

Comparative Investigation of Somatotype, Body Composition and Muscular Fitness Variables of Resistance Training Youths in Two West African Countries

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Abstract

Introduction: Resistance training has grown into a favorite technique for youths to achieve good health, reduce obesity, develop strength, and achieve a positive body image. Establishing the differences in somatotype, body composition, and muscular fitness is required to design a collaborative developmentally regional competitive resistance training programme. This study compared somatotype, body composition, and muscular fitness variables of resistance-trained youths (RTY) in Ghana and Nigeria. **Methods:** A descriptive cross-sectional research design was used. 202 resistance training youths {(Mean age = 21.89 ± 1.37 , F-78(38.6%), M-124(61.4%)} were recruited. Somatotype (ectomorph, endomorph, and mesomorph), body composition [body mass index- BMI), percentage body fat (%BF), waist circumference, hip circumference, waist-hip ratio (WHR), total body water, and skinfold thickness (triceps, suprailiac, biceps, supraspinal, medial calf, thigh)], muscular fitness (hand grip strength, wall squat quadriceps strength, and core strength) were measured. **Results:** There were more ectomorphic Ghanaian resistance training youths than Nigerian resistance training youths ($54 > 41$) and fewer mesomorphic Ghanaian resistance training youths than Nigerian training youths ($45 < 56$), also, there were less endomorphic Ghanaian resistance training youths than Nigerian resistance training youths ($2 < 4$). More Ghanaian resistance training youths were overweight and obese compared to Nigerian resistance training youths although not significantly. Ghana resistance training youths significantly had higher biceps, %BF, BMI, and right- and left-hand grip strengths ($P < 0.05$) while Nigerian resistance training youths significantly had higher supraspinale, medial calf, and thigh measurements ($P < 0.05$). There were no significant differences in weight, triceps, suprailiac, waist circumference, hip circumference, WHR, total body water, wall squat quadriceps strength, and core strength between the two nations. There are many similarities and differences between the two nations. **Conclusion:** In designing a collaborative, regionally competitive resistance training programme, consideration of common criteria is strongly suggested. Further studies could examine the roles of lifestyles, habits, and resistance training modalities.

Keywords: Somatotype, Body Mass Index, Hand Grip Strength, Wall Squat Quadricep, Resistance.

Resumen

Introducción: El entrenamiento de resistencia se ha convertido en una técnica predilecta para que los jóvenes logren una buena salud, reduzcan la obesidad, desarrollen fuerza y logren una imagen corporal positiva. Establecer las diferencias en somatotipo, composición corporal y aptitud muscular es necesario para diseñar un programa de entrenamiento de resistencia competitivo regional y colaborativo para el desarrollo. Este estudio comparó las variables de somatotipo, composición corporal y aptitud muscular de jóvenes entrenados en resistencia (RTY) en Ghana y Nigeria. **Métodos:** Se utilizó un diseño de investigación transversal descriptivo. Se reclutaron 202 jóvenes que entrenaban con resistencia {(Edad media = $21,89 \pm 1,37$, F-78 (38,6%), M- 124

(61,4%)). Se midieron el somatotipo (ectomorfo, endomorfo y mesomorfo), la composición corporal [índice de masa corporal-IMC], el porcentaje de grasa corporal (%BF), la circunferencia de la cintura, la circunferencia de la cadera, el índice cintura-cadera (ICC), el agua corporal total y el grosor de los pliegues cutáneos (tríceps, suprailíaco, bíceps, supraespinal, pantorrilla medial, muslo)] y la aptitud muscular (fuerza de agarre manual, fuerza del cuádriceps en sentadilla contra la pared y fuerza del core). **Resultados:** Hubo más jóvenes ghaneses ectomorfos que nigerianos ($54 > 41$) y menos mesomórficos que nigerianos ($45 < 56$). Además, hubo menos endomórficos que nigerianos ($2 < 4$). Aunque no de forma significativa, más jóvenes ghaneses que practicaban entrenamiento de resistencia tenían sobrepeso y obesidad en comparación con los nigerianos. Los jóvenes ghaneses que practicaban entrenamiento de resistencia tenían valores significativamente mayores de bíceps, %BF, IMC y fuerza de agarre en la mano derecha e izquierda ($P < 0,05$), mientras que los jóvenes nigerianos que practicaban entrenamiento de resistencia tenían valores significativamente mayores de supraespinal, pantorrilla medial y muslo ($P < 0,05$). No hubo diferencias significativas en peso, tríceps, suprailíaco, circunferencia de cintura, circunferencia de cadera, WHR, agua corporal total, fuerza del cuádriceps en sentadilla de pared y fuerza central entre las dos naciones. Existen muchas similitudes y diferencias entre ambas naciones. **Conclusión:** Al diseñar un programa de entrenamiento de resistencia colaborativo y competitivo a nivel regional, se recomienda encarecidamente considerar criterios comunes. Estudios posteriores podrían examinar el papel de los estilos de vida, los hábitos y las modalidades de entrenamiento de resistencia.

Palabras Clave: Somatotipo, Índice de Masa Corporal, Fuerza de Prensión Manual, Cuádriceps en Sentadilla de Pared, Resistencia.

Introduction

Resistance training refers to a specialized method of conditioning which requires different types of resistive loading and a variety of training modalities, aiming to improve health, fitness, and athletic performance (Faigenbaum, 2009). Resistance could be in form of weights, bands, or even our own body weight working against gravity (Lamarca et al., 2021). Resistance training focuses on specific results, such as joint stability, muscular endurance, increased muscle size, strength, and power. Resistance training also involves a wide variety of health benefits which includes boosting metabolism and reducing body fat, increasing bone density, and improving balance, improving mental health, building muscle mass, improving strength and endurance, reducing the risk of sport injuries, and increasing self-esteem (Fragala et al., 2019; Stricker et al., 2020). Resistance training require some equipment such as barbells, dumbbells, kettle bells, resistance bands, suspension trainers and pull up bars (Sanchez-Sanchez and Rodríguez-Fernández, 2022).

The basic principles of resistance training include the overall fitness programme which composed of various exercise types such as aerobic training, flexibility training, strength training and balance exercises (Fleck and Kraemer, 1988; Stricker et al., 2020). Different weights or other types of resistance, for example 2kg hand weight or fixed weight, body weight or rubber band will be used for different exercises during strength training session. A particular exercise, for example, biceps curl, that is designed to strengthen a particular muscle or group of muscles. Repetitions (or reps) which are the number of times that are continuously repeated in each exercise in a set. Set is a group of repetitions performed with rest in between, for example, 4 sets of squats by 10 reps would mean 10 squats then rest muscles before doing another 10 squats. Rest between sets, rest periods vary depending on the intensity of the exercise being performed. Variety is the switching around of workout routine, such as regularly introducing new exercises, which challenges muscles and forces them to adapt and strengthen. Regular adjustments to the training variables, such as frequency, duration, exercises for each muscle group, number of exercises for each muscle groups, sets and repetitions, help to make sure there is progress and improvement in resistance training. Muscle needs time to repair and adapt after a workout. Hence, a good rule of thumb is to rest the muscle group for up to 48 hours before working the same muscle group again. Oranchuk, Storey, Nelson, and Cronin, (2019) submitted that resistance training variables are often manipulated to achieve desired morphological and neuromuscular adaptations. Studies had shown that morphological characteristics and body structure are important determinants of performance in many sports and certain physical impressions such as body composition (body fat, body mass, muscle mass) and physique can significantly influence athletic performance (Krzykała, Karpowicz, Strzelczyk, Pluta, et al., 2020). Researchers have studied the relationship between morphological characteristics and physical performance and their effects on physical predisposition on the choice of sports and the influence of training on the morphological characteristics (Chaouachi, Brughelli, and Levin 2009; Weweg, e tal., 2022). Somatotype is the distribution of muscle mass and fat into long, lean and curvier while others find it hard to gain weight or difficult losing weight (Bolonchuk, et al., 2000; Borer, 2021)

Body comes in different shapes and sizes, influenced by a person's frame and composition which makes human unique. There are three basic different body types which are ectomorph, endomorph, and mesomorph (Şenol et al., 2019; Mikhailova et al., 2022). Ectomorph describes the body as being lean and slender and tends to have less body fat and muscle. Basically, people with this body type can often find it difficult to gain weight in the form of muscle or fat. Endomorph describes the body as one which stores fats, lots of muscle and gains weight easily. People with this body type are not always overweight (Adams, et al., 2006). Research also shows that people who have slower metabolism are at high risk of developing obesity and related health conditions (Ravussin, Lillioja, and Knowler, 1988). Mesomorph describes the body types with a naturally high muscle-to-fat ratio, people with this type of body type respond well to resistance training, they find it much easier than the other people to build or maintain muscle.

Body composition is used in the fitness and health community to refer to the percentage of fat, water, bone, muscle, skin, and other lean tissues that make up the body (Duren et al., 2008; Ackland et al., 2012; Campa et al., 2021). Body composition has become a major field of interest for many exercise, and sports scientists as well as clinicians who specialize in prevention and rehabilitation (Oppert et al., 2021; Weweg et al., 2022;). The body composition phenotype of an athlete displays the complex interaction among genotype, physiological and metabolic demands of a sports, diet, and physical training (Goran, 1998). The purpose of body composition measurements is to identify purposeful measurements of body composition, notably fat and lean muscles masses and determine their impacts on the health and performance of resistance trainers (Holmes and Racette, 2021).

Muscular fitness is the ability for a muscle to do work, it includes two components which are muscle strength and muscle endurance (Weiss, et al., 2010). Muscle strength is the amount of force put out or the amount of weight you can lift (Saeterbakken, Stien, Pedersen, et al., 2021). Strength is underpinned by a combination of morphological and neural factors including muscle cross-sectional area and architecture, musculotendinous stiffness, motor unit recruitment, rate coding, motor unit synchronization, and neuromuscular inhibition (Suchomel, Nimphius, and Bellon, 2018; Young and Bilby, 1993). Muscle endurance is the ability to repeat muscle movement over a period of time. Possessing adequate muscle strength correlates to moderate morphological characteristic and helps to keep up with increased demands on the body, reduce risk of injury and optimize gains in activities of daily living (Stricker et al., 2020.).

Youths are those members of human race with the ages of 18-24years (Deurenberg, Weststrate and Seidell, 1991). In the youth's population, a predictable sequence of physical changes occurs both male and female such as changes in body proportions, rapid skeletal growth, and widen in the shoulders and develop thicker muscles (Bucholtz, 2002; Santtila, et al., 2022). Faigenbaum's (2017) review on resistance exercise and youth revealed that effect of resistance exercise training was moderated by sex and resistance training type. He further reported that independently computed dose-response relationships for resistance training parameters had training period of less than 23 weeks, 5 sets/exercise, 6–8 repetitions/set, a training intensity of 80–89% of 1 repetition maximum, and 3–4 min rest between sets were most effective to improve muscle strength.

Resistance training is trending and there are sequential trends in muscular fitness in modern day youths worldwide including Ghana and Nigeria although majority of youths are not accumulating the recommended amount of moderate to vigorous physical activity daily. The increasing number of youths in Ghana and Nigeria who are involving in sports activities and lifting weights with the specific goal of increasing muscle size, symmetry, and possible goal of entering competitive events that are judged, coupled with the concerns for improvement in self-esteem, self-satisfaction, and quality of life have resulted in increased interest in resistance training.

Comparative studies on resistance training have been conducted. Effectiveness of aerobic exercise training on body weight, body mass index, fasting plasma glucose, high density lipoprotein cholesterol, low density lipoprotein cholesterol, triglycerides and total cholesterol of Ghanaians separately (Asuako, Moses, Eghan, and Sarpong, 2017). Also, separate studies on the effect of weight bearing aerobics combined with resistance exercises and non-weight bearing aerobic combined with resistance exercises on cardiopulmonary parameters (Osho, Akinbo, Osinubi, and Olawale, 2011); chest, triceps, subscapular, axilla, suprailiac, abdomen and thigh; and body mass index (Abass, and Moses, 2013); and gluteal muscle strength, gluteal muscle bulk, and gluteal adiposity (Ekechukwu, and Okoh, 2020) of Nigerians have been reported. These studies were not comparatively conducted among the two countries, did not centered on youths engaging in resistance exercise training, and failed to assessed somatotype, body composition and muscular fitness variables which are the major focus of this study among resistance training youths in two West African countries of Ghana and Nigeria.

Material and Methods

The methodology used in this study is covered in this chapter, including the research design, the study population, the sample size and sampling methods, the inclusion and exclusion criteria, the data collection techniques, the data collection procedures, the data analysis procedures, ethical considerations, and references.

Research Design

The study adopted a descriptive cross-sectional research design. Cross-sectional studies are observational studies that analyze data from a population at a single point in time. They are often used to measure the prevalence of health outcomes, understand determinants of health, and describe features of a population. This research design is useful for establishing preliminary evidence in planning a future advanced study (Wang et al., 2021).

Population

The population was made up of youths from both Nigeria and Ghana who engage in resistance training and gave their consent.

Sample and Sampling Technique

Sample

The study employed 202 (101 participants each) from both countries (i.e., Nigeria and Ghana). The G-Power sample size calculator was used to arrive at the sample size for this study.

Sample Technique

The convenience sampling techniques was used in the study. Convenience sampling is a non-probability sampling method in which units are chosen for inclusion in the sample because they are the most easily accessible to the researcher.

This could be because of geographical proximity, availability at a specific time, or willingness to participate in the research. Convenience sampling, also known as accidental sampling, is a type of non-random sampling. (Etikan & Babatope, 2019).

Instrumentation

The following instruments was used for data collection in the study:

Tape measure (Fiber glass tape measure):

The size of selected resistance trainers was measured with a tape measure. Subjects stood upright with their arms at their sides, their feet close together, and their weight distributed evenly across their feet. It was also used to measure subjects' waist and hip circumferences. When measuring waist circumference, the midpoint between the lower margin of the least palpable rib and the top of the iliac crest was used. The circumference of the

hips were also measured around the widest part of the buttocks. Subjects, on the other hand, removed anything that could interfere with their height measurement, such as bulky clothing and shoes. The height was measured on the flooring without molding and against a flat surface. Subjects stood with their feet flat on the ground, together, and against the wall. Ensuring legs are straight, arms are at the sides, and your shoulders are leveled. The subject looked straight ahead, with a line of sight parallel to the floor. The subject was measured while standing with his or her head, shoulders, buttocks, and heels on a flat surface (wall). All points may not touch the wall depending on the overall body shape of the subjects.

Skin fold Caliper (Lange Skinfold Caliper)

A skin fold caliper was used to measure skin-fold thickness and predict total body fat. It is done by pinching the subject's skin with the thumb and forefinger, pulling the skin away from the body slightly, and placing it on the skin-fold caliper.

Marker (JIAN PAI)

This was used to mark out points in the body for proper measurements. Hand Dynamometer (GRIPX Electronic Hand Dynamometer): This was used to determine the maximum isometric strength of the hand and forearm muscles. The subject held their arm with their elbow bent at a 90-degree angle, then squeeze the dynamometer as hard as they can.

Digital stop watch (Apple Watch Series SE)

The digital stop watch was used to track the time between activating and deactivating it to the nearest second.

Scientific calculator (Casio fx-115ES)

The device was used to enter data prior to, during, and after the study.

Exercise mat (Trojan mat)

This is a soft cushion mat that is essential to any floor exercise, this makes crunches more comfortable and gives support to hips, knees, tailbone and spine whilst exercises movements are being executed. Subjects used this mat to perform some exercises for the study.

Tanita body composition analyzer (Tanita Iron man)

The weight, body fat percentage, total body water, and body mass index (BMI) are all measured by this body composition analyzer. Tanita body composition analyzer was set up on a solid floor (such as tiled or cemented floor). Heavy clothing, such as sweaters, were being removed, and each subject were being asked to stand with both feet on the devices, looking straight ahead, and hands dropped at both sides of the body for proper measurement.

Procedure for Data Collection

In addition to all measurements taken, the evaluation protocol was explained and demonstrated to the subjects.

Height Measurement

The average distance from the floor to the highest point of the head when looking directly forward will be used to calculate the standing height. Shoes were being taken off with the feet together and the arms on the sides. When measuring with a tape measure, the upper back, buttocks, and heels made contact with the wall.

Weight measurement

Body weight was recorded without any items on the person, though it can be measured with clothes on but without shoes or heavy accessories like mobile phones and wallet. Tanita Body Composition Analyzer (Tanita Iron Man) was set up on a solid floor (such as tiled or cemented floor). Heavy clothing, such as sweaters, were being taken off and each subject was asked to stand with both feet on the device, looking straight ahead, and hands dropped at both sides of the body for proper measurement.

Body Mass Index (BMI) Measurement

The BMI was calculated inputting the recorded height of participants into the Body Composition Analyzer (Tanita Iron Man). The value of participants weight(kg) divide by the squared value of the inputted participants height would give the value of participant's BMI.

Waist Circumference Measurement

Subjects stood upright and have their waist circumference measured using a tape measure, as instructed. The measurement was made at the midpoint between the lower margin of the least obvious rib and the top of the iliac crest.

Hip Circumference Measurement

The hip circumference was measured around the widest portion of the individual subject's buttocks using the same tape as the waist circumference measurement.

Waist to Hip Ratio

Waist circumference divided by hip circumference, using the scientific calculator (Casio fx-115ES) resulted to Waist-to-hip ratio.

Total Body Water

Total, body water was recorded without any items on the person, just as the weight is being recorded. Tanita Body Composition Analyzer (Tanita Iron Man) was set up on a solid floor (such as tiled or cemented floor) and each subject was asked to stand with both feet on the device, looking straight ahead, and hands dropped at both sides of the body for proper measurement.

Skin fold Thickness

It was done by pinching the subject's skin with the thumb and forefinger, pulling the skin away from the body slightly, and placing it on the skin-fold caliper (Lange Skinfold Caliper) for measurement. There were 6 sites to be measured for this study; triceps, supra iliac, supra scapular, biceps, medial calf and thigh.

Hand Grip Strength

The subject's elbow was bent to a 90-degree angle for this test, and the dynamometer (GRIPX Electronic Hand Dynamometer) was being squeezed as hard as possible. The subject's strength is instantaneously determined by the hand dynamometer based on the squeeze.

Wall Squat Quadriceps Test Measurement

This test was performed using a digital stop watch, a smooth wall, and a dry surface. Subject stood shoulder-width apart against the smooth wall, then slide downward to assume a sitting position, forming a 90-degree angle at the hip and knee joint. After that, the watch was set to time the subject until failure.

Core Muscle Strength

A digital stop watch, a flat surface, and a mat to support the elbows and arms are required for this test. Instructions were clear and demonstrated after a thorough warm-up and intense stretching of body parts. A short plank position was maintained for the back, neck, head, and shoulders. Once in that position, the watch was set to time the subject's core strength until failure.

Procedure for Data Analysis

Data entry was entered into Microsoft Excel 2019. For data analysis, data entered into Microsoft excel 2019 was exported into Statistical Package for Social Sciences (SPSS) version 26.0 for analysis. T-test was used to compare the differences in the somatotype, body composition and muscular strength among the resistance training youths in the two west African countries (Nigeria and Ghana).

Ethical Approval

The study was submitted to the Committee on Human Research, Publications and Ethics (CHRPE Ref. No.: AP/709/23) of Kwame Nkrumah University of Science and Technology, Kumasi, Ghana for clearance and approval. All the participants signed a consent of participation form after attaining personal understanding of the rationale of the study.

Result

Table 1 shows that the study consisted of 101 participants from both Nigeria and Ghana respectively. Participants were made up of 61.4% (124) males and 38.6% (78) females. These included 50% (101), 47% (95) and 3% (6) mesomorphs, ectomorphs and endomorphs respectively. 55.9% (113) of the participants had a normal BMI, 36.1% (73) were overweight, 6.9% (14) were obese and 1% (2) were underweight.

Table 1. Descriptive distribution of participants' demographics

Demographic Variables	Category	Frequency	Percentage
Gender	Male	124	61.4
	Female	78	38.6
Nationality	Nigeria	101	50
	Ghana	101	50
Somatotype	Ectomorph	95	47
	Mesomorph	101	50
	Endomorph	6	3
BMI	Underweight	2	1
	Normal	113	55.9
	Overweight	73	36.1
	Obese	14	6.9

Table 2. Anthropometric Measurements

Anthropometric Measurements		Mean	Standard Deviation
Body Composition	Age (yrs.)	21.89	1.37
	Height (cm)	174.78	8.29
	Weight (kg)	76.49	11.89
	Body Mass Index (kg/m ²)	24.88	3.16
	Triceps (mm)	3.03	0.69
	Suprailiac (mm)	3.04	0.81
	Biceps (mm)	2.46	0.77
	Supraspinale (mm)	3.10	0.95
	Medial calf (mm)	2.19	0.91
	Thigh (mm)	2.92	0.74
	Waist circumference (inches)	31.70	3.52
	Hip circumference (inches)	38.26	5.01
	Waist-to-hip Ratio	0.83	0.79
	Total body water (%)	52.01	6.64
	Body fat (%)	24.10	8.07
Muscular Strength Fitness	Left hand grip (lbs.)	77.79	21.16
	Right hand grip (lbs.)	87.30	20.44
	Wall seat quadriceps strength (sec)	76.73	25.25
	Core strength (sec)	83.57	28.57

Table 2 shows that the participants had a mean age of 21.89 ± 1.37 years. They had a mean height, weight and BMI of 174.78 ± 8.29 cm, 76.49 ± 11.89 kg, 24.88 ± 3.16 respectively. They also had a skinfold measurement of 3.03 ± 0.69 mm at the triceps, 3.04 ± 0.81 mm at the suprailiac, 2.46 ± 0.77 mm at biceps, 3.10 ± 0.95 mm at the

supraspinale, 2.19 ± 0.91 mm at the medial calf and 2.92 ± 0.74 mm at thigh. Their mean waist and hip circumference were 31.70 ± 3.52 inches and 38.26 ± 5.01 inches respectively. They had a mean waist-to-hip ratio of 0.83 ± 0.79 . Their mean total body water and body fat were 52.01 ± 6.64 and 24.10 ± 8.07 respectively. wall seat time for quadriceps strength as well as core strength of 76.73 ± 25.25 and 83.57 ± 28.57 respectively.

They had a mean left-hand grip and right-hand grip of 77.79 ± 21.16 and 87.30 ± 20.44 respectively. They also had a mean Table 3 shows that there were more ectomorphic Ghanaian resistance training youths than Nigerian resistance training youths ($54 > 41$) and less mesomorphic ($45 < 56$) Ghanaian than Nigerians. Also, there were less endomorphic Ghanaian resistance training youths than Nigerian resistance training youths ($2 < 4$). More Ghanaian resistance training youths were overweight and obese compared to Nigerian resistance training youths respectively ($39 > 32$ and $11 > 3$ respectively).

Table 4 shows that the Nigerian resistance training youths were taller than the Ghanaian resistance training youths (175.16 ± 7.74 cm $>$ 174.43 ± 8.86 cm). With skin fold measurements (table 4), Ghanaian resistance training youths had higher biceps, triceps and suprailiac measurement, with only the suprailiac measurement not being significant ($P < 0.05$), while the Nigerian resistance training youths significantly had higher supraspinale, medial calf, and thigh ($P < 0.05$).

Table 3. Somatotype and Body Mass Index against Nationality and Gender

		Nationality		Chi square	P value	Gender		Chi square	P value
		Nigeria	Ghana			Male	Female		
Somatotype	Ectomorph	41	54	3.65	-0.13	62	33	1.31	0.08
	Mesomorph	56	45			59	42		
	Endomorph	4	2			3	3		
Body Mass Index	Underweight	1	0	7.95	0.19	0	1	7.56	0.15
	Normal	65	51			78	38		
	Overweight	32	39			41	30		
	Obese	3	11			5	9		

Table 4. T-Test Comparison of Anthropometric Characteristics Between the Two Countries

Anthropometric Characteristics	Nationality	Mean $\pm$ SD	Mean diff.	T	P value	95 CI
						Lower, Upper
Height (cm)	Nigeria	175.16 ± 7.74	0.73	0.63	0.533	-1.58, 3.05
	Ghana	174.43 ± 8.86				
Weight (kg)	Nigeria	75.53 ± 10.25	-1.90	-1.12	0.263	-5.20, 1.43
	Ghana	77.41 ± 13.36				
Triceps (mm)	Nigeria	2.84 ± 0.65	-0.40	-4.20	0.000*	-0.58, -0.21
	Ghana	3.23 ± 0.68				
Suprailiac (mm)	Nigeria	2.93 ± 0.83	-0.21	-1.84	0.067	-0.43, 0.02
	Ghana	3.14 ± 0.78				
Biceps (mm)	Nigeria	2.23 ± 0.75	-0.40	-3.77	0.000*	-0.61, -0.19
	Ghana	2.66 ± 0.75				
Supraspinale (mm)	Nigeria	3.30 ± 1.15	0.40	2.96	0.004*	0.13, 0.65
	Ghana	2.91 ± 0.65				
Medial calf (mm)	Nigeria	2.35 ± 1.03	0.31	2.45	0.015*	0.06, 0.56

	Ghana	2.04 ± 0.75				
Thigh (mm)	Nigeria	3.07 ± 0.80	0.32	3.12	0.002*	0.12, 0.52
	Ghana	2.80 ± 0.63				

Table 5. T-Test Comparison of Body Composition Between the Two Countries

Body Composition	Nationality	Mean ± SD	Mean diff.	T	P value	95 CI
						Lower, upper
Waist circumference (inches)	Nigeria	31.42 ± 2.91	-0.57	-1.14	0.256	-1.55, 0.41
	Ghana	32.00 ± 4.05				
Hip circumference (inches)	Nigeria	37.84 ± 4.67	-0.90	-1.28	0.202	-2.30, 0.49
	Ghana	38.74 ± 5.30				
Waist-to-hip ratio	Nigeria	0.83 ± 0.86	0.01	0.70	0.484	-0.01, 0.03
	Ghana	0.83 ± 0.71				
Total body water (%)	Nigeria	51.71 ± 5.95	-0.45	-0.47	0.637	-2.32, 1.42
	Ghana	52.16 ± 7.42				
Body fat (%)	Nigeria	22.13 ± 7.52	-3.86	-3.50	0.001*	-6.03, -1.69
	Ghana	26.00 ± 8.10				
Body Mass Index	Nigeria	24.40 ± 2.75	-0.94	-2.11	0.036*	-1.81, -0.63
	Ghana	25.34 ± 3.48				

*Significant at ≤ 0.05

Ghanaian resistance training youths had higher waist circumference, hip circumference, while the waist to hip ratio of the resistance training youths was similar (table 5). Table 5 also reveals that the resistance training youths in the two countries have similar anthropometric characteristics although significant differences were observed in body fat and body mass index ($P < 0.05$). With body composition, Ghanaian resistance training youths had higher total body water percentage, body fat percentage and BMI than their Nigerians counterpart (tables 5).

Table 6. T-Test Comparison of Muscular Strength Fitness Between the two countries

Muscular Strength Fitness	Nationality	Mean ± SD	Mean diff.	T	P value	95 CI
						Lower, Upper
Left hand grip (lbs.)	Nigeria	73.85 ± 15.60	-7.93	-2.70	0.008*	-13.73, -2.12
	Ghana	81.78 ± 25.04				
Right hand grip (lbs.)	Nigeria	84.23 ± 16.09	-6.21	-2.17	0.031*	-11.85, -0.57
	Ghana	90.43 ± 23.74				
Wall seat quadriceps strength (sec)	Nigeria	79.04 ± 25.16	4.53	1.27	0.205	-2.50, 11.56
	Ghana	74.51 ± 25.37				
Core strength (sec)	Nigeria	85.90 ± 26.70	4.58	1.13	0.259	-3.40, 12.53
	Ghana	81.32 ± 30.41				

*Significant at < 0.05

For muscular fitness, Ghanaian resistance training youths had significantly higher right- and left-hand grip strengths while the Nigerian resistance training youths had insignificantly higher wall seat quadriceps strength and core strength (table 6).

Discussion

The main objective of the study was to comparatively investigate the somatotype, body composition and muscular fitness variables of resistance training youths in two West African countries of Ghana and Nigeria. Findings showed that the participant of the study had a mean age, height and weight of 21.89 ± 1.37 , 174.78 ± 8.29 , 76.49 ± 11.89 respectively (table 2). The study had 61.4% (124) male and 38.6% (78) female participants and 50% (101) were Nigerians while 50% (101) were Ghanaians. The ectomorphs were 47% (95), the mesomorphs were 50% (101) and the endomorphs were 3% (6). The underweight participants were 1% (2), the normal participants were 55.9% (113), the overweight participants were 36.1% (73) and the obese participants were 6.9% (14).

Findings of the study show that, there were more male with the ectomorph and mesomorph groups than females ($62 > 33$ and $59 > 42$ respectively). This was in accordance to Krzykała, et al., 2020, but had equal number of males and female in the endomorph group which contradicts Krzykała, Karpowicz, Strzelczyk, Pluta, et al., study (2020).

Also, the study showed that the Ghanaian resistance training youths had larger biceps, triceps and suprailiac measurement than their Nigerian counterparts, hence they had significantly higher right- and left-hand grip strengths than the Nigerian. This because, according to Saeterbakken, Stien, Pedersen, et al., (2021), having larger biceps may contribute to greater hand grip strength.

The Nigerian resistance training youths significantly had higher supraspinale, medial calf, and thigh measurement than the Ghanaians, hence they possess a significantly higher wall seat quadriceps strength than the Ghanaians. This is in affirmation with study by Lindemann, Mohr, Machann, Blatzonis, et al., (2016), that showed that thigh circumference positively associates to quadriceps strength as well as Isometric quadriceps strength been linked to thigh muscle volume.

Lastly, Ghanaian resistance training youths had higher waist circumference, hip circumference, body fat percentage and BMI than the Nigerians, hence the Nigerians had significantly higher core strength than the Ghanaians. A study from Arif, Gaur, et al (2022) suggested that, the proportion of body fat is positively connected to waist circumference. This indicates that when the waist circumference increases, so does the amount of body fat. Body fat percentage is closely associated with BMI and waist circumference (WC). Waist-to-Hip Ratio (WHR) is also computed by dividing the waist circumference by the hip circumference, where WHR has been discovered to have a substantial relationship with visceral body fat. Excessive visceral fat buildup can put strain on the core muscles, thereby impairing their capacity to operate efficiently. This might result in decreased core strength and stability (Mayer, Nuzzo, Chen, Quillen, et al., 2012).

Conclusion

In conclusion, there are significant disparities in many physical and anthropometric features between Nigerian and Ghanaian resistance training youths. Nigerian resistance training youths were found to be taller than their Ghanaian counterparts. However, Ghanaian youths had greater skin fold measurements in the biceps, triceps, and suprailiac, with only the suprailiac measurement not reaching statistical significance.

In terms of specific body composition measurements, Nigerian resistance training adolescents had considerably higher supraspinale, medial calf, and thigh measurements than Ghanaian youths. Ghanaian resistance training kids, on the other hand, had a larger waist circumference, hip circumference, total body water percentage, body fat percentage, and BMI. Ghanaian resistance training adolescents had considerably stronger right- and left-hand grip strengths, whereas Nigerian resistance training youths had much higher wall seat quadriceps strength and core strength.

These findings emphasize the need to take regional and ethnic variables into account when examining physical characteristics and performance in resistance-trained youngsters. Further study might look at the causes that may be causing these variances, as well as the implications for training programmes and general fitness methods in various groups.

Recommendation

Based on the study results, the following recommendations are suggested:

Fitness trainers and coaches working with Nigerian resistance training youths should encourage upper body strength development, especially in the biceps, triceps, and suprailiac regions. These tailored programs can help optimize muscle development and overall performance. Similarly, coaches working with Ghanaian resistance training youths should prioritize design training programs that focus on enhancing body strength, particularly in the supraspinale, medial calf, and thigh areas.

- i. Since body composition and BMI differed significantly between the two groups, nutritionists and health professionals should consider developing targeted dietary interventions. For instance, Ghanaian resistance training youths may benefit from dietary plans that promote body fat reduction while Nigerian youths could benefit from nutrition plans that support muscle growth and development.
- ii. Considering the differences in grip strength, wall seat quadriceps strength, and core strength, incorporating functional exercises into the training programs can be beneficial. Functional exercises target multiple muscle groups and can help improve overall muscular fitness and functional performance.
- iii. Regular monitoring and assessment of individual progress should be conducted to track changes in body composition and strength levels. This will enable trainers and trainees to make necessary adjustments to training programs, ensuring that progress is being made effectively.
- iv. When implementing training and nutritional interventions, it's essential to be culturally sensitive. Understanding and respecting cultural practices and beliefs related to fitness and nutrition can improve adherence and overall success of the interventions.
- v. Consider implementing educational programs for both resistance training youths and trainers to raise awareness about the importance of tailored training approaches based on individual characteristics. This can lead to better understanding and acceptance of diverse training methods and strategies.
- vi. To gain deeper insight into the factors influencing these differences, conduct longitudinal studies that follow individuals over an extended period. This will help identify potential factors, such as genetic, environmental, or lifestyle influences, contributing to the observed variations.
- vii. Encourage cross-cultural collaboration between fitness experts, researchers, and trainers from both Nigerian and Ghanaian backgrounds. Collaborative efforts can lead to a broader perspective on resistance training practices and open avenues for innovative training techniques and strategies.

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Informed Consent Statement

All the athletes included in the study provided written informed consent.

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