Available online@www.actasatech.com

acta SATECH 12 (1): 47 – 51 (2020)

Journal of Life &Physical Sciences

Serum uric acid and insulin resistance in obese and non-obese students of a private Nigerian University

[*]Adejumo, E.N.[1]; Ovienmhanda, S.O.[1]; Ladipo, O.A.[2] and Nwobi, L.N.[3]

[1]*Department of Medical Laboratory Science, Babcock University, Ilishan-Remo, Ogun State Nigeria*

[2]*Department of Chemical Pathology Babcock University, Ilishan-Remo, Ogun State Nigeria*

[3]*Department of Chemical Pathology Benjamin Carson's School of Medicine Babcock University, Ilishan-Remo, Ogun State Nigeria*

Corresponding author <adejumoe@babcock.edu.ng>

>

Abstract

This present study assessed the association of serum uric acid (UA) and insulin resistance (IR) among obese and non-obese undergraduate students of a private Nigerian University. A descriptive cross-sectional study was conducted involving 120 undergraduates. Anthropometric measurements and biochemical analysis of fasting plasma glucose (FPG), UA and insulin were done using standard procedures. Insulin resistance was determined using the homeostasis model assessment (HOMA- IR). Participants with HOMA- IR ≥ 2 and body mass index (BMI) ≥30 kg/m^2 were classified as having Insulin resistance and obesity respectively. IR prevalence was 38.3% among participants. The median serum insulin levels (13.5 interquartile range (IQR) 10.5, 34.9 vs 6.2 IQR 4.5, 9.2) and HOMA-IR (3.0 IQR2.5, 6.3, vs 1.2 IQR 0.9, 2.0) was elevated among obese participants ($p<0.001$). Insulin was positively correlated with UA in obese participants ($p = 0.001$). For every unit of increase in UA, the likelihood of IR is increased by 38% after controlling for age, gender and obesity. Serum UA was associated with IR among obese undergraduate students of a private Nigerian University.

Keywords: Insulin resistance, Obese, Uric acid, HOMA-IR, Nigeria

1.0 Introduction

The obesity pandemic which began over 50 years ago is essentially a disease of lifestyle and modern nutrition (Noakes. 2018). The human race has progressively become more complacent, indolent and voracious resulting in the consumption of excess calories and accumulation of triglyceride in the liver. Insulin resistance (Ye, 2013), hypertension (Hall et al;

2015), coronary heart disease (Bamba & Radar 2007) and atherogenic dyslipidaemia (Poirier, 2006) are the results of these poor habits.

Insulin resistance (IR) is a state of biological non-responsiveness to endogenous insulin. IR has been implicated in the aetiology of many metabolic disorders. Energy utilization and storage is enhanced by insulin, this function is compromised in the IR state leading to a state of insulin and glucose excess (Ye, 2013). The hyperinsulinaemic state and the accompanied IR is linked to obesity, hypertension, coronary arterial diseases, type 2 diabetes (T2DM) (Goldstein, 2002). In obese individuals with IR glucose transport, metabolism and output is suppressed (Czech 2017; Erion & Corkey 2017; Reaven, 2012). Although there have been several hypotheses for the pathogenesis of obesity-associated IR, the role of inflammation has been widely reported (Jianping, 2013).

Uric acid (UA) is elevated in diabetes and diabetic complications (Prashanthkumar et al., 2015; Kashinath et al., 2014). Hyperuriceamia is a predictor for the development of IR and T2DM. A prospective study demonstrated hyperuriceamia to increase the chances of developing T2DM and IR by 87% and 36% respectively after a 15 year follow up (Krishnan et al., 2012). Hyperuricaemia has been linked with hypertension, atherosclerosis and metabolic syndrome and it was positively correlated with obesity in adolescent and children (Gil et al., 2009). A study has shown a bidirectional relationship between hyperuricaemia and hyperinsulinaemia (Changgui et al., 2013).

There is a dearth of study on UA and IR in Nigeria, available studies focused more on UA levels in T2DM (Mamza et al., 2017; Adibe, 2010). This present study assessed the association between UA and IR among obese and non-obese undergraduates of a private Nigerian University.

Participants and methods

Study design: We conducted a descriptive cross-sectional study.

Study background: This study was carried out in faith-based private Nigerian University located in South-West Nigeria,

Selection criteria: Participants included in this study were apparently healthy young adult (students) between the ages of 16-25 years. Students who had chronic diseases and those who were on treatment for dyslipidaemia, antioxidants, vitamin supplements, antibiotics, contraceptives, insulin and uricosuric drugs were not enrolled into the study.

Sample size: Using the sample size formula for cross-sectional study, the prevalence of IR (7.3%) among University student in a similar study (Barbosa et al., 2016) and an attrition rate of 10%, a sample size of 115 was calculated. However, a sample size of 120 was used.

Sampling technique: Volunteers (students from Babcock University) were consecutively recruited into the study after consent was obtained.

Study procedure: The participant's socio-demographic details were collected using a proforma after recruitment. We determined the body mass index (BMI) form the weight and height measurement taken. About 6 mL of venous blood was collected from participants after an overnight fast (between 10 – 14 hours) for FPG, insulin and UA. Serum UA and FPG were determined using spectrophotometric methods (Randox laboratories limited, United Kingdom), while serum insulin was determined by enzyme inmmunoassay method (Calbiotech Inc, USA).

Definition and classification of IR: We determined the IR using the homeostasis model assessment (HOMA- IR). The serum insulin (mIU/L) and fasting glucose (mmol/L) were multiplied and then divided by 22.5. Participants with HOMA-IR ≥ 2 were classified as having IR based on a previous study (Young et al., 2016).

Calculation of BMI: We divided participants' weight (kg) by the square of the height (m) to determine the BMI and a cutoff of 30 kg/m^2 was used to identify participants with obesity

Ethics: The Ethics committee of Babcock University granted the study approval (BUHREC264/19).

Data analysis: The Statistical Package for Social Sciences (SPSS) version 22 was used for data analysis. The histogram plot of outcome variables (UA, insulin, HOMA-IR) was plotted to know if the distribution followed the Gaussian curve. We determined the mean and standard of numeric numerical variables and categorical variables were expressed as percentages. Mann Whitney U test was used to compare median while Spearman Rho was used to assess the correlation of BMI with UA, insulin, FPG and HOMA-IR. Linear regression was used to assess the relationship between IR (dependent variable) and UA (independent variable) using a while controlling for age, gender and obesity.

Results

One hundred and twenty participants were recruited. The mean age was 20±2.5 years. There were equal number of male and females; and a majority were single (98.3%) as shown in Table 1. The prevalence of IR was 38.3% among participants (Figure 1). Table 2 compared the biochemical parameters in obese and non-obese participants. The median serum insulin levels (13.5 IQR10.5, 34.9mIU/L vs 6.2 IQR 4.5, 9.2mIU/L) and HOMA-IR (3.0 IQR 2.5, 6.3, vs 1.2 IQR 0.9, 2.0) was elevated in the obese participants ($p<0.001$). The median FPG and UA levels between the obese and non-obese participants were not significant ($p>0.05$). A high proportion (78.6%) of the obese participants had insulin resistance, while 24 (26.1%) of the 92 non-obese participants had insulin resistance ($p < 0.001$). The female participants had higher median levels of FPG (78.0 IQR 70.8, 87.0mg/dL vs 85.0 IQR 78.0, 96.5mg/dL), serum insulin (10.7 IQR 6.4, 14.3mIU/L vs 5.7 IQR 4.2, 9.2mIU/L) and HOMA-IR (2.4 IQR 1.3, 3.5 vs 1.1 IQR 0.8, 1.9) than males ($p < 0.001$). However, the male had higher serum UA levels than females UA (6.7 IQR 5.4, 8.4mg/dL vs 4.6 IQR 3.3, 6.3mg/dL) ($p < 0.001$) (Table 3). The correlation of BMI with FPG, insulin, UA and HOMA-IR (Table 4). BMI was positively correlated with HOMA-IR, insulin and UA ($p < 0.001$). There was no correlation between BMI and FPG ($p =0.260$). There was no correlation between UA and insulin. FPG and HOMA-IR among non-obese participants. However, insulin was positively correlated with UA in obese participants ($p = 0.001$) as shown in Table 5. For every unit of increase in UA, the likelihood of IR was increased by 38% (Adjusted odds ratio 1.38, 95%CI: 1.22 – 1.55; $p<0.001$).

Discussion

Our study shows that the prevalence of IR among undergraduate students of Babcock University was 38.3%. This was higher compared to the prevalence obtained from an apparently healthy population from the South-west (Raimi et al., 2012) and lower than what was obtained from Southeastern Nigeria among women (Young et al., 2016). Ethnicity, the metabolic condition of the study population, and HOMA-IR cutoff may be responsible for this variation (Bastard et al., 2000). The proportion of obese participants with IR was significantly higher than non-obese participants with IR. Elevated interleukin-6 (IL-6) and Tumor Necrosis Factor Alpha (**TNF**-α) in obese patients enhances oxidation of free fatty acids and lipoprotein lipase inhibition resulting in IR (Antuna-Puente et al., 2011).

In this study, the median serum UA was higher among obese participants similar to what was observed in a study among adolescents (Josiane et al., 2015). Increase serum UA in obese individuals may be due to the lower renal clearance of UA, resulting in higher serum uric levels (Yamashita et al., 1986), association between obesity and elevated xanthine oxidase activity or increased activity of xanthine oxidase and the production of UA by the adipose tissue (Sushima et al., 2013).

The males had higher UA levels in our study. This may be physiological, UA concentration is shown to increase with age and lower in women than men (Richette & Bardin, 2010; Roddy & Doherty, 2010).

Our study shows an association between serum UA and IR among undergraduates. The chance of IR was increased by 38% for each unit rise in UA after adjusting for age, gender and obesity. Also, there was a correlation between HOMA-IR and UA among obese participants. Our findings are similar to what was reported by Josiane et al., 2015 and

Cardoso et al., 2013. Hyperuricaemia is a predictor of IR in T2DM (Cardoso et al., 2013; Juraschek et al., 2014). A meta-analysis showed a 17% increase in the risk of T2DM for every unit rise in serum UA (Kodama et al., 2009). Although the mechanisms of the connection between increase serum UA and IR is not fully understood, increased serum insulin is thought to reduce the renal excretion of UA thereby resulting in hyperuricaemia Little is known about whether hyperuricaemia precede IR or the other way round (Li et al., 2013; Feig et al., 2008).

Conclusion

The prevalence of IR was high at 38.3% in this study and there was an association between UA and IR among obese undergraduate students in a private Nigerian University. There is an urgent need to educate the youths on lifestyle modification to forestall the associated complications

References

Adibe, M.O. (2010). Prognosticators of high serum uric acid level in Nigerian type 2 diabetic patients. Journal of Pharmacy Research, 3:2102-2104.

Antuna-Puente, B., Disse, E., Rabasa-Lhoret, R., Laville, M., Capeau, J., & Bastard, J.P. (2011). How can we measure insulin sensitivity/resistance? Diabetes Metab, 37:179–188.

Barbosa, J.B., Santos, A., Miranda, D., Barbosa, M.M., Barbosa, M.M., Carvalho, C.A., Fonseca, P.C.A., Fonseca, J.M.,

Barbosa, M.C.L., Bogea, E.G., & Silva, A.A.M. (2016). Metabolic syndrome, insulin resistance and other cardiovascular risk factors in university students. Ciência & Saúde Coletiva, 21(4):1123-1136.

Bastard, J.P., Jardel, C., Bruckert, E., Blondy, P., Capeau, J., Laville, M., Vidal, H., & Hainque, B. (2000). Elevated levels of interleukin 6 are reduced in serum and subcutaneous adipose tissue of obese women after weight loss. J Clin Endocrinol Metab, 85:3338–3342.

Cardoso, A.S., Gonzaga, N.C., Medeiros, C.C., Carvalho, D.F. (2013). Association of uric acid levels with components of metabolic syndrome and non-alcoholic fatty liver disease in overweight or obese children and adolescents. J Pediatr (Rio J), 89:412–418.

Changgui, L., Ming-Chia, H., & Shun-Jen Chang. (2013). Metabolic syndrome, diabetes, and hyperuricemia. Curr Opin Rheumatol, 25:210-216.

Feig, D.I,, Kang, D.H., & Johnson, R.J. (2008). Uric acid and cardiovascular risk. N Engl J Med, 359:1811–1821.
Gil, M., Aguilera, C., Canete, R., & Gil, A. (2009). Uric acid is associated with features of insulin resistance syndrome in obese children at prepubertal stage. Nutr.Hosp, 24(7):607-13.

Goldstein, B.J. (2002). Insulin resistance as the core defect in type 2 diabetes mellitus. The American Journal of Cardiology, 90: 3-10.

Jianping, Y. (2013). Mechanisms of insulin resistance in obesity. Front. Med, **7**(1): 14–24.

Josiane, A., Guilherme, B., Raissa., I, Mariana., C, Vanessa, S., Carlos., A, & Carla, M. (2015). The role of uric acid in the insulin resistance in children and adolescents with obesity. Rev Paul Pediatr, 33(4):431-436.

Juraschek, S.P., McAdams-Demarco, M., Miller, .E.R., Gelber, A.C., Maynard, J.W., Pankow, J.S., Young, H., Coresh, J., & Selvin, E. (2014). Temporal relationship between uric acid concentration and risk of diabetes in a community-based study population. Am J Epidemiol, 179: 684-691.

Kashinath, R.T., Nagendra, S., & Srinivas, S. (2014). Hyperuricemia in Type 2 Diabetes Mellitus. Global Journal of Medical Research, 14(3).

Kodama, S., Saito, K., Yachi, Y., Asumi, M., Sugawara, A., Totsuka, K., Saito, A., & Sone, H. (2009). Association between serum uric acid and development of type 2 diabetes. Diabetes Care, 32:1737–1742.

Krishnan, E., Pandya, B., Chung, L., Hariri, A., & Dabbous, O. (2012). Hyperuricemia in young adults and risk of insulin resistance, prediabetes, and diabetes: a 15-year follow-up study. Am J Epidemiol, 176:108-116.

Li, C., Hsieh, M.C., & Chang, S.J. (2013). Metabolic syndrome, diabetes, and hyperuricemia. Curr Opin Rheumatol, 25:210–216.

Mamza, Y.P., Aladeusi, B.R., Gali, R.M., Mshelia, D.S., Genesis, R.Y., & Habu, S.A. (2017). Association between serum insulin and uric acid concentrations in type 2 diabetic subjects in Nigeria. African Journal of Diabetes Medicine, 25: 11-13

Prashanthkumar, G., Nagendra, S., & Kashinath, R.T. (2015). Plasma Uric Acid Levels in Relation to Plasma Cholesterol Levels in Type-2 Diabetes Mellitus. Global Journal of Medical Research, 29.

Raimi, T.H., Odusan, O.O., Fasanmade, O.A., Odewabi, A.O., Ajala, M.O., Oritogun, K., & Ohwovoriole, A.E. (2012). Insulin resistance in semi-urban south western Nigeria and its relationship with indices of obesity. Nigerian Endocrine Practice, 6:46- 50.

Reaven, G.M. (1994). Syndrome X: 6 years later. Journal of Internal Medicine, 236: 3-26.

Richette, P., & Bardin, T. (2010). Gout. Lancet, 375:318-328.

Roddy, E., & Doherty, M. (2010). Epidemiology of gout. Arthritis Res Ther, 12:223.

Tsushima, Y., Nishizawa. H., Tochino, Y., Nakatsuji, H., Sekimoto, R., Nagao, H., Shirakura, T., Kato, K., Imaizumi, K., Takahashi, H., Tamura, M., Maeda, N., Funahashi, T., & Shimomura, I. (2013). Uric acid secretion from adipose tissue and its increase in obesity. J Biol Chem, 288:27138–27149.

Yamashita, S., Matsuzawa, Y., Tokunaga, K., Fujioka, S., & Tarui, S. (1986). Studies on the impaired metabolism of uric acid in obese subjects: marked reduction of renal urate excretion and its improvement by a low-calorie diet. Int J Obes, 10:255–264.

Ye, J. (2007). Role of insulin in the pathogenesis of free fatty acid-induced insulin resistance in skeletal muscle. Endocrine, Metabolic and Immune Disorders - Drug Targets, 7: 65-74.

Young, E.E., Okafor, C.N., Iroezindu, M.O., & Agbalu, I.S. (2016). Insulin resistance, metabolic syndrome, and lipids in African women. Niger J Clin Pract, 19: 793-798.