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HYPERTENSION, AND BLOOD PRESSURE RESPONSE TO GRADED EXERCISE IN YOUNG OBESE AND NON- ATHLETIC NIGERIAN UNIVERSITY STUDENTS.

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Summary: Hypertension, and the effect of graded exercise on Blood pressure (BP), in 60 obese non-athletic young medical students (40 females and 20 males) with Body Mass Index (BMI) greater than 30 were studied. The subjects were in the age range of 18-22 years with mean age of 20.30±1.32 years. Twenty percent of the males and 7 percent of the females were found to be hypertensives ($P<0.05$) and the severity of the hypertension significantly ($P< 0.05$) increased linearly with increase in BMI ($r =0.6$). Our study reveals a positive direct correlation between obesity and socioeconomic status and BP. Marked increases in systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), time of return (RT) were observed in the obese individuals compared to control at all levels of graded exercise with the highest rises seen during severe exercise. Among the obese subjects, the increases in BP were more in the males than females, but time of return was higher in females than males. This study further confirms that obese young individuals are prone to early onset of hypertension and thus other cardiovascular diseases and less tolerant to physical exercises. Our results add to the evidence that hypertension is common among obese young adults.

Key Words: *BMI, Hypertension, Exercise, mean arterial pressure*

Introduction

Obesity is defined as a BMI of $\geq 95^{th}$ percentile for age and gender (Stamler *et al* 1978, Cassono *et al* 1990). Young adults with a BMI between the 85^{th} to 95^{th} percentile for age and gender are defined as being at risk of obesity (Julius *et al* 2000). Individuals with BMI less than 19.0 are underweight, BMI 19.0 to 25.0 are normal, BMI 26.0 to 30.0 are considered as over-weight and BMI of greater than 30.0 are considered as obese (Barlow *et al* 1998). Adolescent and young adult obesity is now a significant public health concern because of it`s immediate impact on their physical and psychological health such as loss of confidence and self esteem often leading to isolation and depression. More importantly, it is a risk factor for the development of chronic diseases later in life.(Dietz, 1998).Recent studies have shown a significant increase in the prevalence of obesity in adolescents and young adults in America and in the United Kingdom (Van Itallie 1997, Dietz 1998), and the cost of obesity and its associated illnesses is also increasing (Wang and Dietz 2002).

Indeed, the prevalence of obesity increased in all ages, genders and ethnic/racial groups during the past three decades being most prevalent in Hispanic males (27.5%) and African American females (26.6%), adolescent and young adults (Ogden *et al* 2002).The number of factors responsible for this condition ranges from genetic factors (Rosenbaum and Liebel 1998), environmental factors such as increased calorie intake and decreased physical activity (Birch and Fisher, 1998), psychological disorders (Barlow and Dietz, 1998) and endocrine and genetic syndromes (Greger and Edwin 2001). Obese young adults do less physical activities, prefer sedentary lifestyles and are less tolerant to physical exercises. These attitudes ultimately increase their predisposition to hypertension and other cardiovascular diseases later in life due to continuous deposition of fatty adipose tissue and “quickened” atherosclerotic changes in different blood vessels in their body (Hirsch *et al* 1976).

Also, a decreased cardiac, vascular, glucose and phosphate response to B-agonist is found in obese individuals (Kannel *et al* 1979) and this further reduces their ability to dissipate excess calories and reduces their susceptibility to hypertension. In Edo state, Nigeria, though no published data are available, every day contact with obese adolescents and young adults of high socioeconomic status suggests an increase in the prevalence of obesity amongst this age group and class. This correlates positively with the Westernization of diet and rapid emergence of fast food and confectionaries which are highly patronized by young adults especially of the higher socioeconomic group. Hence the need for this study which will provide baseline data for our environment.

Materials and Method

Sixty obese subjects (20 males and 40 females) in the age range 18-22 years were selected from among the 400 medical students of Igbinedion University Okada (a private University mainly for the affluents) using the cluster sampling method. The body mass index, that is weight in kilograms divided by height in meters squared (Kg/m^2) was used to determine obesity. Weight was measured with light clothes on using a calibrated beam scale placed on a firm surface and height measured using a meter rule. BMI greater than 30 was chosen as obese.

Informed consent was obtained, after which a structured health and lifestyle questionnaire was administered to obtain information on general lifestyle, eating habit and health status. Subjects with known history of hypertension or any cardio-respiratory diseases, Diabetes Mellitus, pregnant females, smokers, athletes, alcoholics and those on medication known to affect cardiovascular function were excluded. An age and sex-matched control group of 60 subjects (20 males and 40 females) with BMI between 19 and 24 was employed in this study. The blood pressure for each subject was measured using the auscultatory method. A standard mercury column sphygmomanometer was used. All measurements were done in the seated position with cuff tied around the left arm. The procedure was usually done in the morning between 9 am and 12 noon. BP was expressed as mean SBP ±SD mmHg and mean DBP± SD mmHg.

Following a standardized protocol, two separate measurements of BP at rest were made at 15 minutes interval and the average of the two measurements recorded. Where high blood pressure was recorded for the first time, it was re-checked more than twice and the average of two close readings was taken. To confirm the increase in BP, this procedure was repeated after a week and the average of both readings was finally taken and recorded as the systolic and diastolic blood pressures. Graded exercises were performed in a quiet well -ventilated room (29°C). Subjects were instructed not to consume any beverage containing alcohol or coffee prior to exercise and BPmeasurements. After 10 minutes of quiet rest, the subject's pre -exercise systolic and diastolic blood pressures were re-measured to check for consistency with previously taken resting values. The subjects were asked to perform exercise on a cycle ergometer for 5 minutes at a rate of 5-10 cycles per minute (mild exercise). The systolic and diastolic blood pressures were measured and monitored until it returned to pre- exercise values and the time taken to return to pre-exercise values was recorded for each subject. After resting for at least 30 minutes, the subjects exercise at 20-25 cycles per minute for 5 minutes (moderate exercise) and later 30-40 cycles per minute for 5 minutes (severe exercise) still observing the 30 minutes quiet rest in between the exercises and the times taken for the blood pressure to return to pre-exercise values were recorded. Only 60 of the initial 70 obese subjects recruited completed the study. The other 10 subjects could not complete the severe aspect of the graded exercise and thus were not included in the final analysis.

For the purpose of this study, SBP greater than 140mmHg and DBP greater than 90mmHg was regarded as hypertension. Data were analyzed using the student t-test and chi square and expressed as mean ± S.D. Statistical significance was set at $P<0.05$. A correlation analysis was used to establish a relationship between BMI and BP.

From the analysis of the questionnaire, in 56% of the obese subjects, the obesity was probably “genetic” since one or both parents were “fat”. 75% of the subjects did not exercise at all, while 25% exercised occasionally. All the subjects had at one stage of their lives been psychologically traumatized because of their obese condition. 100% of the subjects had the knowledge that obesity could be deleterious to their health and would welcome “any” intervention to help lose weight.

Seven out of the 60 obese subjects (12%) were hypertensive ($p<0.05$). They had a mean BMI of 32.45±1.1 Kg/m^2, mean SBP of 158.26 ±10 mmHg and mean DBP of 96.5± 9 mmHg. Unlike the obese subjects, there was no incidence of hypertension in the control subjects. 5 of the 7 obese subjects with hypertension (70%) had episodes of un-explained headache and dizziness, while the other 2(30%) had episodes of unprovoked epistaxis.70% of all obese subjects admitted that they consistently fed on high calorie diet mainly snacks, fizzy sugary drinks and confectionaries- the so called ‘‘junk food’’. All obese subjects with hypertension were in this category.

Table 1: Pre-exercise blood pressure of obese subjects.

SEX	Age (yr)	No	Height (m)	Weight (Kg)	BMI (Kg/m2)	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)
Males	20.3± 1.3	20	1.7±1.0	91.1±1.6	31.8±1.3	137.4±11	82.6±12	100.8±13
Females	19.3±1.4	40	1.6±1.1	85.0±2.4	32.0±1.1	126.8±10	79.4±12	93.3±12

Table 2 : Pre-Exercise Blood Pressure Of Control Group

Sex	Age (Years)	No	HT (Meters)	WT (KG)	BMI Kg/m2	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)
Males	20.2±1.4	20	1.7±0.2	63.8±3.0	21.3±0.9	119.4±8.9	70.6±5.9	84.2±5.2
Females	19.3±1.2	40	1.65±0.8	56.8±8.0	21.9±2.8	110.1±11.0	69.4±7.6	80.6±8.2

Table 3: Blood pressure changes in obese subjects following graded exercise.

SEX	SBP (mmHg)	DBP (mmHg	MAP (mmHg)	RT (Mins)	Degree of Exercise
Males	156.3±14.0	87.9±10.0	110.2±12.0	5.97±1.2	Mild
Females	141.0±9.0	86.4±10.1	107.3±8.0	7.4±1.4	Mild
Males	163.4±10.0	93.6±7.0	119.3±10.0	8.0±1.0	Moderate
Females	152.3±11.0	92.0±6.0	114.3±9.0	9.3±1.4	Moderate
Males	173.1±14.0	98.5±10.0	124.2±12.0	11.2±1.3	Severe
Females	163.1±9.0	95.4±10.0	118.8±7.0	13.1±1.9	Severe

Results from Table 1 show the pre-exercise values of SBP, DBP, MAP to be 137.4±11, 82.6± 12 and 100.8± 13mmHg in obese males and 126.8± 10, 79.4± 12, and 93.4± 13mmHg in obese females and this is higher than in control SBP, DBP, MAP i.e. 119.4±9, 70.6 ±6, 84.2± 5 mmHg in non-obese males and 110.1± 11., 69.4± 8, 80.6± 8mmHg in non obese females respectively (Table2).

Following graded exercise, there was a marked increase in SBP, DBP, and MAP in obese subjects as the intensity of the exercise increased from mild to severe i.e. from 156.3 ±14, 87.9± 10, 110.2± 12mmHg SBP, DBP, and MAP respectively, to 173.1± 14, 98.5± 9, 124.2± 13 mmHg in obese males; and 141.0±9, 86.4 ±10, 107.3± 8mmHg to 163.1± 9, 95.4± 10, and 118.8± 7mmHg in obese females. In the control only modest increases were noticed, SBP, DBP and MAP values from 133.0± 7., 70.1± 7.9 and 95.9±9mmHg to 153.0±13, 89.2± 12 and109.5± 9mmHg in non- obese males; and 134.5±11, 74.6±4, 94.6± 5mmHg to 148.8± 12, 85.8± 11 and 106.7± 9mmHg in non- obese females (Tables 3 and 4).

Also the time in minutes taken for the blood pressure to return to pre-exercise levels was considerably longer in obese subjects compared to control subjects in all the categories of graded exercises. In the obese group, it was longer in females than in males i.e. 5.97 ±1.21, 7.9± 1.01, 11.21± 1.34 minutes in obese males following mild, moderate and severe exercises and 7.36± 1.41, 9.31± 1.40, 13.14±1.92 minutes in obese females following same graded exercise (Table 3) .The time was shorter in control subjects i.e. 4.40± 1.31, 6.93± 2.16, 9.44± 2.37 minutes in non- obese males and 5.43± 1.49, 8.50± 1.44, 11.6 ±1.73 minutes in non-obese females ($p<0.05$) Table 4.

The increases in BP following exercise in the obese when compared with the non-obese subjects are shown in Tables 5A and 5B. The increases were highly significant for SBP ($P < 0.01$). When male obese were compared with the female obese subjects, SBP also increased more significantly following exercise in the males than females-Table 6A and 6B.

Table 4: Blood pressure changes in control subjects following graded exercise.

Sex	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)	RT (Mins)	Degree of Exercise
Males	135.0±7.4	70.1±7.4	95.9±9.2	4.4±1.3	Mild
Females	134.5±10.5	74.6±4.2	94.6±5.1	5.4±1.5	Mild
Males	148.2±14.8	84.6±12.4	105.7±10.9	6.9±2.2	Moderate
Females	140.3±11.6	78.3±9.2	101.3±7.6	8.5±1.4	Moderate
Males	153.0±13.1	89.2±11.5	109.5±9.4	9.4±2.4	Severe
Females	148.8±11.8	85.8±10.9	106.7±9.1	11.6±1.7	Severe

Table 5a: Changes in SBP in obese and non-obese subjects.

SBP(mmHg)

Degree of Exercise	Obese	Non – Obese	Significance
Mild	150.4± 10.3	94.3 ± 8.6	P < 0.01
Moderate	161.7± 9.6	113.8 ± 10.1	P < 0.01
Severe	169.4± 11.2	126.0 ± 10.8	P < 0.01

Table 5b: Changes in DBP in obese versus non-obese subjects.

DBP(mmHg)

Degree of Exercise	Obese	Non – Obese	Significance
Mild	85.4± 8.6	78.3 ± 9.4	NS
Moderate	91.7 ± 6.0	83.9 ± 7.5	NS
Severe	97.4± 8.9	89.3 ± 9.2	NS

Discussion

Obesity in young adults has become a significant public health problem because of its impact on the physical and psychological health and because it is a risk factor in the development of chronic cardiovascular and metabolic diseases later in life (Stamler *et al* 1978, Cassono *et al* 1990, Julius *et al* 2000.).

Blood pressure elevation may be the intermediate phenotype of an underlying sympathetic over activity in hypertension where stimulation of B-adrenergic receptors increases the total body energy expenditure. A chronic increase in the sympathetic tone causes down regulation of B-adrenergic receptors leading to a decreased cardiac, vascular, glucose and phosphate responses.(Julius *et al* 2000). This suggests that obesity is linked with hypertension through the sympathoadrenal system. (Landsberg 1986).

Our result indicates that the prevalence of obesity among young adults (18-22 years age range) is 15% (i.e. 60 of the 400 subjects) This agrees with Ogden *et al* 2002 who reported the prevalence of obesity in adolescent and young adults to be 15%. From our study, the occurrence of hypertension among the obese young adults was 12% and this is in line with Bertsias *et al* 2003 who reported similar levels of prevalence among medical students in Crete, Greece. From this study, the increase in BP was more in obese males than females. The SBP, DBP, MAP of hypertensive obese male subjects were higher than those of their female counterparts .The male: female ratio for the development of hypertension among obese young adults was 3:1 as 20% of the obese males had hypertension compared to 7% of the obese females.

Table 6a; Changes In SBP In Obese Males Versus Obese Females

SBP(mmHg)

Degree of Exercise	Male	Female	Significance
Mild	156.3± 14.0	141.0 ± 9.0	P <0.05
Moderate	163.4± 10.0	152.3± 11.0	P <0.05
Severe	173.1± 14.0	163.1± 9.0	P <0.05

Table 6b: Changes in DBP in obese males versus obese females.

DBP(mmHg)

Degree of Exercise	Male	Female	Significance
Mild	87.0± 10.0	86.4± 10.1	NS
Moderate	93.6± 7.0	92.0± 6.0	NS
Severe	98.5± 10.0	95.4± 10.0	NS

Though genetic factors play a very significant role in the development of obesity, environmental factors seem to be the most plausible explanation for the increased prevalence of obesity among adolescents and young adults in our study in a university campus where 70% of the obese subjects consistently fed on high calorie foods, such as fast food and confectionaries which are readily available, and heavily promoted among this age group. Also exercise and physical activities are no longer part of regular young adult's everyday life as some never walk or cycle to school, or play any kind of sport. It is not unusual for adolescents and young adults to spend hours in front of the television or computer. This is evident from our study where 75%(45) of our obese subject don't exercise at all while only a mere 25% (15) occasionally involve themselves in exercise. Our study also shows that there is a direct relationship between obesity and family income since all the obese subjects were from wealthy affluent homes compared to our control group where most of the subjects were from average or outright poor homes. This contrasts with the findings of Trioano and Flegal 1998 who reported an inverse relationship between obesity and family income in non-Hispanic white adolescents.

The present study indicates that blood pressure parameters rise to higher levels in obese adolescents and young adults under conditions of graded exercise compared with non-obese adolescents and young adults. This finding is consistent with those of Dempsay *et al*, 1966, Lampman *et al* 1985, Segal *et al* 1989, and Shephard *et al* 1994. SBP is labile and changes more rapidly during exercise and this may explain the significant difference SBP between obese and non-obese subjects as opposed to DBP, which is slow to respond to exercise. The obese were more stressed by the graded exercises than the non- obese; in other words, the exercise tolerance levels of the obese young adults were considerably lower compared to control. Whereas all the control subjects were able to complete the various levels of graded exercise, only 60 of the 70 initial obese subjects could complete the graded exercises. Comparing male and female obese subjects, exercise tolerance was lower in obese females than their male counterpart as 9 of the 10 obese subjects who could not complete the graded exercise were females and this correlates with previous works done by Foss *et al* 1975, Lampman *et al* 1987, Sakamoto *et al* 1993, Shephard *et al* 1994. Also, the time to return to pre-exercise levels was longer in the females.

Conclusion

Obesity is associated with premature increase in BP. A significant number of young obese adults in this study were hypertensive, a situation that would predispose them to cardiovascular complications and other health problems in future. The early increase in BP is a result of interwoven genetic and environmental factors. Also, the time of return of BP parameters to baseline values was longer in obese adolescents and young adults than non-obese adolescents and young adults following graded exercise. Our results underscores the need to perform large scale epidermiologic studies within the general Nigerian young adult population, and implement health promotion programmes for them.

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