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ORIGINAL RESEARCH

Insulin resistance and associated factors in healthy volunteers in South-west Nigeria

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Abstract

Background: Insulin resistance (IR) is linked with the pathophysiology of some non-communicable diseases including Type 2 Diabetes mellitus and metabolic syndrome.
Objective: To determine the factors associated with IR among apparently healthy individuals in South-west Nigeria.
Methods: A cross-sectional study of a cohort of apparently healthy volunteers aged 18 years and above consecutively recruited from two communities was conducted. IR was determined using the homeostasis model assessment for IR (HOMA-IR) based on the cut off values of ≥ 2. Bivariate and multivariate analyses were used to determine the crude and adjusted odds ratio of IR associated factors.
Results: A total of 520 participants aged 18–89 years were recruited for the study. Their mean age was 46.7±14.6 years and the prevalence of IR was 43.5%. Alcohol intake (AOR 2.1, 95%CI 1.3 – 3.4; p<0.001), lack of physical exercise (AOR 1.5, 95%CI 1.0 – 2.3), and Body Mass Index (AOR 1.03, 95%CI 1.0 – 1.1) were the factors associated with IR.
Conclusion: The prevalence of IR among apparently healthy individuals in this study was high. The need for proactive measures to avert the sequelae of IR is of utmost importance.

Keywords: Associated factors, Diabetes mellitus, HOMA IR, Insulin resistance, Metabolic syndrome, Nigeria.

Introduction

Insulin resistance (IR) occurs when the adipose tissue, skeletal muscles, pancreas, and the liver tissues have a poor response to or failed response to normal circulating levels of insulin as a result of metabolic, genetic, and nutritional disorders. [1] The pathophysiology of some non-communicable diseases, including metabolic syndrome and Type 2 Diabetes mellitus (which have increased in epidemic proportion at the turn of this millennium), has been linked to IR. [2,3] The burden of diabetes mellitus and metabolic syndrome have increased globally. [4] The population of individuals with diabetes mellitus was projected to increase from 171 million (in 2000) to 366 million by 2030. Interestingly, about 81% of this increase is expected to occur in developing regions like sub-Saharan Africa. [5] Also, 70% of deaths from diabetes mellitus and cardiovascular

diseases (CVD) were estimated by the World Health Organization to occur in developing countries. [6] Early detection of IR portends the possibility of preventing its potential sequelae and improve the quality of life of affected individuals. [7] Therefore, there is a need for concerted and targeted preventive strategies among healthy individuals.

The euglycaemic hyperinsulinaemic clamp is the preferred method for measuring IR but due to its cost, complexity, and invasiveness, its use in a large study population is limited. [8] The Homeostasis Model Assessment (HOMA) method, proposed by Matthews *et al*, [9] strongly correlated with the clamp method. [10] The latter is also a simpler and more acceptable method in the evaluation of IR.
Previously, we assessed the prevalence of metabolic syndrome in two communities in South-west Nigeria. [11] This follow-up study was meant to determine the factors associated with IR among apparently healthy individuals in South-west Nigeria communities.

Methods

This was a cross-sectional study conducted in two communities (Ilara/Akaka in Ogun State and Ikeja in Lagos State) in South-west Nigeria. Apparently healthy volunteers aged 18 years and above, not hypertensive or diabetic were consecutively recruited from the two communities selected by the multi-staged sampling method. The selection process for the study locations as well as the selection of the participants had been previously described. [11] The biodata and sociodemographic details of the participants were collected using a proforma. The participants' weight and height were measured and insulin and blood glucose estimation were also done.

Measurement of outcome variables
Anthropometric variables (independent variable)
The body weight was measured to the nearest 0.1kg using a standardised portable digital weighing scale. The height was measured to the nearest 0.1metre without shoes, caps, or headgear, using a portable Stadiometer while the Body mass index (BMI) was calculated and classified according to the World Health Organization recommendation. [12]

Laboratory analysis
Venous blood sample was drawn from the participants after an overnight fast (10-14 hours). Serum and plasma samples were prepared using standard laboratory methods and were stored at -20^{0}C. Fasting plasma glucose was estimated by standard enzymatic method while serum insulin was measured using an Enzyme-Linked Immunosorbent Assay (DRG Instrument GmbH, Germany).
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Definition of Insulin resistance
The homeostasis model assessment for IR (HOMA- IR) was calculated as the product of fasting serum insulin (mU/L) and fasting glucose (mmol/l) divided by 22.5. Insulin resistance (HOMA- IR) was defined as≥ 2 in this study. [13]

Statistical Analysis
The Statistical Package for Social Sciences (SPSS) IBM version 22 was used for data analysis. The mean values (with standard deviation) were determined for continuous variables whereas percentages were derived for categorical variables. Differences between categorical variables were compared using the Chi-Square test while Crude and Adjusted odds ratios of the factors associated with IR were determined. In this study, P<0.05 was considered statistically significant.

Ethical considerations
The institutional review boards of the Lagos State University Teaching Hospital (LASUTH) Ikeja and Babcock University, Ilishan Remo, Ogun State granted the ethical approvals for the study.

Results

A total of 520 participants between 18–89 years were recruited for the study. Their mean age was 46.7±14.6 years, with the male-to-female ratio of 1:2.7. A majority (74.8%) of the participants, were married while 9.6%, 17.7%, and 32.7% reported to smoke cigarettes, take alcohol, and engage in physical exercises respectively as shown in Table I.

About forty-three percent of participants (43.5%) had IR. On bivariate analysis, age, alcohol intake, lack of exercise, and high BMI were associated with IR ($p < 0.05$) (Table II).

Table III shows the multivariate regression analysis of the factors associated with IR. Alcohol intake (AOR 2.1, 95%CI 1.3–3.4; $p<0.001$), lack of physical exercise (AOR 1.5, 95%CI 1.0–2.3; $p = 0.028$) and high BMI (AOR 1.03, 95%CI 1.0–1.1; $p = 0.041$) were the factors associated with IR.

Discussion

Insulin resistance is a major abnormality in the aetiology of metabolic syndrome. Systematic reviews and meta-analysis have established the association between elevated levels of insulin and glucose with increased cardiovascular (CVD) risks, especially among individuals without diabetes mellitus. [14, 15] In this study, the prevalence of IR was 43.5%. This is low compared with 35% reported in a population of the elderly in south-western Nigeria. [16] Studies conducted among hypertensives and healthy individuals from Nigeria also reported a prevalence of IR lower than what was obtained in this study. [17, 18] However, a study among women in south-east Nigeria reported the prevalence of IR as 43.5%, [13] similar to the finding in this study. The differences in the prevalence of IR observed in Nigerian studies may be due to the characteristics of the study population (since HOMA-IR is defined by population-based percentile criteria), method of estimation, HOMA-IR cut off employed, ethnicity and metabolic conditions of the population studied. [19]

This present study showed no gender difference in IR rates contrary to what was reported in a similar study in south-western Nigeria. [18] However, previous reports on gender differences in IR were inconsistent. While some suggested that women had less IR, [20, 21] others have reported no gender differences. [22, 23] IR has been associated with the clustering of CVD risk factors more among women, leading to the conclusion that women are more insulin sensitive than men. [24]

In this study, the IR prevalence was higher in participants with self-reported low physical activity level and the risk of developing IR was 50% higher in people with low physical activity. Physical exercise and weight loss programs are reported to improve IR in individuals with diabetes mellitus. [25] However, the mechanisms underlying this improvement are not completely understood. It is difficult to distinguish the metabolic benefits of physical activity from the improvement in cardiorespiratory fitness that accompanies an increase in physical activity. In a study involving over 800 individuals, accumulated physical activity over the day was reported as the determinant of insulin sensitivity. [26]

The findings in this study suggest that alcohol consumption increased the risk of IR two-fold. Studies have also reported that moderate alcohol use improved insulin sensitivity. [27-29] Alcohol increases leptin and adiponectin levels which decrease food intake and increase energy expenditure, thus increasing insulin sensitivity. [30, 31]

Table I: Socio-demographic characteristics of participants

Characteristics	*Frequency (n = 520)*	*Percentages*
Age group (years)		
<30	60	11.5
30-39	104	20.0
40-49	141	27.1
50-59	99	19.0
≥60	116	22.3
Gender		
Male	142	27.3
Female	378	72.7
Ethnic groups		
Yoruba	386	74.2
Igbo	84	16.2
Hausa	11	2.1
Others	39	7.5
Marital status		
Single	61	11.7
Married	389	74.8
Previously married	70	13.5
Educational qualification		
None formal	64	12.3
Primary	134	25.8
Secondary	195	37.5
Tertiary	127	24.4
Cigarette smoking		
Yes	50	9.6
No	470	90.4
Alcohol intake		
Yes	92	17.7
No	426	82.3
Physical exercise		
Yes	170	32.7
No	350	67.3
BMI (kg/m^2)		
Normal	247	47.5
Overweight	145	27.9
Obesity	128	24.6

Table II: Factors associated with Insulin Resistance (IR)

Characteristics	*IR absent (n = 294)*	*IR present (n = 226)*	*P*
Age group (years)			
<30	39 (65.0)	21 (35.0)	
30-39	71 (68.3)	33 (31.7)	
40-49	75 (53.2)	66 (46.8)	
50-59	44 (44.4)	55 (55.6)	
≥60	65 (56.0)	51 (55.6)	
Mean±SD	45.6±15.3	48.2±13.6	0.048**
Gender			
Male	75 (52.8)	67 (47.2	
Female	219 (57.9)	159 (42.1)	0.294*
Cigarette smoking			
Yes	27 (54.0)	23 (46.0)	
No	267 (56.8)	203 (43.2)	0.703*
Alcohol intake			
Yes	37 (40.2)	55 (59.8)	
No	257 (60.0)	171 (40.0)	<0.001*
Physical exercise			
Yes	109 (64.1)	61 (35.9)	
No	185 (52.9)	165 (47.1)	0.015*
BMI (kg/m^2)			
Normal	151 (61.1)	96 (38.9)	
Overweight	78 (53.8)	67 (46.2)	
Obesity	65 (50.8)	63 (49.2)	
Mean±SD	25.7±5.9	27.0±6.4	0.017**

*** Chi-Square test; ** Student's t-test**
Figures in parentheses are percentages of the respective total

Another study demonstrated that binge drinking causes IR by impairing the action of insulin in the hypothalamus. [32] However, the quantity of alcohol consumed and the frequency of consumption were not ascertained in the present study.

Conclusion

The prevalence of IR among apparently healthy individuals in this study is high with obesity, lack of physical activity, and alcohol intake as factors associated with IR. There is a need for a large scale multi-center study to ascertain the appropriate cut-off point for HOMA-IR and determine the prevalence of IR in the environment.

Authors' Contributions: AEN conceived and designed the study, collected the data, and drafted

the manuscript. AAO participated in data collection, analysis, and drafting of the manuscript. OAO participated in designing the study and review of the draft for sound intellectual contents. All the authors approved the final version of the manuscript.

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Table III: Regression analysis of factors associated with IR

Variables	*P*	*AOR*	*95%CI*
Age	0.125	1.010	0.997-1.022
Gender			
Female		Reference	
Male	0.279	1.296	0.810-2.074
Smoking			
No		Reference	
Yes	0.295	1.461	0.719-2.970
Alcohol			
No		Reference	
Yes	0.004	2.084	1.260-3.447
Exercise			
Yes		Reference	
No	0.028	1.539	1.047-2.262
BMI	0.041	1.032	1.001-1.064

AOR-Adjusted Odd Ratio; CI-Confidence Interval

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