HOAJ Biology
ISSN 2050-0874

HOAJ
Herbert Open Access Journals

Research Open Access

Correlation between body mass index and blood glucose levels among some Nigerian undergraduates

Onyesom Innocent[1†], Oweh O ThankGod[1†], Etumah O Sandra[2†] and Ifie E Josiah[1*]
*Correspondence: esejossy@yahoo.com
†These authors contributed equally to this work.
[1]Department of Medical Biochemistry, Delta State University, Abraka, Nigeria.
[2]Department of Science Laboratory Technology, University of Benin, Benin City, Nigeria.

Abstract

Background: Obesity is a frequent co-morbid condition associated with excessive increase in weight. It is one of the most important modifiable risk factor in the pathogenesis of health disorders such as hypertension and type-2 diabetes mellitus. Association between Body Mass Index (BMI) and blood glucose level has been consistently observed, but remain poorly understood possibly because of interactions with other influencing factors. One unresolved question is whether there is a linear relationship.

Methods: This study investigated the correlation between BMI and blood glucose level among 253 consenting Nigerian undergraduates in apparent good health and with a mean age of 22.65 ± 5.52 years (males: 22.65 ± 5.22 years, female: 22.31 ± 6.41 years).

Results: Older female subjects (24.53 ± 5.46 years) had significantly higher BMI when compared with other male counterpart (23.13 ±3.08Kg/m2 versus 22.14 ± 5.40Kg/m2, p≤0.05). Blood glucose levels, however showed no statistical significant difference between the male and female (4.09±0.74mmol/L versus 4.19±0.85mmol/L) subjects. There was a positive but weak correlation between BMI and blood glucose levels among the male subjects (r=0.43, n=151 and p≤0.05), while female subjects showed positive and strong (significant) correlation (r=0.53, n=102 and p≤0.05).

Conclusions: Older females in Nigerian undergraduates have considerable risk of increased BMI and associated abnormalities in blood glucose homeostasis. Concerted efforts need to be made by the management of Nigerian Universities to educate undergraduates on the health hazards of increased weight and the advantage of weight maintenance within the limits of what is formally acceptable.

Keywords: Obesity, weight, hypertension

Background

Obesity is a frequent co-morbid condition associated with excessive increase in weight [5]. It is also one of the most important modifiable risk factor in the pathogenesis of health disorders such as atherosclerosis and type-2 diabetes reported in most biochemical researches and cross-sectional studies.

In recent times, there have been a lot of critical biochemical investigations into the inter-relationship between body mass index (BMI) and other biochemicals such as luteinizing hormone (LH) [18], serum 25 hydroxyl vit-D in post-menopausal women [11], and blood pressure [10].

From biochemical metabolic analysis, it has been established that fatty acids which constitute the body fat contents, can be synthesized from simple carbohydrates such as glucose [12]. Thus, it is not unexpected for increase in blood glucose to induce increase in BMI; as increase in blood glucose level have associated with increase in lipid biosynthesis (lipogenesis) and hence, an increase in weight [12]. Since BMI is proportional to weight from its standard formular; weight/square height, it is therefore expected that factors such as blood glucose which influence weight will ultimately affect BMI.

A strong correlation has been established between a high BMI and the development of type-2 diabetes mellitus from a study of more than 7000 British men (mean follow-up of 12 years) [9]. These observations were expected as obesity is known to induce insulin resistance due to decrease in insulin-sensitive receptors as the weight increases [16]. Insulin is known to facilitate the uptake of glucose through the specialized membrane of the insulin-sensitive cells which invariably results in an increase in blood glucose level due to delayed glucose uptake [7]. It is therefore, expected that BMI should correlate with blood glucose levels but this is not however always the case because a Scottish study [8] has shown no significant statistical correlation between the random blood sugar level and Body Mass Index (BMI). A population-based, cross-sectional study of 1,978 subjects with Chronic Kidney Disease (CKD) of a Japanese community [13] showed BMI and the prevalence of obesity higher in subjects

Table 1. Body Mass Index (BMI) and Blood Glucose Level (BGL) for male and female subjects in different age Groups.

Age (years)	Sex	N	BMI (Kg/M²)	BGL (mMol/L)
16-20	M	35	20.11±2.03	3.74±0.64
	F	35	22.89±3.02	4.05±0.57
	Total	70	21.35±2.92	3.90±0.63
21-25	M	84	22.89±3.06	3.84±0.78
	F	46	23.02±3.42	4.28±0.92
	Total	130	22.93±3.19	4.14±0.83
26-30	M	32	23.19±2.63	3.98±0.92
	F	21	24.81±2.40	4.62±1.02
	Total	53	24.03±2.55	4.23±0.82

Values are expressed as Mean ± SD for "n" subjects.
BMI-Body Mass Index and BGL-Body Glucose Level.
BMI classification: <18.5: underweight, 18.5-25.0: normal, 25-30.0: overweight, 30.0-35.0: obese class I, 35-40.0: obese class II and >40.0: obese class III.

Table 2. Body Mass Index (BMI) and Blood Glucose Levels (BML) for subjects in different levels (100-400) of study.

LEVEL	N	AGE (Yrs)	BMI (Kg/M²)	BGL (mMol/L)
100	53	20.09±4.16	19.36±2.81	3.82±0.43
200	35	20.98±3.67	22.76±3.18	3.98±0.73
300	60	22.31±3.94	23.28±3.16	4.28±0.93
400	105	24.69±4.84	24.29±2.82	4.33±0.73

Values are expressed as Mean ± SD for "n" subjects.
BMI – Body Mass Index; BGL – Glucose Level.BMI classification: <18.5: underweight, 18.5-25.0: normal, 25-30.0: overweight,
30.0-35.0: obese class I, 35-40.0: obese class II and >40.0: obese class III.

Table 3. Gender differences in BMI and BGL for all the subjects.

Sex	N	BMI (Kg/M²)	BGL (mMol/L)	r-values	p-values
Male	151	22.14±5.40	4.09±0.74	0.23	P≤0.05
Female	102	23.13±3.08	4.19±0.85	0.53	P≤0.05
Total	253	22.54±4.63	4.12±0.78	0.38	P≤0.05

expressed as Mean±SD for "n" subjects.
BMI-BGL Mass Index, BGL-Blood Glucose Level BMI classification: ≤18.5: Underweight,18.5-25.0: normal 25.0-30.0: Overweight, 30.0-35.0: obese class I, 35.0-40.0: obese class II and >40.0: obese class III.

with Chronic Kidney Disease (CKD) in both genders with also, an elevated level of blood pressure, fasting blood sugar and triacylglycerol in female subjects with Chronic Kidney Disease.

Notwithstanding the enormous investigations in this field, much more are yet to be studied. This research was therefore undertaken to determine the correlation between BMI and blood glucose levels in some apparently healthy Nigerian Undergraduates. This will be of importance to health care professionals in Africa and other developing countries.

Materials and methods

Subjects

Two hundred and fifty three (253) apparently healthy Nigerian Undergraduates between the ages of 16 and 30 years were selected from Delta State University, Abraka and University of Benin, Edo State , both in Southern Nigeria . Subjects with abnormal BMI and BGL were excluded from this study.

Collection Of Blood Specimen

About 2ml fasting whole blood was collected from each consenting subject into fluoride oxalate bottle using the vene puncture technique. The whole blood was then centrifuged at 1200xg for 5mins at room temperature (29-31^{0}C) to separate the plasma which was decanted into bijou bottle and stored frozen for analysis.

Blood Glucose Determination

Fasting plasma glucose level was estimated using the glucose oxidase method as previously described [17]. The reagent kit used was supplied by Randox Laboratories, Ardmore, UK .

Body Mass Index (Bmi) Estimation

Weights were taken to the nearest 0.05kg and height to the nearest 0.05cm from which BMI was calculated for each subject using the standard formular; weight/square height (kg/m^2).

Statistics

The Pearson's correlation coefficient was used to analyze data and level of significance was set at $\alpha \leq 0.05$ ($P \leq 0.05$). Informed consent was sought and obtained from the subjects and the study was approved by our Faculty's Research and Ethics Committee.

Results

Body Mass Index (BMI) and blood glucose levels were measured for two hundred and fifty-three (253) consenting Nigerian undergraduates in apparent good health and the results obtained are presented in Tables 1,2 and 3.

As age group increases (that is, from 16-20 to 21-25 and then to 26-30 years), BMI and blood glucose levels (BGL) showed a corresponding increase for both male and female subjects although values were proportionately higher for the female subjects.

For the age group, 16-20 years, the female subjects showed a positive but weak correlation between BMI and BGL (r=0.43, P≤0.05 and n=35), while the male subjects showed a positive but significant correlation between BMI and BGL (r=0.63, P≤ 0.05 and n=35). Overall, there was a significant positive correlation between BMI and BGL among subjects in this age (r=0.67, P≤0.05 and n=70).

doi: 10.7243/2050-0874-2-4

For the age group, 21-25 years, the male and female subjects showed a positive significant (male; r=0.67, n=84, P≤0.05 and female; r=0.82, n=46, P≤ 0.05). Overall, there was a positive and statistical significant correlation between BMI and BGL among subjects in this group (r=0.76, n=130 and P≤0.05).

For the age group, 26-30 years, there was a positive and low statistical correlation between BMI and BGL among the male and female subjects (male; r=0.48, n=32 and P≤0.05 and female; r=0.54, n=21 and P≤0.05). Overall, BMI and BGL showed a positive and weak correlation among subjects in this age group (r=0.51, n=53 and P≤0.05).

In all, there appear to be a relationship between BMI and BGL irrespective of sex and age.

As academic levels of the undergraduates (100-400) increase, there was a corresponding increase in both BMI and BGL mean values of the subjects. For 100 level subject, BMI and BGL showed a positive and significant correlation (r=0.65, P≤0.05 and n=53). BMI and BGL showed a positive and strong significant correlation (r=0.80, P≤0.05 and n=35) among the 200 level students. But for the significant correlation (r=0.60, P≤0.05 and n=60). For 400 level subjects, BMI and BGL showed a positive and significant correlation (r=0.75. P≤0.05 and n=105).

BMI and BGL showed a positive but weak correlation among male subjects (r=0.23, P≤0.05 and n=151). Among the female subjects, there was a positive and significant correlation (r=0.53, P≤0.05 and n=102). Overall, for the 253 subjects, BMI and BGL showed a positive but low significant correlation (r=0.38, P≤0.05 and n=253).

Discussion

One major objective for the study of chemical pathology with biochemical investigations into plasma analytes is the application of its knowledge to the maintenance of the body steady state [14]. Obesity is probably the most important modifiable acquired risk factor in the pathogenesis of types 2 diabetes reported in most biochemical researches and cross-sectional studies [2].

A prospective study involving a legion of men living in Uppsala , Sweden [15] with a normal glycemic state and follow-up for development of type-2 diabetes mellitus found that the incidence of diabetes mellitus rose by a factor of twenty-two when individuals with the highest BMI were compared with those who had the lowest BMI.

A study involving Caucasian and African-American women [6] showed that the difference in BMI not correlating with random blood sugar level may result from racial and other biological factors. It has also been shown [18] that there exist an inverse relationship between BMI and luteinizing hormone (LH) as seen in women with polycystic ovarian syndrome (PCOS).

It has been established [11] that vit. D (serum 25 hydroxyl vit. D; 25 (OH) d) when administered to mothers and children can prevent type-1 diabetes in children. This study of 753 menopausal women showed a negative correlation between blood glucose level and serum 25 (OH) D) and as such, diabetes is more common in adults with low serum vit. D.

A recent study of 36 patients with diffused idiopathic skeletal hyperostosis (DISH) by [5] showed a strongly positive correlation of BMI with serum insulin concentration and a negative correlation of BMI with basal growth hormone (GH) and insulin –like growth factor-1. This thus, shows that an increase in basal growth hormone secretion, causes a decrease in BMI, and a decrease in basal growth hormone and IGF-1 characterized wit aging produces a corresponding increase in BMI.

Associations between BMI and blood pressure (BP) have been consistently investigated but remain poorly understood [10]. This led to the study of 11,235 a duet men and women from seren low-BMI populations in African and the Carribeans that showed an aged-adjusted slope of blood pressure on BMI were uniformly higher in men than in women with a positive and strongly statistical significant correlation of BMI with blood pressure among female subjects. Thus, establishing the mechanisms that underlie the relationship between BMI and Blood Pressure as gender-based.

In this present study, BMI and BGL were positively correlated among the 253 subjects who participated in the study. The relationship was positively and strongly correlated among the female subjects. These differences in gender values may be because the male undergraduates have been linked to increased muscular activities unlike the female counterpart who are more sedentary. Muscular activities result in the activation of the peptide hormone adiponectin that causes the cascade activation of AMPK to inhibit the acetyl COA carboxylase (ACC) from synthesizing malonyl-CoA for fatty acid biosynthesis in hepatocytes [11]. AMPK once activated also increases the uptake of glucose and fatty acid from the blood myocytes into the hepatocytes for metabolism [4,7].

It has been shown that weight tends to increase after a stressful condition associated with "after stress syndrome". The Nigerian university community is such that it is characterized by much stress and it has been observed that girls (female undergraduates) tends to rest more after such strenuous periods leading to "creeping weight" due to the sensitization of hormone "ghrelin" that increases the hunger reflexes in both males and females [1]. This increase in dietary in-take by male is balanced by exercise but female tends to relax more and as such, there is the tendency of weight gain.

Investigations into female anatomy and physiology [16] have shown that there is an increase in fat deposition as female increase in age especially from the age of 12 years; to enable them prepare for ovulation and pregnancy. A similar investigation into male anatomy show that a similar increase also occurs to enable spermatogenesis [16]. This may account for the increase in BMI as age and level of study (100-400) increased.

There had been a biochemical investigation into the "relationship between the random blood sugar and body mass index in an African population". The study which involved 317 subject showed that BMI is significantly higher in females than in male, while blood glucose level (random blood sugar), showed no statistical difference [3]. This cross-sectional study is therefore consistent with the increased BMI in female subjects than in male although inconsistent with no correlation among male subjects as this study thus shows the presence of a positive and statistical significant correlation between "BMI and BGL" among male undergraduates. Older female Nigerian undergraduates therefore, have considerable risk of increased BMI and hence, the tendency to be glucose intolerant.

Conclusion

Based on this research findings of increased BMI among female undergraduates and the health risks associated with increased weight, the university management have to make concerted efforts to address the issues within the limits of what is formally accepted maybe through the introduction of courses involving physical exercise/training programmmes among all levels and cutting across all discipline. This will help reduce sedentary life among undergraduates especially the female gender.

Competing interests

The authors declare that they have no competing interests.

Publication history

Received: 4-Dec-2012 Revised: 12-Jan-2013
Accepted: 19-Feb-2013 Published: 26-Mar-2013

References

1. Adam TC and Epel ES: **Stress, eating and the reward system**. *Physiol Behav* 2007, **91**:449-58. | Article | PubMed
2. Bakari AG and Onyemelukwe GC: **Actiopathogenesis type-2 diabetes mellitus**. *Diabetes Int'l.* 2005, **13**:7-9.
3. Bakari AG, Onyemelukwe GC, Sani BG, Aliyu IS, Sani SH and Aliyi TM: **Relationship between Random Blood Sugar and Body Mass Index in an Africa Population**. *Int'L J Diabetes Metab*. 2006, **14**:144-145. | PDF
4. Braun B, Zimmermann MB and Kretchmer N: **Effects of exercise intensity on insulin sensitivity in women with non-insulin-dependent diabetes mellitus**. *J Appl Physiol* 1995, **78**:300-6. | Article | PubMed
5. Denko CW and Malemud CJ: **Body mass index and blood glucose: correlations with serum insulin, growth hormone, and insulin-like growth factor-1 levels in patients with diffuse idiopathic skeletal hyperostosis (DISH)**. *Rheumatol Int* 2006, **26**:292-7. | Article | PubMed
6. Dowling HJ and Pi-Sunyer FX: **Race-dependent health risks of upper body obesity**. *Diabetes* 1993, **42**:537-43. | Article | PubMed
7. Henriksson J: **Influence of exercise on insulin sensitivity**. *J Cardiovasc Risk* 1995, **2**:303-9. | Article | PubMed
8. Janghorbain M, Hedley AJ and Jones RB: **Is the association between glucose levels and "all causes" and cardiovascular mortality risk, dependent on body mass index?** *Met J. IR. I.* 1991, **6**:205-212.
9. Kahn CR: **Banting Lecture. Insulin action, diabetogenes, and the cause of type II diabetes**. *Diabetes* 1994, **43**:1066-84. | Pdf | PubMed
10. Kaufman JS, Asuzu MC, Mufunda J, Forrester T, Wilks R, Luke A, Long AE and Cooper RS: **Relationship between blood pressure and body mass index in lean populations**. *Hypertension* 1997, **30**:1511-6. | Article | PubMed
11. Need AG, O'Loughlin PD, Horowitz M and Nordin BE: **Relationship between fasting serum glucose, age, body mass index and serum 25 hydroxyvitamin D in postmenopausal women**. *Clin Endocrinol (Oxf)* 2005, **62**:738-41. | Article | PubMed
12. Nelson DL and Cox MM: **Lehninger Principles of Biochemistry**. **4th** (**ed**), W.H Freeman and Company, New York. 2005.
13. Nomura I, Kato J and Kitamura K: **Association between body mass index and chronic kidney disease: a population-based, cross-sectional study of a Japanese community**. *Vasc Health Risk Manag* 2009, **5**:315-20. | Article | PubMed Abstract | PubMed Full Text
14. Nduka N: **Clinical Biochemistry for Students of Pathology, Longman**, Nigeria 1991.
15. Skarfors ET, Selinus KI and Lithell HO: **Risk factors for developing non-insulin dependent diabetes: a 10 year follow up of men in Uppsala**. *BMJ* 1991, **303**:755-60. | Article | PubMed Abstract | PubMed Full Text
16. Sue RW and Sara LA: **Nutrition and Diet Therapy**. **7th** (**ed**), Mosby, USA 1993.
17. Tietz NW: **Clinical Guide to Laboratory Tests**. **3rd** (**ed**), W.B. Sauders, Philadelphia 1995.
18. Pagan YL, Srouji SS, Jimenez Y, Emerson A, Gill S and Hall JE: **Inverse relationship between luteinizing hormone and body mass index in polycystic ovarian syndrome: investigation of hypothalamic and pituitary contributions**. *J Clin Endocrinol Metab* 2006, **91**:1309-16. | Article | PubMed

Citation:
Innocent O, ThankGod O O, Sandra E O and Josiah I E: **Correlation between body mass index and blood glucose levels among some Nigerian undergraduates**. *HOAJ Biology* 2013, **2**:4.
http://dx.doi.org/10.7243/2050-0874-2-4