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Research

Association of angiotensin converting enzyme gene polymorphism among overweight hypertensive patients attending Murtala Muhammad Specialist Hospital, Kano State, Nigeria

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Abstract

One risk factor for high blood pressure is obesity. An enzyme called the angiotensin-converting enzyme (ACE) is responsible for vasoconstriction. It is possible that ACE gene insertion or deletion polymorphisms are linked to hypertension. The goal of this investigation is to identify a correlation between blood pressure and polymorphisms in the ACE gene in obese patients. This study employed a cross-sectional design and an analytical observational approach. To investigate ACE gene polymorphism, blood samples were collected from 40 overweight patients. The Kruskal-Wallis test was employed to examine the correlation hypothesis. The findings indicated that type II (62.5%), type ID (25%), and type DD (12.5%) ACE gene polymorphisms were the most prevalent; the mean systolic blood pressure values for type II were 129.5 mmHg, type ID was 142.3 mmHg, and DD was 164.9 mmHg. Diastolic pressure was 90.5 mmHg on average for ACE gene polymorphism type II, 101.4mmHg on average for type ID, and 113.9 mmHg on average for type DD. There was a correlation between the angiotensin ACE gene polymorphism and systolic pressure at p=0.002 and the diastolic pressure at p=0.004. There was a correlation between ACE gene polymorphism and BMI at p= 0.004, waist circumference at p= 0.001, body adiposity index at p= 0.003, and mid-upper-arm circumference at p= 0.006. Thus, we concluded that there is a relationship between blood pressure, degree of obesity, as measured by anthropometric indices, and polymorphism in obese, hypertensive patients.

INTRODUCTION

Obesity is recognized as a risk factor for high blood pressure (WHO, 2021). Medical risk rises progressively with increasing degrees of obesity beginning with overweight, defined by BMI between 25.0 and 29.9 kg/m2, through class I obesity (BMI, 30.0 to 34.9 kg/m2), class II obesity (BMI, 35.0 to 39.9 kg/m2) and class III or extreme obesity (BMI 40 kg/m2) (Lyznicki et al., 2001).

Approximately 650 million adults over the age of 18 are obese. Approximately 11% of men and 15% of women worldwide are obese (Thristy et al. 2025). More than 1.9 billion persons aged 18 and older were overweight in 2016, making obesity a global health problem (Tiara, 2020). In Nigeria, adult obesity rates are still rising, with males at 19.7%, females at 32.9%. The prevalence of hypertension disease is also rising (Pan et al., 2016).

Fat cells may contribute to hypertension by producing harmful substances that affect the heart and blood vessels (Handayani et al., 2021). Blood pressure and fluid volume are hormonally regulated by the renin-angiotensin system (RAS) (Ali et al., 2013). An essential component of the RAS system, the angiotensin-converting enzyme (ACE) converts angiotensin I into angiotensin II, a vasoconstrictor implicated in angiogenesis, differentiation, apoptosis, and cell proliferation.

ACE gene polymorphism refers to variation in the angiotensin converting enzymes (ACE) gene that are present in the general population. These variations can affect the activity of the ACE enzymes, which play a role in blood pressure regulation and possibly fat metabolism. Polymorphism is relatively common, meaning that many people have different versions of the ACE gene. We are interested in exploring how these variations might influence individual differences in hypertension risk.

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Polymorphisms in the insertion or deletion of the ACE gene may be linked to both fat storage and hypertension (Simonyte e al., 2017), but the relationship between ACE gene polymorphism, fat storage, and hypertension is complex and still debated. The purpose of this study is to assess whether ACE gene polymorphisms are associated with blood pressure in an overweight patient population.

MATERIALS AND METHODS

This study used cross-sectional, analytical, and observational methods. Overweight in- and out-patients from Murtala Muhammad Specialist Hospital comprised the study population. Patients who satisfied the following requirements were included: must be between the ages of 20 and 60, have a body mass index of 25 or above, have their Blood Pressure measured; Systolic Blood Pressure (SBP) greater than or equal to 140 mmHg and Diastolic Blood Pressure (DBP) greater than or equal to 90mmHg, and who are willing to participate in the study by signing an informed consent form. Patients who took antihypertensive medications were excluded from this study.

SAMPLE COLLECTION

A total of 40 individuals were sampled from Murtala Muhammad Specialist Hospital and had their blood pressure checked. The patients' blood samples were then collected to assess the ACE gene polymorphism. Blood testing for the ACE gene polymorphism was done at Bayero University Kano, Faculty of Biochemistry lab.

DNA extraction, primer design, and gel electrophoresis

First, DNA was extracted using the Wizard Genomic DNA Purification Kit to examine for ACE gene polymorphism. Primer 3 F 5'- GAT GTG GCC ATC ACA TTCGTC AGAT -3' and Primer 3 R 5'-CTG GAC ACC ACT CCC ATC CTT TCT -3' were used to continue the PCR (Polymerase Chain Reaction) process after the DNA sample had been held at 2-8ºC. The results showed products as DNA bands at 490 bp and 190 bp. The PCR employed a thermal cycler, with the first sequence lasting 2 minutes at 98 °C. This was followed by thirty-one cycles for 15 seconds at 98 °C, one minute at 58 °C, and 30 seconds at 75 °C. The samples were kept at 4ºC following 31 cycles at 75ºC for five minutes. 2% agarose gel electrophoresis stained with Gel Red was used to read the PCR results. The PCR results are interpreted as polymorphism II if only one DNA band is detected at 490 bp, DD polymorphism if only one DNA band is detected at 190 bp, and ID polymorphism if two DNA bands are detected at 490 bp and 190 bp.

ANTHROPOMETRIC MEASUREMENT

Height and weight were measured according to the protocol of the International Society for the Advancement of Anthropometry. Height was measured to the nearest 0.1 cm in bare feet with participants standing upright against a mounted stadiometer. Weight was measured to the nearest 0.1 kg with the participants lightly dressed using a portable manual weighing scale. At the beginning of each measurement day, the accuracy of the weighing scale was checked by using a known standardized weight placed on the scale. Before each measurement, the scale was tared.

Body mass index was determined using weight (in kilogram, kg) divided by height (meters, m) squared i.e kg/m2. The World Health Organization classifies BMI as underweight (16.1-18.5 kg/m2), normal (18.5-25.0 kg/m2), and overweight (25.1-30.0 kg/m2).

The waist circumference was measured at the level of the iliac crests using a flexible tape, passing it along the umbilical level of the unclothed abdomen. The hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the floor.

Mid-upper-arm-circumference (MUAC) was measured at the level of the midpoint of the upper left arm, with the arm hanging relaxed by an accurate soft tape to the nearest 0.1 cm range.

We used the WHO MUAC categorization: normal < 28.5cm, overweight/obese ⩾ 28.5 cm.

Body adiposity index (BAI) was calculated using the following formula (Krakauer & Krakauer 2012):

$$BAI = \frac{Hip\ Circumference\ (cm)}{Height\ (m)^{1.5}} - 18$$

The BAI of the study participants was categorized as recommended by WHO: normal (8-20%), high body fat (21-24.9%), and very high body fat (⩾ 25%).

STATISTICAL ANALYSIS

Each variable, both independent and dependent, was described using univariate analysis, which included examining frequency distribution tables and calculating the number and percentage of each variable. Descriptive analysis and hypothesis testing were part of the data analysis. The Shapiro-Wilk test was used to assess normality. The Kruskal-Wallis test was employed to examine the correlation hypothesis.

ETHICAL APPROVAL

Ethical approval was obtained from the Kano State Hospitals Management Board (HMB), and the College of Health Sciences, Bayero University Kano. Patients were required to sign consent forms after being fully informed about the research project. Every detail was kept private.

RESULTS

Of the 40 participants, 23 were male. The most common type of polymorphism observed was Type II, present in 25 people (62.5%), followed by the ID gene (25%), and the least common was the DD gene, with 4 cases (12.5%). Table 1 presents findings from the anthropometric measurements. The sample had a high prevalence of excess body weight, central obesity, and adiposity.

Table 2 shows associations between sample characteristics and ACE gene polymorphism. Based on the results of the Shapiro-Wilk normality test (p> 0.05), the data were not normally distributed; therefore, the data were analyzed using the nonparametric Kruskal-Wallis test. DD polymorphism was linked to being older, having higher blood pressure values, and being more overweight.

Table 3 presents correlations between ACE gene polymorphism and anthropometric indices of the sample patients. Type II does not significantly correlate with anthropometric indices. There is a strong positive

association between Type ID and WC. Significant positive relationships were found between Type DD and each anthropometric index.

Table 1: Frequency distribution based on anthropometric indices

Parameters	Frequency (n=40)	Percentage (%)
Waist Circumference (cm)		
Low risk		
Men: < 0.90	2	5
Women: < 0.80		
High risk		
Men: 0.90-0.99	10	25
Women: 0.80-0.84		
Very high risk		
Men: ⩾ 1.00	28	70
Women: ⩾ 0.85		
Body Adiposity Index (%)		
Normal		
Men: 8-20.9	3	7.5
Women: 21-32.9		
High body fat		
Men: 21-24.9	14	35
Women: 33-35.9		
Very high body fat		
Men: ⩾ 25	23	57.5
Women: ⩾ 36		
Mid upper arm circumference (cm)		
Normal		
Men: <28.5 (⩾ 9.6 in)	12	30
Women: <27.5 (⩾ 9.1 in)		
Overweight/obese		
Men: ⩾28.5 (⩾11.2 in)	28	70
Women: ⩾ 27.5 (⩾ 10.8 in)		

Table 2. Factors associated with ACE gene polymorphism

Parameters	II (n= 25)	ID (n=10)	DD (n= 5)	P - value
Age	34.5 ± 6.3	44.1 ±12.5	48.5 ± 13.4	0.006
Systole	129.5 ± 21.1	142.3 ± 38.4	163.9 ± 61.3	0.002
Diastole	90.5 ± 16.3	101.4 ± 26.3	113.9 ± 36.3	0.004
BMI	32.1 ± 4.2	36.5 ± 5.1	40.2 ± 6.3	0.004
WC	105.2 ± 10.5	115.6 ± 12.8	125.9 ± 15.1	0.001
BAI	41.2 ± 5.5	45.9 ± 6.8	51.2 ± 8.2	0.003
MUAC	34.5 ± 4.8	38.2 ± 5.5	42.1 ± 6.8	0.006

Table 3: Association between ACE gene Polymorphism and anthropometric indices of overweight patients

Parameters	BMI	WC	BAI	MUAC
II	0.15	0.12	0.08	0.10
ID	0.32	0.35*	0.28	0.30
DD	0.45*	0.50*	0.42*	0.48*

* Association is significant at P < 0.05 Level

DISCUSSION

We found that the most common type of ACE polymorphisms in a sample of overweight patients was type II (insertion), which accounted for 62.5%, followed by type ID, which accounted for 25%, and the least common was type DD, which accounted for 12.5%. Research conducted in Malaysia obtained similar results, with the most common types of ACE gene polymorphism in obesity being type II (insertion), at 54.5%, followed by type ID at 36.6%, and type DD at 8.9% (Apidi et al., 2020). They also found no significant difference in the type of allele or genotype of the ACE gene between obese individuals and those of normal weight. Research in Korea showed that the most prevalent ACE gene genotype among obese people was type ID (57.1%), followed by type II (30.8%), and the least common was type DD (12%) (Kwon, 2020). A study conducted in Brazil showed that the most genotypes found in obese patients were type ID and the least were type II (Lelis et al., 2019). In the three studies mentioned, there was no relationship between ACE gene polymorphism and obesity (Kwon, 2020).

The present study found an association between ACE gene polymorphism and systolic and diastolic blood pressure, as well as anthropometric indices, which contradicts some previous research that found no such correlation (Sudayasa & Husdaningsih, 2023). However, other studies found, as we did, that there was an association between ACE gene polymorphisms and blood pressure (Fan et al., 2019; Pinheiro et al., 2019). Another study mentioned that the DD gene polymorphism tends to increase systolic and diastolic blood pressure compared to the ID and II gene polymorphisms (Liu et al., 2021)

Our data suggest that individuals with the DD polymorphism tend to have higher anthropometric indices, consistent with previous studies showing a relationship between genetic polymorphisms and obesity-related traits (Adegoke et al., 2021). We also found that the DD gene polymorphism had higher mean values of systole (163.9 ± 61.3) and diastole (113.9 ± 36.3) compared to II and ID gene polymorphisms. Overweight is known to be a factor contributing to an increase in blood pressure (Fulton and Stepp, 2020; Pita et al., 2022). However, genetic variations, lifestyle, and environment can also influence the relationship between ACE genes and blood pressure (Birhan et al., 2023).

CONCLUSION

The Angiotensin-Converting Enzyme (ACE) gene polymorphism in overweight patients among hypertensive patients attending Murtala Muhammad Specialist Hospital, Kano was found to be predominantly type II, with the least common type being DD. There was a relationship between blood pressure, anthropometric indices and polymorphism in these overweight patients.

AUTHOR CONTRIBUTIONS

MAG: Conceptualization, Methodology, Writing Original Draft, funding acquisition, Resources, software analysis. AMH: Investigation, Data Curation, Validation, formal analysis. SYB: Supervision, Writing Review and Editing. All authors have read and approved the final version of the paper and its submission and gave consent for publication.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN SCIENTIFIC WRITING

Nothing to disclose.

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