



Relationship between Anthropometric Parameters and Fasting Blood Sugar in Apparently Healthy Young Adults

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Authors' contributions

This work was carried out in collaboration among all authors. Author SOO designed the study, performed the statistical analysis. Authors TGI and FS wrote the protocol, wrote the first draft of the manuscript and managed the analysis. Author EEO Managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Anthropometric parameters refer to several quantitative measurements of the body adipose and muscle composition. It serves as an important indicator of nutritive status and physical fitness among adults as well as children.

Aim: This research aims to ascertain the relationship between anthropometric parameters and fasting blood sugar in healthy young adults.

Methodology: This is a randomized cross sectional observational study. 220 apparently healthy students (54 male and 166 female) of Rivers State College of Health Sciences and Management Technology, Port Harcourt were recruited into the study. Anthropometric measurements including Waist Circumference (cm), Abdominal Circumference (cm), Hip Circumference (cm), were taken alongside Fasting blood sugar.

Results: Males respondents were observed to have slightly higher values of waist, abdominal and hip circumferences while females were observed to have slightly higher values of waist to hip ratio. A significant positive correlation between fasting blood glucose and HC ($r=0.165$, $p<0.05$) was observed while showing a significant negative correlation between fasting blood sugar and WHR ($r=-0.149$, $p<0.05$).

Conclusion: Waist, abdominal, hip circumferences and BMI are determined by gender, age and metabolic changes.

Keywords: Anthropometric; cardiovascular; hip circumference; waist; abdomen.

1. INTRODUCTION

Anthropometric parameters are useful in the diagnosis and classification of obesity [1]. Their usefulness in determining obesity makes them important in assessing other health conditions like diabetes mellitus, hyperlipidemia, hypertension and many more [1]. These parameters when combined with each other in several ways or with other variables can be useful in calculating anthropometric indices such as weight-and- height, which is usually an assessor of acute malnutrition, height-and-age used in the measurement of chronic malnutrition and also in weight-and-age commonly used for the determination of protein-energy malnutrition [2]. Hence, anthropometric measures can be said to be dependable estimation for assessment of nutritional and health status as the measured values are closely related to nutrition, total genetic makeup and other environmental characteristics such as social and cultural conditions, lifestyle and overall health [3]. While universal factors had been reported to influence human shape and size, gender, ethnicity, age, occupation and lifestyle of population could cause variations in overall body dimensions [4]. These changes will often require the regular and timely updates of anthropometric data [5]. Gender differences exist in the changes associated with body at different life stages which are reflected in anthropometric measures; therefore the utilization of different anthropometric indicators at different stages of life to evaluate the nutritional status of both men and women becomes a necessity [6]. There are several methods for the measurement of anthropometric measurements in adults and children. In children, the mid-upper arm circumference (MUAC) is mostly preferable as a marker of nutritional status while in adults, the measurement of weight, height and body circumferences (hip, waist, calf and thigh) and calculations of waist to height ratio (WHtR) and waist-to-hip ratio (WHR) are mostly used.

Because of the importance of glucose as evidenced by its plethora of sources, the body precisely ensures that blood glucose is regulated during metabolic homeostasis [7]. Glucose homeostasis is tightly coupled with the balance of two major hormones, insulin and glucagon [8,9]. They are both released from the pancreas. While insulin promotes the uptake of glucose into cell due to high glucose levels, glucagon promotes the release of glucose into the blood by gluconeogenesis and glycogenolysis [10,11]. In the light of data paucity on the possible association between anthropometric parameters and diabetes, it has become necessary to conduct population based studies in order to provide a baseline population based data. This study therefore attempts to determine the relationship between anthropometric parameters and fasting blood sugar in healthy young adults.

2. MATERIALS AND METHODS

This study is a randomized cross sectional observational study.

2.1 Sampling Methods

A total of 220 students were selected from the college via multistage sampling technique.

2.1.1 First stage

Five (5) out of 10 schools in the college were selected by simple random sampling

2.1.2 Second stage

One (1) department from the preselected schools.

Total of 5 departments were selected namely: Community Health, Dispensing optician, Emergency Medical Technician, Health Information Management and Medical Social Work department.

2.1.3 Third stage

Forty four (44) participants were finally selected from each of the 5 preselected departments namely: Community Health, Emergency Medical Technician, Dispensing, Health Information, Management and Medical Social Work department.

2.2 Study Protocols

The target population for this study consisted of all students of Rivers State College of Health Science and Management Technology (RIVSCOHSMAT), Port Harcourt.

2.2.1 Inclusion criteria

The inclusion criteria for the study include;

- ✓ Human subjects
- ✓ Students from same institution (Rivers State College of Health Science and Management Technology)
- ✓ Consenting teenagers and adults.
- ✓ Young adults that do not have any health disorders.
- ✓ Physically and mentally healthy subjects

2.2.2 The exclusion criteria include;

- ✓ Non-human subjects
- ✓ Students from a different institution
- ✓ Young adults that have any health challenge.
- ✓ Mentally unstable
- ✓ All students who were absent during data collection
- ✓ Students who had already taken their breakfast
- ✓ Students who didn't give their consent during recruitment
- ✓ Students who were found physically handicapped with both lower limbs affected

2.3 Sample Size/Sampling Technique

Sampling of participants was done in the College. A sample of 220 was selected using Population Proportion – Sample Size formula [12] to calculate the size of the sample for an estimated population of healthcare students as follows:

$$n = N \cdot X / (X + N - 1)$$

Where,

$X = Z_{\alpha/2}^2 \cdot p \cdot (1-p) / MOE^2$ and $Z_{\alpha/2}$ = critical value of the Normal distribution at $\alpha/2$

MOE = the margin of error p = sample proportion

N = population size, Using

$Z_{\alpha/2} = 1.96$

MOE = 5%

$p = 50\%$

$N = 500$

X is therefore obtained as 384 while sample size n is obtained as 218. This was however rounded up to 220.

2.4 Data Collection

Recruited students from each pre-selected department were gathered at the practical demonstration hall of the department of Community Health on each day of meeting. Each department met in two days; on each first day of meeting they were briefed on what the study entails. They were instructed to take their last meal at night before going to bed and do an all-night fast, and return fasting the following day between the hours of 8am to 10am for the study to avoid the specific dynamic action of food on Blood Sugar level determination. On each second day of meeting, only those that complied with the advice (starving overnight) were eligible for the study, information regarding their age, sex and tribe were obtained using respondents identification card with Serial Number 1-220 (S1.....S220) constructed by the researcher.

2.4.1 Weight

The weight was recorded using standard scale (Seca GMBH & Co., German).

2.4.2 Height

Standing in an erect position with barefoot and head in contact with the wall (Frankfurt position), the height of each respondent was taken with a stadiometer

2.5 Waist Circumference

This was determined with a measuring tape at the point of the mid-axillary line, approximately halfway between the last rib and the superior iliac crest and taken to the nearest 0.1cm.

2.6 Abdominal Circumference

Measured using a tape horizontally at the point of maximum circumference between the waist and the hip and taken to the nearest 0.1 cm.

2.7 Hip Circumference

Measured using a tape horizontally at the point of maximum gluteal protrusion and taken to the nearest 0.1 cm. It was ensured that the measuring tape was held lightly so as not to compress the skin.

2.8 Blood Pressure

The measurement of the blood pressure was done by manual methods using a mercury sphygmomanometer (Accoson®) and a Littmann® stethoscope.

2.9 Fasting Blood Glucose

FBG of each subject was measured using Accu-Chek^(R) Active (Roche, Germany).

2.10 Limitation

The present study was limited to establish the influence of gender, age and metabolic changes on some anthropometric parameters and also determine the relationship between some anthropometric parameters and fasting blood sugar in apparently healthy young adults.

2.11 Statistical Analysis

Statistical Package for Social Sciences version 11 (SPSS Inc., Chicago, USA) was used for data analysis. A p value of <0.05 was considered to be statistically significant.

3. RESULTS AND DISCUSSION

Distribution of Age and the anthropometric Parameters in the study Population (Table 1): shows how the age and anthropometric parameters of male and female subjects in the study population compare with one another. The outcomes of the study indicate that the values for female and male show similar values for all the parameters under consideration as there are no significant variations. However, the males were observed to have slightly older, taller and higher values for waist, abdominal and hip circumferences while the females were observed to have slightly heavier with higher values for BMI and waist to hip ratio.

Age Classification of Anthropometric Parameters of the Study Population (Table 2): shows the age distribution of the anthropometric parameters of the population of study. The result indicate that the mean values for weight, BMI, waist, hip and abdominal circumferences, waist to hip ratio and waist to height ratio of the study population showed a significant increase among the age groups ($p < 0.05$).

Table 1. Distribution of Age and the anthropometric Parameters in the study Population

Parameters	Male (n=54)	Female (n=166)	t-Test Significance
Age (Yrs)	30.52±6.93 (20-40)	29.59±5.95 (20-45)	p=0.34
Weight (Kg)	62.48±13.34 (42-90)	63.09±13.98 (42-99)	p=0.78
Height (m)	1.64±0.87 (1.49-1.83)	1.61±.088 (1.29-1.95)	p=0.11
Waist Circumference (cm)	(25.00-57.00)	(24.00-45.00)	
Abdominal Circumference (cm)	34.69±5.88 (26-43)	33.77±5.89 (20-51)	p=0.31
Hip Circumference (cm)	40.64±5.84 (31-57)	39.6958±5.09 (28-58)	p=0.26
Waist to Hip Ratio	0.85±0.15 (0.55-1.36)	0.85±0.01 (0.60-1.41)	p=0.99
Waist to Height Ratio	0.21±0.04 (0.15-0.33)	0.21±0.03 (0.15-0.30)	p=0.94

Results are given as mean ± standard deviation (range)

Table 2. Age Classification of Anthropometric Parameters of the Study Population

Parameters	20-29yrs (n=118)	30-39yrs (n=80)	40-49yrs (n=22)	ANOVA Significance
Weight (Kg)	60.08±11.37 (42-90)	64.21±14.34 (42-95)	73.64±17.16 (42-99)	0.01*
Height (m)	1.60±0.08 (1.29-1.82)	1.65 ±0.09 (1.39-1.95)	1.6405±0.09 (1.51-1.83)	0.01*
Waist Circumference	32.19±4.39 (24-45)	34.71±5.17 (25-57)	37.36±6.14 (30 -57)	0.01*
Abdominal Circumference (cm)	33.00±5.48 (22-51)	34.51±5.96 (20-48)	37.41±5.95 (28-45)	0.01*
Hip Circumference (cm)	38.52±5.12 (28-57)	41.04±5.06 (32-57)	43.43±5.45 (33-58)	0.01*
Waist to Hip Ratio	0.84±0.10 (0.55-1.41)	0.86±0.11 (.60-1.36)	0.87±0.15 (.65-1.36)	0.01*
Waist to Height Ratio	0.20±0.03 (0.15-0.28)	0.21±0.03 (0.15-0.33)	0.23±.04 (0.19-0.33)	0.01*

Results are given as mean ± standard deviation (range)

Table 3. Tribal Classification of Age and Anthropometric Parameters of the Population of Study

Parameters	Hausa (n=16)	Igbo (n=66)	Yoruba (n=17)	Ikwere (n=25)	Ijaw (n=96)	ANOVA Significance
Age(yrs)	30.69±4.67 (22-40)	28.08±6.12 (20-45)	30.24±7.17 (20-41)	32.12±5.32 (24-44)	30.20±6.33 (20-44)	p=0.05
Waist Circumference	33.44±4.54 (27-44)	34.09±5.36 (25-57)	32.06±4.76 (25-41)	34.84±5.00 (28-43)	33.30±5.18 (27-57)	p=0.42
Abdominal Circumference (cm)	35.94±5.94 (25-43)	33.74±5.51 (22-47)	31.12±4.55 (22-39)	35.44±6.34 (25-45)	33.97±5.91 (20-51)	p=0.09
Hip Circumference (cm)	41.75±4.96 (34-51)	39.31±5.17 (28-57)	38.41±4.24 (28-57)	40.24±4.72 (31-51)	40.24±5.87 (31-58)	p=0.35
Waist to Hip Ratio	0.80±0.08 (0.70-1.05)	0.87±0.12 (0.67-1.36)	0.83±0.11 (0.55-1.06)	0.88±0.10 (0.65-1.07)	0.88±0.10 (0.65-1.07)	p=0.11
Waist to Height Ratio	0.20±0.02 (0.15-0.24)	0.21±0.03 (0.15-0.33)	0.20±0.03 (0.15-0.26)	0.21±0.04 (0.16-0.30)	0.21±0.03 (0.15-0.33)	p=0.43

Results are given as mean ± standard deviation (range)

Tribal Classification of Age and Anthropometric Parameters of the Population of Study (Table 3): shows the tribal distribution of the age and anthropometric parameters of the population of study. No significant change in the mean values of all the parameters under consideration ($p>0.05$).

A Scattergram of fasting blood sugar vs Hip circumference (HC) and Waist to Hip ratio (WHR) (Fig. 1): The figure above shows a scatter plot of fasting blood sugar vs hip circumference (HC) and waist to hip ratio (WHR). The study shows a significant positive correlation

between fasting blood glucose and HC ($r=0.165$, $p<0.05$) while showing a significant negative correlation between fasting blood sugar and WHR ($r=-0.149$, $p<0.05$).

Measurements of Waist, Abdominal and Hip Circumferences represent very important anthropometric variables used along with the BMI. Though male and females have different ranges for these measurements, it was observed that no significant differences existed in the mean values for waist, abdominal and hip circumferences of the study population ($p>0.05$). The result also showed that all the values fell

below the WHO recommended cut off points for metabolic complications for both gender. The waist, abdominal and hip circumferences showed a similar age dependent increase with a significant difference observed across age groups ($p < 0.05$). Highest measurements were also seen among the 40-49yrs group while the lowest measurement was observed within the 20-29yrs group. Also, these measurements were shown to be BMI dependent as the obese and overweight subjects had higher waist, abdominal and hip circumferences unlike the underweight and normal subjects ($p < 0.05$). Studies [13,14,15,16,17] have corroborated the increase in waist, abdominal and hip circumferences with age and BMI as these measurements have been shown to be simple, reliable and exact determinants of excess fat distribution which is a major determinant of obesity and other health complication [18,19,20]. No tribal differences existed in the mean values of these measurements ($p > 0.05$).

The study also show a significant positive correlation between fasting blood sugar and hip circumference ($r = 0.165$, $p < 0.05$) while showing a significant negative correlation between fasting blood sugar and waist hip ratio ($r = -0.338$, $p < 0.05$). This positive association between fasting blood sugar does not agree with a previous study where larger HC was linked with lower fasting blood sugar [21]. They opined that larger HC is related to greater muscle mass at the gluteal region, a major target tissue for insulin resistance. However, hypertrophic obesity has been shown to be connected to adipose tissue malfunctioning which causes inflammation and insulin resistance. In this case, where the β cells of pancrease is not able to compensate, this leads to a rise in blood glucose concentration observed for our study population. Also hyperglycaemia can worsen adipose cell dysfunction in overweight and obese subjects.

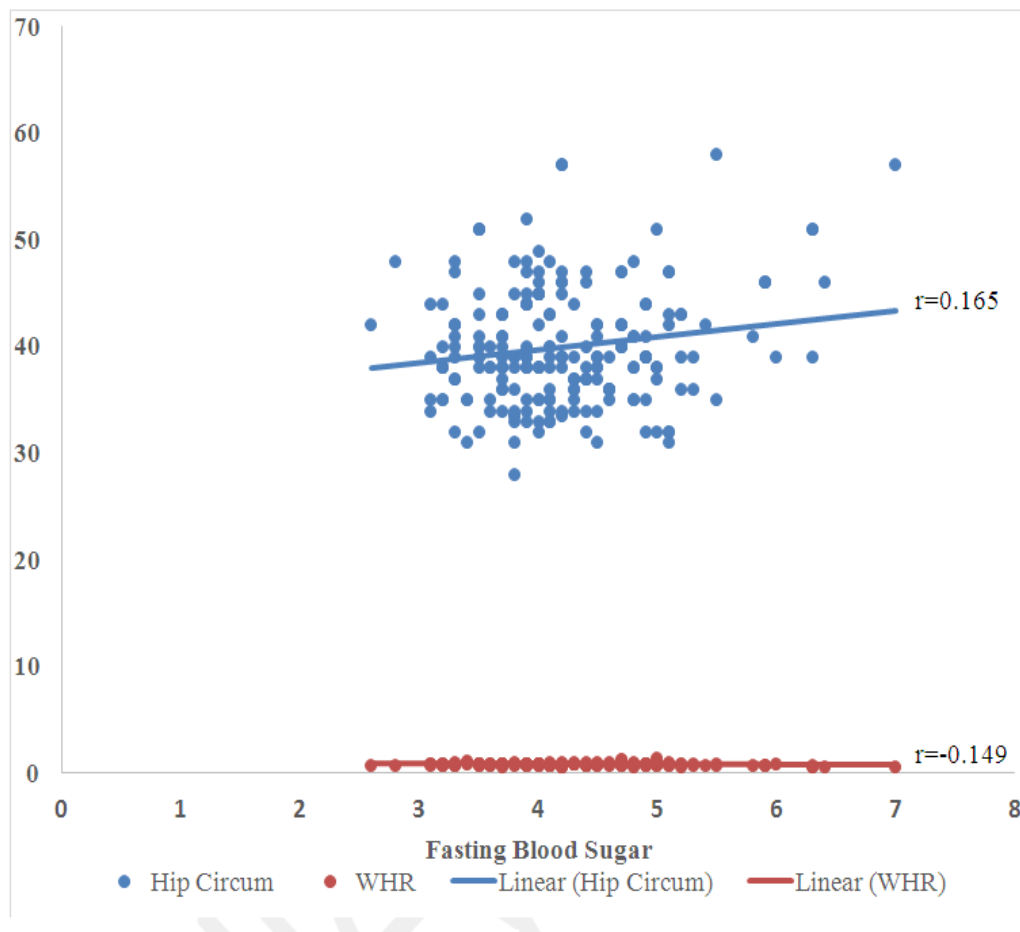


Fig. 1. A Scattergram of fasting blood sugar vs Hip circumference (HC) and Waist to Hip ratio (WHR)

4. CONCLUSION

In conclusion, this study identified a relationship between anthropometric parameters and fasting blood sugar in healthy young adults. There were statistically significant age dependent elevation in the waist, abdominal and hip circumferences ($p < 0.05$). Waist, abdominal, hip circumferences and BMI are determined by gender, age and metabolic changes.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT AND ETHICAL CONSIDERATION

Ethical approval and clearance was sought and obtained from the University of Port Harcourt Ethical Committee. An introduction letter was also obtained from the department of Human Physiology and was shown to the Authority at RIVSCOHSMAT for permission to carry out the study. The nature, purpose and procedure of the research were explained to the respondents after which written consent was obtained from those who agreed to participate in the study. Respondents were given the chance to freely decide to partake in the study if they so desired and were assured of anonymity of information provided hence identification numbers were used instead of their names, and as many that gave their consent were recruited for the study until the sample size was reached.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Hanson L, Sperling L, Gard G, Ipsen S, Vergara CO. Swedish anthropometrics for product and workplace design. *Applied Ergonomics*. 2009;40(4):797-806.
2. Colombo A, Morgan O, Drewry I. Anthropometric indices. From London School of Hygiene and Tropical Medicine; 2009. Available: http://conflict.lshhtm.ac.uk/page_121.htm
3. Mathew FO, Yetunde A, Folorunso O. Anthropometric indices and lipid profiles in tertiary institution students. *American Journal of Biochemistry*. 2014;4(3):41-45.
4. Amoo-Tella SY, Danborbo BS, Akuyam S, Adebisi SS. Gender-and age-related differences in anthropometric and body composition parameters in Nigerians, Zaria, Nigeria. *Journal of Experimental and Clinical Anatomy*. 2017;16(2):137.
5. Villareal DT, Apovian CM, Kushner RF, Klein S. Obesity in older adults: Technical review and position statement of the American Society for Nutrition and NAASO, The Obesity Society. *The American Journal of Clinical Nutrition*. 2005;82(5):923-934.
6. Perissinotto E, Pisent C, Sergi G, Grigoletto F, Enzi G, Group IW. Anthropometric measurements in the elderly: Age and gender differences. *British Journal of Nutrition*. 2002;87(2): 177-186.
7. Gurung P, Jialal I. Plasma Glucose StatPearls [Internet]: StatPearls Publishing; 2019.
8. Jayawardena R, Ranasinghe P, Ranathunga T, Mathangasinghe Y, Wasalathanthri S, Hills AP. Novel anthropometric parameters to define obesity and obesity-related disease in adults: A systematic review. *Nutrition Reviews*. 2020;78(6):498-513.
9. Boron WF, Boulpaep EL. *Medical physiology* (3rd ed.). Elsevier Health Sciences, Philadelphia; 2016.
10. Boulpaep EL, Boron WF, Caplan MJ, Cantley L, Igarashi P, Aronson PS, Moczydlowski E. *Medical physiology a cellular and molecular approach*. Signal Transduct. 2009;48:27.
11. Hall JE. Guyton and Hall textbook of medical physiology. Elsevier Health Sciences; 2015.
12. Daniel WW, Cross CL. *Biostatistics: A foundation for analysis in the health sciences*. Wiley; 2018.
13. Seddon JM, Cote J, Davis N, Rosner B. Progression of age-related macular degeneration: Association with body mass index, waist circumference, and waist-hip

- ratio. Archives of Ophthalmology. 2003; 121(6):785-792.
14. Fredriks AM, van Buuren S, Fekkes M, Verloove-Vanhorick SP, Wit JM. Are age references for waist circumference, hip circumference and waist-hip ratio in Dutch children useful in clinical practice? European Journal of Pediatrics. 2005;164(4):216-222.
 15. Stevens J, Katz EG, Huxley RR. Associations between gender, age and waist circumference. European Journal of Clinical Nutrition. 2010;64(1):6-15.
 16. WHO. Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8-11 December 2008; 2011.
 17. Bacopoulou F, Efthymiou V, Landis G, Rentoumis A, Chrousos GP. Waist circumference, waist-to-hip ratio and waist-to-height ratio reference percentiles for abdominal obesity among Greek adolescents. BMC Pediatrics. 2015; 15(1):1-9.
 18. Seidell JC, Pérusse L, Després J-P, Bouchard C. Waist and hip circumferences have independent and opposite effects on cardiovascular disease risk factors: The Quebec Family Study. The American Journal of Clinical Nutrition. 2001;74(3):315-321.
 19. Biggaard J, Frederiksen K, Tjønneland A, Thomsen B, Overvad K, Heitmann B, Sørensen T. Waist and hip circumferences and all-cause mortality: usefulness of the waist-to-hip ratio? International Journal of Obesity. 2004;28(6):741-747.
 20. WHO. World Health Organization. Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8-11 December 2008; 2011.
 21. Seidell JC, Pérusse L, Després J-P, Bouchard C. Waist and hip circumferences have independent and opposite effects on cardiovascular disease risk factors: The Quebec Family Study. The American Journal of Clinical Nutrition. 1997;74(3): 315-321.

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