16.2 (12)
Overweight (25 - 29.9)	40.5 (29)
Obese (≥30)	44.6 (33)
Mean Waist Circumference:	
Female	96.4 cm
Male	101.4 cm
Mean Weight	88.9 kg
Mean height	167.7 cm
Mean HbA1c Values:	
Female	5.7 %
Male	5.2 %
Pre-diabetic:	
Yes	40.5 (30)
No	59.5 (44)
Family History:	
Yes	68.9 (51)
No	31.1 (23)
Physically Active:	
Low	32.4 (24)
Moderate	45.9 (34)
High	21.6 (16)
Smoking status:	
Yes	4.0 (3)
No	95.9 (71)
Hypertension:	
Yes	2.7 (2)
No	97.3 (72)

Variable	% (n)
Symptoms of Increase Thirst	
Yes	31.1 (23)
No	68.9 (51)
Dry Mouth	
Yes	20.3 (15)
No	79.7 (59)
Itchy Skin	
Yes	27.0 (20)
No	73.0 (54)
Blurred Vision	
Yes	32.4 (24)
No	17.6 (50)
Loss of Appetite	
Yes	23.0 (17)
No	77.0 (57)
Frequent Urination	
Yes	33.8 (25)
No	66.2 (49)

FHS-Faculty of Health Sciences, FNS-Faculty of Natural Sciences, FSS-Faculty of Social Sciences, FOA-Faculty of Agriculture, FOT-Faculty of Technology, FEH-Faculty of Education & Humanities

Table 2. BMI and diabetes status among participants

BMI status	n (%)	95% CI	p-value
Normal	12 (16.2)	8.7-26.6	
Overweight	29 (39.2)	28.0-51.2	
Obese	33 (44.6)	33.2-56.6	≤0.05
Diabetes status			
Normal	38 (51.4)	39.4-63.1	
Pre Diabetes	30 (40.5)	29.3-52.6	
Diabetes	6 (8.1)	3.0-16.8	≤0.001

Previous studies have assessed the relationship between obesity and pre-diabetes incidence [11]. In most of these studies reported to date, obesity was measured using body mass index (BMI) as it has shown many advantages as a surrogate of body fat, such as simplicity and reproducibility. However, a significant limitation of using BMI is its inability to differentiate between lean mass and fat mass, especially in patients with a BMI <30 kg/m2 across age, sex and race [12]. Secondly, fat distribution could not be distinguished by BMI, whilst it has been generally accepted that visceral adiposity plays a more important role in developing insulin resistance and diabetes rather than overall adiposity. When comparing Asians and Europeans with similar BMIs, subjects with BMIs less than 25 kg/m2 need to be considered as high-risk for type 2 diabetes or heart diseases [13].

Waist circumference (WC) is considered a good anthropometric indicator for abdominal obesity because it is an aggregate measurement of the actual amount of total and abdominal fat accumulation. It has long been assumed that diabetes is associated with abdominal obesity and anthropometric measurements such as waist circumference that correlate with regional body fat distribution more so than BMI. Correlations of intra-abdominal visceral fat with waist circumference is thought to be the biological explanation for the superiority of waist circumference as a predictor of diabetes compared to BMI. Coelho et al. [14] reported that accumulation of visceral fat stores affects insulin metabolism by releasing a number of bioactive substances such as free fatty acids which when elevated, induce hepatic insulin resistance, particularly by enhancing gluconeogenesis. This was further supported by the fact that

gluconeogenesis increases in proportion to visceral fat [15]. Other studies have also suggested that the waist-to-height ratio is the best measure of obesity, compared to other anthropometric measures [16].

Females accounted for the highest number of pre-diabetes person in the study, which can be tied to the fact that the larger portion of the study population constituted females. Moreover, this may be a good representation of the large number of women at risk of developing future diabetes in Guyana, a country with an increasing prevalence of diabetes among women [5]. This study showed a high incidence of pre-diabetes (40.5%), which is a worrisome especially due to the fact that participants are young adults from the university. International Diabetes Federation (IDF) estimates 587 million individuals with pre diabetes by 2045 [9].

In addition, the odd of someone being pre-diabetic is 2.86 for the Amerindian ethnicity compared to the African ethnicity. This implies that a pre-diabetic person is 2.86 times more likely to be from the Amerindian descendant compared to the African descendant from the study population.

This study has several limitations that should be considered. The major limitation was the cross-sectional design, which describes the exposure and outcomes at a time. Therefore, our data had shown only the associations with present risk factors but did not predict the future risk of prediabetes. Longitudinal follow-up studies are needed to further examine the relationship found in our study. Secondly the small sample size and the few numbers of cases with prediabetes that decrease the statistical power of the analysis. Furthermore, our study population was not a representative of the general population. Lastly, caution should be taken in interpreting our results as even though the use of Waist Circumference (WC) provided a simple measurement for Visceral fat (VF), it does not represent only VF, as subcutaneous fat (SCF) also contributes to it. Computerized Tomography (CT) is the gold standard for the measurement of visceral fat volume, however, it is expensive and involves radiation which does not justify its use as a screening tool. Nevertheless, this study has several strengths including sizable response rate (80%), followed by simple random procedure for sample collection and using anthropometric variables, not self-reported values, in a sample of university students with very reliable data. Furthermore, confounding effects of various confounders and mediators were considered in data analyses.

5. CONCLUSION

Although the magnitude of pre-diabetes can differ across nations and by personal characteristics, there is an international consensus that the health complications associated with pre-diabetes in young adults are alarming and therefore strategies aimed at preventing abdominal obesity are urgently needed to reduce the increasing burden of diabetes, CVD, and metabolic diseases.

We the researchers recommend the following:

- Conduct follow-up studies with a larger sample size.
- Prioritization of pre-diabetes care and prevention such as hosting nationwide awareness sessions.
- Development of an operational policy/ strategy/action plan to reduce overweight and obesity.
- Extend health promotion to reduce pre-diabetes and its complications.

CONSENT

All authors declare that 'written informed consent was obtained from the patient.

ETHICAL APPROVAL

Approval was granted from IRB, Ministry of Public Health, Guyana.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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