Elevated Body Mass Index and Waist Circumference Induced Hypertension is not Significantly Reversed by Oral Administration of Antihypertensive Agent

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ABSTRACT

Aims: This study investigated the effects of elevated body mass index and waist circumference on blood pressure control in hypertensive subjects under a specific antihypertensive agent in comparison with normotensive subjects.

Study Design: One factor quasi-experimental design.

Place and Duration of Study: Department of Biochemistry, Ekiti State University, Ado- Ekiti, Ekiti State, Nigeria. December, 2014-November, 2015.

Methodology: The research subjects and control subjects between ages 31-60 years both male and female subjects were selected. Systolic and diastolic blood pressures were measured using mercury sphygmomanometer. The body mass index was calculated as weight in kilograms divided by the square of the height in metres. While the waist circumference was measured at the level of the

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iliac crests using a flexible tape and passing along the umbilical level of the unclothed abdomen.

**Results:** Comparing the body mass index and waist circumference of both untreated and treated hypertensive subjects with the normotensive subjects showed a significant increase ($P=0.0001$).

**Conclusion:** Elevated body mass index and waist circumference may be a predisposing factor to high blood pressure and resistant to antihypertensive agents. Reducing body mass index and waist circumference may be a way of enhancing effectiveness of antihypertensive agents.

**Keywords:** Hypertension; antihypertensive agents; body mass index; waist circumference; normotensive; subject.

**1. INTRODUCTION**

Hypertension is a medical condition characterized by persistent elevation of diastolic or systolic blood pressure above the level of normal blood pressure of 140/90 mmHg [1,2]. Hypertension is currently considered a major public health problem due to its importance as a cardiovascular risk factor. According to World Health Report of 2002, it was said that high blood pressure is the primary or secondary cause of 50% of all cardiovascular diseases worldwide. Researchers have shown growing evidence that prevalence of hypertension is on the increase in most Sub-Saharan African countries including Nigeria [3]. Interestingly, a meta-analysis of prevalence rate of hypertension in Nigerian populations ranged from a minimum of 12.4% to a maximum of 34.8% with a combined prevalence of 22% [4-5]. In the same vein, other studies from Nigeria on the knowledge of risk factors and lifestyle showed that over 4.3 million Nigerians above 15 years were classified as being hypertensive [6-8]. Hypertension has been linked to dietary pattern and other sedentary lifestyle with grave biochemical and metabolically consequences [9-10]. The last few years have witnessed considerable changes in the treatment of high blood pressure in Nigeria with different brands of antihypertensive agents available in Nigeria market. It has been reported that the use of antihypertensive agents tripled and resulted in an eight-fold increase in the pharmaceutical expenditure for these agents in the recent year, yet, many still find it difficult to reduce their blood pressure. Past studies have shown that between 50% and 75% of patients diagnosed with or receiving treatment for hypertension do not have adequate control of their blood pressures [11]. Factors such as central obesity increases risk and constitute a base for the development of hypertension [12-17] while body mass index (BMI) is commonly used for monitoring the occurrence of obesity in the population. Due to high prevalence of unhealthy eating habits and lifestyle together with high prevalence of overweight, obesity and increased consumption of different brands of antihypertensive agents by Nigerians, it is important to investigate the relationship between antihypertensive agent consumption; blood pressure control and selected anthropometric measurement especially body mass index and waist circumference. Hence, the need for this study.

**2. MATERIALS AND METHODS**

**2.1 Subjects**

The research subjects between ages 31 – 60 years both male and female were selected from Nigerians living in Ilesa metropolis of Osun State and grouped into three. Group one consist 100 essential hypertensive subjects that have been under a specific antihypertensive agent for more than six months, group two consist of 100 essential hypertensive subjects that are not under antihypertensive agent while group three consist of 100 subjects that are not hypertensive and not under any antihypertensive agent. Exclusion criteria include secondary hypertension and any other pathological case. Four classes of commonly used oral antihypertensive agents’ namely diuretic, adrenergic receptor antagonist, Calcium channel blockers and angiotensin-converting enzyme inhibitor were selected for this study. The ethical clearance for this study was obtained from Osun State Hospitals’ Management Board Ethics and Research Committee.

**2.2 Measurements**

Informed consent was obtained from the subjects after the study guidelines had been explained to them before clinical history was obtained using structured questionnaire. Blood pressure was taken from dominant arm after ten minutes of rest using appropriate cut size and mercury sphygmomanometer. Systolic (SP) and diastolic blood (DP) pressures were measured at the first and the fifth keroktoff sound respectively. Three
consecutive measurements were made at an interval of five minutes. The mean SP and DP from the 2nd and 3rd measurement were used for the data analysis. The weight (WGT) was measured to the nearest 0.5kg using a weighing scale with the participant wearing light clothing and removing their footwears. Height (HGT) was measured to the metre using a stadiometer. The BMI was calculated as weight in kilograms divided by the square of the height in millimeters. The waist circumference was measured at the level of the iliac crests using a flexible tape and passing along the umbilical level of the unclothed abdomen.

2.3 Statistical Analysis

Results are presented as mean± SEM. Statistical significance and difference from control and test values evaluated by Student's t-test. Statistical difference at probability of P= .05 were considered to be significant.

3. RESULTS AND DISCUSSION

The benefits of blood pressure reduction following antihypertensive therapy are no longer questioned but attaining a normal blood SP and DP (≤140 and 90) has been a challenge in some cases. BMI (body mass index) and WC (waist circumference) are used to access overweight and obesity and risk of cardiovascular disease among others. This research study the effect of elevated body mass index and waist circumference on blood pressure control in hypertensive subjects under a specific antihypertensive agent and in hypertensive subjects that are not under antihypertensive agent in comparison with normotensive subjects and four commonly used antihypertensive agents were considered namely diuretic, adrenergic receptor antagonist, calcium channel blockers and angiotension converting enzyme inhibitor which must have being administered for minimum of six (6) months. Significant increase (P =.0001) were observed when the BMI, WGT, SBP, DBP, WC and HGT of untreated hypertensive subjects and treated hypertensive subjects were compared with normotensive subjects with the exception of HGT of both male treated ( male treated group under angiotensin converting enzyme inhibitor therapy not included) and untreated hypertensive subjects which showed no significant change (P=1.000) (Tables 1 - 5).

Table 1. Anthropometric data of normotensive compared with hypertensive subjects

| Indices | Gender | Male | | | Female | | |
|---------|--------|------|---|---|------|---|
|         | Normo. (n=50) | Hyper. (n=50) | Normo. (n=50) | Hyper. (n=50) | Normo. (n=50) | Hyper. (n=50) |
| HGT (m) | 1.7±0.090 | 1.7±0.011 | 1.7±0.009 | 1.6±0.008* |
| WGT (kg) | 72.5±1.632 | 81.4±1.752* | 72.5±1.632 | 84.8±1.436* |
| WC (cm) | 77.4±4.326 | 98.2±1.915* | 66.0±5.746 | 83.5±3.419* |
| BMI (kg/m^2) | 25.2±0.470 | 29.5±0.692* | 26.6±0.420 | 32.3±0.642* |
| SP (mmHg) | 119.0±1.910 | 161.4±2.841* | 125.4±1.601 | 153.5±3.164* |
| DP (mmHg) | 80.0±1.127 | 104.2±2.204* | 79.1±1.076 | 94.5±1.564* |

Values are mean ± SEM. Significant difference between normotensive and hypertensive group by t-test *P=.0001.

HGT=Height, WGT=Weight, WC=Waist circumference, BMI=Body mass index, Normo. = Normotensive, Hyper = Hypertensive, n = sample size, SP = Systolic blood pressure, DP = Diastolic blood Pressure

Table 2. Anthropometric data of normotensive compared with hypertensive subjects under diuretic therapy

| Indices | Gender | Male | | | Female | | |
|---------|--------|------|---|---|------|---|
|         | Normo. (n=50) | Hyper. (n=50) | Normo. (n=50) | Hyper. (n=50) | Normo. (n=50) | Hyper. (n=50) |
| HGT (m) | 1.7±0.090 | 1.7±0.013 | 1.7±0.009 | 1.6±0.008* |
| WGT (kg) | 72.5±1.632 | 82.4±1.793* | 72.5±1.632 | 83.6±1.519* |
| WC (cm) | 77.4±4.326 | 96.8±2.886* | 66.0±5.746 | 88.9±3.235* |
| BMI (kg/m^2) | 25.2±0.470 | 30.0±0.618* | 26.6±0.420 | 32.0±0.675* |
| SP (mmHg) | 119.0±1.910 | 149.0±2.310* | 125.4±1.601 | 148.2±2.804* |
| DP (mmHg) | 80.0±1.127 | 93.1±1.439* | 79.1±1.076 | 91.1±1.246* |

Values are mean ± SEM. Significant difference between normotensive and hypertensive group by t-test *P=.0001.

HGT=Height, WGT=Weight, WC=Waist circumference, BMI=Body mass index, Normo. = Normotensive, Hyper = Hypertensive, n = sample size, SP = Systolic blood pressure, DP = Diastolic blood Pressure
Table 3. Anthropometric data of normotensive compared with hypertensive subjects under adrenergic receptor antagonist therapy

| Indices          | Gender                  | Male                  | Female                |
|------------------|-------------------------|-----------------------|-----------------------|
| HGT (m)          | Normo. (n=50)           | 1.7±0.090             | 1.7±0.014             | 1.70±0.009 | 1.60±0.007* |
|                  | Hyper. (n=50)           | 1.7±0.013             | 1.7±0.013             | 75.2±1.362 | 85.2±1.278* |
| WGT (kg)         | Normo. (n=50)           | 72.5±1.632            | 83.6±1.588*           | 66±5.746 | 82.2±3.978* |
|                  | Hyper. (n=50)           | 75.2±1.362            | 85.2±1.278*           | 66±5.746 | 82.2±3.978* |
| WC (cm)          | Normo. (n=50)           | 77.4±4.326            | 96.9±2.021*           | 66±5.746 | 82.2±3.978* |
|                  | Hyper. (n=50)           | 153.3±2.523*          | 125.4±1.601           | 79.1±1.076 | 94.6±1.090* |
| BMI (kg/m²)      | Normo. (n=50)           | 25.2±0.470            | 30.8±0.666*           | 26.6±0.420 | 32.5±0.579* |
|                  | Hyper. (n=50)           | 30.8±0.666            | 32.5±0.579*           | 26.6±0.420 | 32.5±0.579* |
| SP (mmHg)        | Normo. (n=50)           | 119.0±1.910           | 153.3±2.523*          | 125.4±1.601 | 148.2±2.668* |
|                  | Hyper. (n=50)           | 125.4±1.601           | 148.2±2.668*          | 79.1±1.076 | 94.6±1.090* |

Values are mean ± SEM. Significant difference between normotensive and hypertensive group by t-test *P=.0001.

HGT=Height, WGT=Weight, WC=Waist circumference, BMI=Body mass index, Normo. = Normotensive, Hyper = Hypertensive, n = sample size, SP = Systolic blood pressure, DP = Diastolic blood pressure.

Table 4. Anthropometric data of normotensive compared with hypertensive subjects under calcium channels blocker therapy

| Indices          | Gender                  | Male                  | Female                |
|------------------|-------------------------|-----------------------|-----------------------|
| HGT (m)          | Normo. (n=50)           | 1.7±0.090             | 1.7±0.014             | 1.7±0.009 | 1.6±0.007* |
|                  | Hyper. (n=50)           | 1.7±0.014             | 1.7±0.014             | 75.2±1.362 | 85.2±1.278* |
| WGT (kg)         | Normo. (n=50)           | 72.5±1.632            | 83.6±1.588*           | 66±5.746 | 82.2±3.978* |
|                  | Hyper. (n=50)           | 75.2±1.362            | 85.2±1.278*           | 66±5.746 | 82.2±3.978* |
| WC (cm)          | Normo. (n=50)           | 77.4±4.326            | 96.9±2.021*           | 66±5.746 | 82.2±3.978* |
|                  | Hyper. (n=50)           | 153.3±2.523*          | 125.4±1.601           | 79.1±1.076 | 94.6±1.090* |
| BMI (kg/m²)      | Normo. (n=50)           | 25.2±0.470            | 30.8±0.666*           | 26.6±0.420 | 32.5±0.579* |
|                  | Hyper. (n=50)           | 30.8±0.666            | 32.5±0.579*           | 26.6±0.420 | 32.5±0.579* |
| SP (mmHg)        | Normo. (n=50)           | 119.0±1.910           | 153.3±2.523*          | 125.4±1.601 | 148.2±2.668* |
|                  | Hyper. (n=50)           | 125.4±1.601           | 148.2±2.668*          | 79.1±1.076 | 94.6±1.090* |

Values are mean ± SEM. Significant difference between normotensive and hypertensive group by t-test *P=.0001.

HGT=Height, WGT=Weight, WC=Waist circumference, BMI=Body mass index, Normo. = Normotensive, Hyper = Hypertensive, n = sample size, SP = Systolic blood pressure, DP = Diastolic blood pressure.

Table 5. Anthropometric data of normotensive compared with hypertensive subjects under angiotensin converting enzyme inhibitor therapy

| Indices          | Gender                  | Male                  | Female                |
|------------------|-------------------------|-----------------------|-----------------------|
| HGT (m)          | Normo. (n=50)           | 1.7±0.090             | 1.7±0.014             | 1.7±0.009 | 1.6±0.007* |
|                  | Hyper. (n=50)           | 1.7±0.014             | 1.7±0.014             | 75.2±1.362 | 85.2±1.278* |
| WGT (kg)         | Normo. (n=50)           | 72.5±1.632            | 83.6±1.588*           | 66±5.746 | 82.2±3.978* |
|                  | Hyper. (n=50)           | 75.2±1.362            | 85.2±1.278*           | 66±5.746 | 82.2±3.978* |
| WC (cm)          | Normo. (n=50)           | 77.4±4.326            | 96.9±2.021*           | 66±5.746 | 82.2±3.978* |
|                  | Hyper. (n=50)           | 153.3±2.523*          | 125.4±1.601           | 79.1±1.076 | 94.6±1.090* |
| BMI (kg/m²)      | Normo. (n=50)           | 25.2±0.470            | 30.8±0.666*           | 26.6±0.420 | 32.5±0.579* |
|                  | Hyper. (n=50)           | 30.8±0.666            | 32.5±0.579*           | 26.6±0.420 | 32.5±0.579* |
| SP (mmHg)        | Normo. (n=50)           | 119.0±1.910           | 153.3±2.523*          | 125.4±1.601 | 148.2±2.668* |
|                  | Hyper. (n=50)           | 125.4±1.601           | 148.2±2.668*          | 79.1±1.076 | 94.6±1.090* |

Values are mean ± SEM. Significant difference between normotensive and hypertensive group by t-test *P=.0001.

HGT=Height, WGT=Weight, WC=Waist circumference, BMI=Body mass index, Normo. = Normotensive, Hyper = Hypertensive, n = sample size, SP = Systolic blood pressure, DP = Diastolic blood pressure.

The BMI and WC of all hypertensive subjects whether under medication or not fall outside normal range (18.5-24.9 kg/m² and 92 cm/80 cm for men/women) ranging from over weight to obesity which was in line with other findings [18-19] and this is directly proportional to the SBP and DBP. Also, it was discovered that each of the antihypertensive agent could not reduce the blood pressure to normal range (≤ 140/90 mmHg) and that the weight of each of the hypertensive group whether under medication or not was found significantly increased when compared with normotensive group. This suggests that in the case of essential hypertension, elevated BMI and WC may be a predisposing factor to high blood pressure and resistant to antihypertensive agents effectiveness which support the findings of other researcher [20-22].
4. CONCLUSION

Therefore, it may be concluded that reducing body mass index and waist circumference may be a way of enhancing effectiveness of antihypertensive agent in achieving effective blood pressure control and a non pharmacological way of controlling hypertension.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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