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Original Research

The Hypertriglyceridemic Waist Phenotype is Associated with an Adverse Cardiometabolic Profile in this Cohort of Nigerians

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Abstract

Background: The hypertriglyceridemic waist (HTGW) phenotype was introduced as a means of identifying individuals at risk of developing metabolic syndrome as well as cardiovascular diseases and diabetes. However, studies surrounding the prevalence of the phenotype and its relationship with established markers of cardiometabolic risk, especially in the Nigerian population, remain sparse. This study aimed to determine the prevalence of the HTGW phenotype and explore its relationship with cardiovascular risk markers, namely Castelli Risk Indices I and II (CRI-I and CRI-II), Atherogenic Index of Plasma (AIP) and serum triglyceride-HDL cholesterol ratio (TG/HDL).
Methodology: In this retrospective cross-sectional study, the records of 206 patients presenting at a cardiac hospital from November 2022 to October 2023 were analysed. The HTGW phenotype was deemed present with a waist circumference of at least 94cm in men or 80cm in women and a serum triglyceride level of 150mg/dl or more in both sexes.
Results: At-risk waist circumference was more prevalent in women (92.7% vs 77.3%; p=0.002). The prevalence of the HTWG phenotype in the patient cohort was 29.6%, with more males than females (31.8% vs 27.1%) presenting with the phenotype (p=0.004). Patients with the phenotype also had higher systolic blood pressure, waist circumference, body mass index, triglycerides, AIP, and TG/HDL (all p<0.0005). The HTWG phenotype was also associated with a lower HDL and LDL cholesterol (p<0.0005) as well as a lower CRI-II (p=0.049).
Conclusion: The HTWG phenotype correlates with an increased cardiometabolic risk among Nigerians. This finding warrants the implementation of routine anthropometric and serum triglyceride measurements in screening programmes and hospitals for the early detection of individuals at risk of developing cardiovascular diseases.

Keywords: Abdominal Obesity, Cardiometabolic Risk Factor, Dyslipidaemia, Hypertriglyceridemic Waist, Nigeria, Obesity, Waist Circumference

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Introduction:

Weight and cholesterol and their influence on cardiovascular risk development and mortality in both sexes is well established and has been known since the 1980s thanks to the Framingham Heart Study.[1,2] The concept of the hypertriglyceridemic waist (HTGW) is a relatively new one brought on by further years of research in preventive cardiology. Introduced in 2007 by Lemieux and colleagues, it involves the prediction of individuals at risk of developing metabolic syndrome, coronary heart disease, and diabetes by the presence of concurrently elevated waist circumference and serum triglycerides.[3] The HTGW phenotype has been shown to increase cardiovascular risk, even independent of already well-known risk factors.[4,5] Individuals with the phenotype have also been demonstrated to have a higher incidence of abnormal glucose metabolism, insulin resistance, pre- and frank diabetes.[6–8]

Lipid ratios such as the ratio of total to low-density lipoprotein cholesterol (TC/LDL) are an important indicator of vascular risk and they have been demonstrated to have a greater predictive power for cardiovascular risk.[9,10] However, the HTGW phenotype and its association with cardiometabolic risk (assessed using lipid ratios) have been inadequately explored in the Nigerian population. In this article, our objectives were to determine the prevalence of the HTGW phenotype among Nigerian patients attending a cardiac hospital along with its relationship with established cardiovascular risk factors and lipid ratios. The lipid ratios studied were the Castelli Risk Indices-I and II, the Atherogenic Index of Plasma, and the serum triglyceride- HDL cholesterol ratio.

Methodology

Study design: This retrospective study used the clinical records of patients presenting at a private cardiac health facility in Lagos, Nigeria, and was carried out in line with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational studies. The sample population consisted of patients presenting to the hospital's outpatient clinic for the first time between November 1, 2022, and October 31, 2023. The inclusion criteria used in this research were: new patients, previously unregistered with the hospital, at least 18 years of age, and who presented to the facility within the specified period (November 1, 2022 - October 31, 2023). The exclusion criteria were patients with missing anthropometric, clinical, and laboratory data from their records. In total, 428 patients presented to the hospital within the specified period. The clinical records of 206 patients remained eligible for inclusion in the study after 222 records were excluded for incomplete data. The research was granted a waiver by the Health Research Ethics Committee of the Lagos University Teaching Hospital, Idi-Araba, Lagos, Nigeria, with identification number ADM/DSCST/HREC/APP/6494.

Definition of variables: The HTGW phenotype was defined as the presence of a serum triglyceride level of at least 150mg/dL,[11] with an enlarged waist circumference of ≥94cm for males or ≥80cm in women.[12] Four cardiometabolic risk ratios were compared to the HTGW phenotype to assess its usefulness as a surrogate of cardiovascular risk: the Castelli Risk Index I and II, the Atherogenic Index of Plasma (AIP), and the Triglyceride- HDL cholesterol (TG/HDL) ratio. The Castelli Risk Index I is a ratio of the total cholesterol to the HDL cholesterol (TC/HDL) and was defined as ≥3.5.[13] In contrast, the Castelli Risk Index II is defined as the LDL to HDL cholesterol (LDL/HDL) ratio with a value of at least 3.0, conferring increased cardiovascular risk.[13] The TG/HDL ratio cutoff was set at >3.0 to confer increased risk.[14] The Atherogenic Index of Plasma is the log to the base 10 of the TG/HDL ratio. Low cardiovascular risk is an AIP of -0.3 to 0.10, intermediate risk 0.11 to 0.23, and high risk ≥0.24.[13]

Hypertension and Diabetes mellitus were defined as patients with a past medical history of these conditions and/or on medications for these conditions. Smoking was noted as positive in patients whose notes showed that they were current cigarette smokers. A body mass index (BMI) of at least 30kg/m^2 was considered obesity[15] and the Adult Treatment Panel II document was the basis for cutoffs for serum total, low- and high-density lipoprotein cholesterol as well as triglycerides.[11]

Statistical Analysis: All data was collected by two authors at any given time into a pre-designed Microsoft Excel spreadsheet and cross-checked by a third author. Clinical notes were examined to obtain information on hypertension, diabetes, alcohol use, and smoking habits of the patients. Laboratory and anthropometric measurements were all taken from patient clinical notes. All data used for the study were obtained at the first presentation. The data was analysed by a biostatistician independent of the research group. The data was summarised using descriptive statistics of frequency and percentage for categorical variables, while continuous variables were described using mean and standard deviation. The Chi-squared test of association was used to determine the association between categorical variables, while Analysis of Variance (ANOVA) was used to compare the continuous and categorical variables. P-values of <0.05 were statistically significant. The dataset was analysed using the Statistical Package for the Social Sciences (SPSS) software version 21 (SPSS Inc., Chicago, IL, USA).

Results

The mean age of the population under study was 53.33±14.72 years (53.4% male, 45.6% between 45 and 64). Table 1 describes the prevalence of central obesity, elevated triglycerides, and the various HTGW phenotypes by gender. Central obesity was much more prevalent in the study population than elevated triglycerides (84.5% vs 32.5%, respectively), with females having a significantly higher prevalence of central obesity than males (92.7% vs 77.3%, respectively; p=0.002). The hypertriglyceridemic waist phenotype was observed in 29.6% of the study participants. Table 2 demonstrates no observable difference between patients over and under 50 regarding the prevalence of abdominal obesity, at-risk triglycerides, and the HTGW phenotypes in our study population.

Table 1: Prevalence of different HTGW phenotypes by gender

Gender				
Risk parameters	**Total sample**	**Female**	**Male**	***p-value***
At-risk waist circumference (women ≥ 80 cm, men ≥ 94cm)	84.5	92.7	77.3	**0.002***
At-risk triglycerides (≥150mg/dl)	32.5	27.1	37.3	0.119
HTGW PHENOTYPES				
Normal waist & normal triglycerides (NWNT)	12.6	7.3	17.3	**0.004***
Normal waist & at-risk triglycerides (NWHT)	2.9	0.0	5.5	
At-risk waist & Normal triglycerides (HWNT)	54.9	45.5	65.6	
At-risk waist & at-risk triglycerides (HTGW)	29.6	27.1	31.8	

Table 2: Prevalence of different HTGW phenotypes by age

Age				
Risk parameters	**Total sample**	**<50**	**≥50**	***p-value***
At-risk waist circumference (women ≥ 80 cm, men ≥ 94cm)	84.5	87.0	80.7	0.223
At-risk triglycerides (≥150mg/dl)	32.5	32.5	32.5	0.999
HTGW PHENOTYPES				
Normal waist & normal triglycerides (NWNT)	12.6	14.5	11.4	0.501
Normal waist & at-risk triglycerides (NWHT)	2.9	4.8	1.6	
At-risk waist & Normal triglycerides (HWNT)	54.9	53.0	56.1	
At-risk waist & at-risk triglycerides (HTGW)	29.6	27.7	30.9	

As seen in Table 3, patients with the HTGW phenotype had significantly higher systolic blood pressure, waist circumference, BMI, and serum triglyceride levels. This population also had lower HDL and LDL cholesterol levels. Table 4 compares calculated lipid risk ratios between HTGW positive and negative participants. Individuals with the HTGW phenotype have a significantly higher atherogenic index of plasma and TG/HDL ratio.

Table 3: Association between the cardiometabolic risk indices and the different phenotypes

Characteristics	**HTGW (-) N=145**	**HTGW (+) N=61**	**p-value**
Age (mean±SD)	52.27±15.49	55.87±12.45	NS
Gender (%)			0.458
- Female	48.3	42.6	
- Male	51.7	57.4	
Diabetes (%)			0.062
– No	84.8	73.8	
– Yes	15.2	26.2	
Smoking (%)			0.594
– No	93.1	95.1	
– Yes	6.9	4.9	
Alcohol Intake (%)			0.119
– No	60.0	47.5	
– Yes	40.0	52.5	
Systolic Blood Pressure (mmHg)	135.13±25.75	136.36±21.68	**<0.005***
Diastolic Blood Pressure (mmHg)	80.53±14.40	79.38±12.45	NS
Waist Circumference (cm)	99.23±13.32	109.31±14.05	**<0.005***
Body Mass Index (kg/m^2)	30.33±6.87	33.02±6.58	**<0.005***
Total cholesterol (mg/dl)	192.46±43.63	190.61±44.89	NS
Waist circumference-to-height ratio	0.593±0.09	0.65 ±0.09	NS
HDL cholesterol (mg/dl)	53.17±11.80	50.58±12.34	**<0.005***
LDL cholesterol (mg/dl)	116.97±38.46	101.19±39.24	**<0.005***
Triglycerides (mg/dl)	117.18±31.09	200.76±62.32	**<0.005***

NS=Not significant

Table 4: Comparison of the characteristics of different HTGW phenotypes

Variables	**HTGW (-)**	**HTGW (+)**	**p-value**
TC/HDL (Castelli Risk Index I)	3.71±0.89	3.85±0.73	0.291
LDL/HDL (Castelli Risk Index II)	2.26±0.82	2.03 ±0.69	**0.049***
TG/HDL	2.33±0.89	4.22±1.81	**<0.001***
AIP	0.337±0.17	0.60±0.15	**<0.001***

Discussion

Our paper is one of the initial reports on the prevalence of the HTGW phenotype and demonstrate a significant association with a deranged cardiometabolic risk profile in the Nigerian population. The comparison between lipid ratios and the HTGW was specifically chosen to highlight how a simple,

relatively inexpensive method combines an anthropometric measurement and a lipid profile and effectively deduces cardiovascular risk, especially in resource-poor settings such as Nigeria.

The prevalence of the HTGW phenotype in our study population was 29.6% with a higher prevalence in males than females (31.8% vs 27.1%; p=0.004). This is a slightly higher prevalence than the results obtained in another Nigerian study carried out among hypertensives, which reported an overall prevalence of 23.4% with a male predominance (26.8% vs 19.4%).[16] However, in different populations, the prevalence has been reported as 13.3%, 17.8%, 19.4%, 21.5%, 26.7% and 35.4% respectively.[17-22] In women-only studies, prevalences of 33% and 40.6% have been reported.[23,24] Gender differences in prevalence are also common. Our study reports a male predominance. Same with Vaverkova and colleagues, who report a prevalence of 45.7% in men vs 32.3% in women.[25] The reverse is the case as this study demonstrated that 82.2% of individuals with the HTGW phenotype were women.[20] The differences in prevalence may partly be accounted for by the differences in populations where the studies were carried out and the different cutoffs for at-risk waist circumference used in those populations.

Our research showed no significant association between age and the prevalence of the HTGW phenotype. However, in a study carried out by Ferreira et al., the highest prevalence of the HTGW phenotype was found in the age range of 31-50 years (57.4%; p = 0.001).[19] This might be of benefit in screening for CVD, as younger populations are often left out.

Regarding association with cardiovascular risk factors, our study demonstrates a significantly higher systolic blood pressure, waist circumference, body mass index, and triglycerides with lower HDL cholesterol (p for all <0.005) for individuals with the HTGW phenotype. Our findings agree with other authors on this subject regardless of the study population.[21,26-30] A surprising association noted was the lower LDL cholesterol in patients with the HTGW phenotype. Some other studies have reported no significant difference in the LDL cholesterol values in both groups of patients.[24,31] Our study did not obtain a history of statin use in the participants, which may account for the findings above. However, it has been demonstrated that carotid plaques are associated with high VLDL cholesterol levels but not total and LDL cholesterol.[32] VLDL cholesterol also independently conferred an increased risk of coronary artery disease, with the majority (75%) of patients with elevated VLDL having normal LDL cholesterol levels.[33] While our study did not obtain VLDL results from the patients' files, it is hoped that this study presents a starting point for further research in the Nigerian population.

Associations were also sought between the HTGW phenotype and four cardiometabolic indices: Castelli Risk Indices I and II, TG/HDL, and the AIP. Our study demonstrated a significant positive association between the HTGW phenotype and an increased TG/HDL ratio and the AIP (p <0.001 for both). This result aligns with studies out of Nigeria and the Czech Republic with a positive relationship between the HTGW phenotype and the AIP,[16,25] and by Ferreira and colleagues that demonstrated an association between the hypertriglyceridemic waist and the TG/HDL ratio.[19] The Castelli risk indices I and II have been proven to be positively associated with the HTGW phenotype,[17,23] a finding we could not replicate in our study. The CRI-II was significantly higher in patients without the HTGW phenotype (p=0.049), although lower than the threshold for increased cardiovascular risk. This may be a direct result of the elevated LDL cholesterol observed in this patient group. The CRI-I was higher in persons with the HTGW phenotype, though not significantly.

The high prevalence of the HTGW phenotype is alarming in the Nigerian population. The phenotype has been associated with an increase in CVD risk and the incidence of type 2 diabetes, as well as all-cause and CVD-specific mortality.[34,35] This is of profound importance in a population in which cardiovascular diseases have been demonstrated to cause significant mortality.[36,37] The evaluation of cardiovascular risk will likely become routine across all levels of healthcare when inexpensive methods such as hypertriglyceridemic waist phenotype become commonplace.

The results of this study will allow for the development of screening programmes designed to detect individuals at risk of cardiovascular disease before overt symptomatology is present. Of importance is screening younger aged individuals as this phenotype does not show, in this study, a predominance for age. This would be effective both at the community level and in-hospital.

Limitations of this study

This study employed a cross-sectional retrospective design, which prevented a temporal association between the hypertriglyceridemic waist phenotype and cardiovascular risk from being drawn. Secondly, the population of the study was Nigerians who presented to a cardiac facility for evaluation and thus may also be at increased risk of developing cardiovascular disease. This study was also carried out in a privately owned hospital. It, therefore, would be inappropriate to generalise the results of this study to other populations. This also accounts for the amount of patient records excluded from the analysis. Furthermore, our study obtained plasma lipid profile results from patients' clinical files. It was not possible to determine if these were fasting samples or not. As such, some patients may have been misclassified as either having normal or deranged serum lipids, thus further reducing our ability to decipher associations between cardiometabolic risk and the hypertriglyceridemic phenotype. A history of statin intake was also not obtained from the records, which may explain the lipid results obtained. A prospective study on this subject amongst Nigerians would remedy the above, with a sample size calculated to produce a significantly powered study and provide more insight into the association between the HTGW phenotype and cardiometabolic risk in the Nigerian population. This would have more impact as a multicentre study involving at least one public teaching hospital in each geopolitical zone to reflect the true relationship between the HTGW phenotype and markers of cardiometabolic risk in the Nigerian population.

Conclusion:

The hypertriglyceridemic waist phenotype is prevalent in this cohort of Nigerians and was associated with a deranged cardiometabolic profile. The HTWP may be a practical and relatively inexpensive measure in screening for CVD risk. Therefore, we recommend including routine anthropometric measurements and serum triglyceride quantification during community screening programmes as well as in clinics and hospitals. This would aid early identification of at-risk individuals with the prompt institution of lifestyle changes and pharmacological therapies as necessary.

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