Epidemiology of conventional cardiovascular risk factors among hypertensive subjects with normal and impaired fasting glucose

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Background. Impaired fasting or glucose tolerance and/or diabetes can occur with hypertension, which theoretically predicts a worse cardiovascular risk profile, and consequently requires intensive cardiovasular risk management.

Objectives. To characterise the frequency of the occurence of conventional cardiovascular risk factors among hypertensive subjects with impaired fasting blood glucose.

Methods. We studied 120 hypertensive subjects and 80 age- and sex-matched normotensive controls. Relevant history, clinical examination, laboratory and other tests were undertaken. Body mass index was determined. Informed consent was obtained from all participants, and ethical approval was obtained.

Results. There was no statistically significant diference between the age and gender of the hypertensive subjects and the controls (55.1±10.83 v. 54.7±10.89 years, p=0.76). The serum fasting lipids were higher, but not statistically significantly, among the hypertensives than the controls (triglycerides 1.23±0.50 v. 1.22±0.48, p=0.900; total cholesterol 4.51±1.52 v. 4.38±0.84, p=0.842; LDL

2.51±1.41 v. 2.4±0.63, p=0.811, respectively). The prevalence of impaired glucose tolerance among newly presenting hypertensive subjects was 30.0%. Hypertriglyceridaemia (38.9% v. 6.0%, p=0.038), hypo-HDL cholesterolaemia (52.7% v. 31.0%, p=0.028) and visceral obesity (52.8% v. 27.4%, p=0.036) were statistically more prevalent among hypertensive subjects with impaired glucose tolerance than among those with normal glucose tolerance.

Conclusion. The prevalence of impaired glucose tolerance among newly presenting hypertensive subjects is very high, and they have more clusters of cardiovascular risks than those without impaired glucose tolerance. The former therefore need intensive cardiovascular assessment and appropriate preventive and treatment modalities. Glucose parameters of newly presenting hypertensive subjects must be determined to evaluate their cardiovascular risk profile.

The prevalence of cardiovascular disease is continuously rising throughout Africa.[1-5] The epidemiological transition impelling the developing world towards more non-communicable diseases, and especially cardiovascular disease, has been attributed to westernisation, reduced physical activity, obesity and the growing prevalence of cardiovascular risk factors.[1] Although the prevalence of cardiovascular diseases is at present less than in the developed world, an enormous rise in the near future, and also that most of the increase will come from developing nations (especially Africa), has been predicted.[6] The African INTERHEART Study,[7] which looked at the contribution of conventional risk factors among subjects with developed coronary heart disease (CHD), found that 90% of these subjects had the conventional risk factors of smoking, diabetes mellitus (DM), hypertension, abdominal obesity and dyslipidaemia. This finding further highlights a similar pathway in the evolution of cardiovascular diseases.

Hypertension and diabetes are related to one another in many ways. Both can individually and jointly increase cardiovascular risk, morbidity and mortality of individual subjects.[5] Heart disease (especially CHD) is a major cause of morbidity and mortality among subjects with abnormal glucose tolerance.[9] The National Cholesterol Education Programme Adult Treatment Panel III views diabetes as

being a cardiovascular risk factor equivalent to hypertension.[10]

It has been suggested that impaired glucose tolerance develops slowly among hypertensive subjects.[11] There are few reports on the pattern of CHD risk factors among hypertensive subjects with impaired glucose tolerance in Africa. However, studies have shown that impaired glucose tolerance is more prevalent among hypertensive subjects than normotensive subjects.[11,12]

We studied the epidemiology of conventional CHD risk factors among hypertensive subjects with abnormal fasting glucose and those with normal fasting glucose.

Material and methods

One hundred and twenty consecutive newly presenting subjects with systemic hypertension were recruited from the Cardiology Clinic of Ladoke Akintola University Teaching Hospital (LAUTECH) in Osogbo, Nigeria. Hypertension was diagnosed when blood pressure was persistently ≥140/90 mmHg. The investigators took blood pressures using standardised protocols.[13] Eighty age- and sex-matched normotensive subjects who were not previously diagnosed hypertensive subjects and whose blood pressures were persistently ≥140/90 mmHg were recruited among hospital staff and patients' relatives after informed consent was obtained.

Each subject had a relevant clinical history taken, including demographic parameters, age, gender, occupation, past history of hypertension and DM, smoking history, alcohol intake, and family history of hypertension and diabetes. Past history of early morning facial puffiness, frothiness of urine or passage of smoky urine was taken to rule out renal causes of secondary hypertension. Other causes of secondary hypertension were ruled out by appropriate history, and any suspected case was subsequently excluded. All the subjects had urinalysis and renal ultrasound.

Weight to the nearest 0.5 kg was taken by a standard weighing scale with the subjects in light clothing. Waist circumference was taken at the midpoint between the lowest rib and the anterior

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superior illiac spine. Hip circumference was taken over the greater trochanters. The waist/hip ratio (WHR) was determined. Height was taken with a stadiometer. Body mass index (BMI) (kg/m²) was defined as weight/(height²). Obesity was defined as BMI >30 and/or waist circumference >102 cm for men and >88 cm for women. A fasting serum lipid was also done to estimate the fasting serum total cholesterol, triglycerides, low-density lipoprotein (LDL) and high-density lipoprotein (HDL). Low HDL was defined as <1.3 mmol/l for females and <1.03 mmol/l for males. Hypertriglyceridaemia was defined as triglycerides >1.7 mmol/l, and total cholesterol was considered high if >6.1 mmol/l. Fasting blood sugar was done using the glucose oxidase method after at least an 8-hour fast. Abnormal glucose tolerance was defined as fasting blood sugar ≥5.5 mmol/l according to the International Diabetes Federation criteria.[14] Ethical clearance was obtained for the study.

Data were analysed using Statistical Package for Social Sciences (SPSS) 16.0 (Chicago, Ill.). Quantitative data were summarised as means ± SD, while qualitative data were summarised as frequency and percentages. Student's *t*-test and the chi-square test were used appropriately. Statistical significance was taken as *p*<0.05.

Results

The clinical characteristics of the study participants are as shown in Table I. Mean waist circumference, BMI, fasting blood glucose and waist/hip ratio were significantly higher among hypertensive subjects than normotensive controls. The distribution of major cardiovascular risk factor among hypertensive subjects with normal fasting glucose and those with impaired fasting glucose is shown in Table II. Hypertriglyceridaemia, low HDL, hyperchlesterolaemia and elevated LDL were significantly higher among hypertensive subjects with impaired fasting glucose than among hypertensive subjects with normal fasting glucose. Furthermore, hypertensive subjects with impaired fasting glucose had higher mean waist circumferences

than those with normal fasting glucose, as shown in Table III. Other clinical characteristics were similar between these two groups.

Discussion

The frequency of occurence of impaired fasting glucose in the present study was 30.0%; this is a high figure and reinforces the interrelationship between hypertension, progresive insulin resistance and the development of DM, a finding that agrees with similar reports by Essien *et al.*[11] who subjected hypertensive subjects to oral glucose tolerance tests and reported that 32.8% of them had impaired glucose tolerance. In this and other studies,[15] the basal blood glucose level was higher among hypertensive subjects than control subjects. It has also been shown that simple clinical parameters such as BMI, fasting glucose, and insulin levels can be used to predict the prescence of hyperinsulinaemia among hypertensive subjects. These tests may therefore be used to predict progression of abnormal glucose tolerance.[15]

The relationship between hypertension and diabetes is complex. Hypertension is considerably more prevalent in diabetic patients than in nondiabetics.[16,17] Hypertensive patients are 2.5 times more likely to develop type 2 diabetes than their normotensive counterparts when matched to age, sex, ethnicity, adiposity, level of physical activity and family history.[17,18] Suggested causes for the increased tendency to develop DM include altered insulin sensitivity of skeletal muscle tissue and reduced blood flow to skeletal muscle tissue owing to vascular hypertrophy, rarefaction and vasoconstriction.[16,19]

Impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) are strong predictors of type 2 DM, cardiovascular diseases and other complications of DM.[20,21] The Strong Heart Study has also shown that IFG and IGT are associated with a greatly increased risk of cardiovascular disease even in prehypertensive individuals.[22] Therefore, to identify high-risk individuals early, the glucose blood profile of hypertensive subjects should always be taken.[23,24]

Table I. Clinical characteristics of the study population

Parameter	Hypertensives (*N*=120)	Controls (*N*=80)	*p*-value
Age (years)	55.1±10.83	54.7±10.89	0.76
Gender			
Male (%)	66 (55.0%)	47 (58.8%)	
Female (%)	54 (45.0%)	35 (41.2%)	0.822
SBP (mmHg)	147.72±26.47	115.1±13.2	<0.001*
DBP (mmHg)	89.3±17.0	70.96±9.7	<0.001*
No. of smokers(%)	12 (10.0%)	1 (1.25%)	0.0023*
Waist (cm)			
Male	93.72±12.64	84.1±6.93	
Female	93.99±11.55	83.6±10.6	<0.001*
TC (mmol/l)	4.51±1.52	4.38±0.84	0.847
BMI (kg/m²)	26.9±5.31	23.9±3.5	<0.001*
LDL (mmol/l)	2.5±1.41	2.4±0.63	0.811
Triglycerides (mmol/l)	1.23±0.50	1.22±0.48	0.900
HDL (mmol/l)			
Male	1.16±0.45	1.28±0.37	
Female	1.25±0.49	1.18±0.47	0.642
FBS (mmol/l)	5.6±1.93	3.98±1.29	0.000*
PP (mmHg)	57.93±24.84	44.76±10.25	0.000*
WHR			
Male	0.97±0.07	0.92±0.05	
Female	0.92±0.08	0.89±0.05	0.01*

*Statistically significant.
SBP = systolic blood pressure; DBP = diastolic blood pressure; TC = total cholesterol; BMI = body mass index; LDL = low-density lipoprotein; HDL = high-density lipoprotein; FBS = fasting blood sugar; PP = pulse pressure; WHR = waist/hip ratio.

Table II. Distribution of major cardiovascular risk factors among hypertensive subjects with normal and impaired glucose tolerance

Parameter	Hypertensives with NFG (N=84) N (%)	Hypertensives with IFG (N=36) N (%)	p-value
Hypertriglyceridaemia	5 (6.0%)	14 (38.9%)	0.038*
Cigarette smoking	7 (8.3%)	5 (13.9%)	0.432
Low HDL	26 (31.0%)	19 (52.7%)	0.028*
Family Hx of DM	4 (4.8%)	3 (8.3%)	0.894
Family Hx of HTN	21 (25%)	13 (36.1%)	0.798
BMI>30kg/m^2	15 (17.9%)	12 (33.3%)	0.463
Visceral obesity	23 (27.4%)	19 (52.8%)	0.036
Elevated cholesterol	12 (14.3%)	18 (50%)	0.019*
High LDL level	7 (8.3%)	10 (27.8%)	0.034*

*Statistically significant.
HDL = high -density lipoprotein; DM = diabetes mellitus; HTN = hypertension; BMI = body mass index; LDL = low-density lipoprotein.

Table III. Clinical characteristics of hypertensive subjects with normal and impaired fasting glucose

Parameter	Hypertensives with NFG (N=84)	Hypertensives with IFG (N=36)	p-value
Age (years)	56.03±10.7	57.37±9.43	0.101
BMI (kg/m^2)	27.08±4.96	27.17±5.7	0.268
Pulse pressure (mmHg)	59.28±18.71	54.78±16.61	0.366
Waist/hip ratio	0.95±0.08	0.94±0.08	0.195
Waist circumference (cm)	94.29±11.95	96.45±12.41	0.011
Systolic blood pressure (mmHg)	146.80±22.31	140.50±26.29	0.356
Diastolic blood pressure (mmHg)	87.52±16.41	87.2±17.74	0.995

*Statistically significant.
NFG = normal fasting glucose; IFG = impaired fasting glucose

The mean fasting lipid levels in this study were not statistically different among the hypertensive and normotensive subjects, although the hypertensive subjects tended to have a higher level of LDL, triglycerides and total cholesterol, and a lower level of HDL. Other authors have documented similar results among hypertensive subjects and normotensive counterparts.[25] However, the proportion of smokers was statistically significantly higher among the hypertensive subjects. Comparing the hypertensive subjects with normal fasting glucose with those with impaired fasting glucose, the latter tended to have higher rates of hypertriglyceridaemia, hypo-HDL-cholesterolaemia, elevated LDL, hypercholesterolaemia and visceral obesity than those who had normal fasting glucose (Table II). An association between visceral obesity, dyslipidaemia and hypertension has been described.[26,27]

Comparing clinical characteristics between the above two groups, visceral obesity as assessed by waist circumference was the only statistically significant demographic parameter contributing to the presence of impaired fasting glucose. Though subjects with impaired glucose tolerance were older, this study does not confirm the contribution of age to the presence of impaired glucose tolerance among hypertensive subjects. Other workers have documented increased prevalence of cardiovascular risk factors among hypertensive subjects.[7,28-30] The present study therefore suggests that hypertensive subjects with impaired fasting glucose may be at an increased cardiovascular risk owing to the tendency for more clustering among them of the major cardiovascular risk factors. Longitudinal studies are therefore necessary to document the pattern of cardiovascular morbidity and mortality of these patients.

The study has some limitations. Firstly, it is hospital-based and may not truly respresent the population at large. Secondly, being a cross-sectional study by design, it cannot associate causal relationships between the factors under study.

Conclusion

Hypertensive subjects with impaired glucose tolerance have a higher chance than those with normal fasting glucose of having many more of the other conventional cardiovascular risk factors. Hypertriglyceridaemia, hypercholesterolaemia, elevated LDL, visceral obesity and low HDL were more common among them than hypertensive subjects with normal fasting glucose. Prospective longitudinal studies are suggested to identify the associated pattern of cardiovascular risk among this population.

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