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Waist-to-hip ratio measures as predictors of cardiorespiratory fitness among females human kinetics students in university of Ilorin

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Abstract
Being overweight is a major risk factor for a variety of chronic ailments and injuries including cardiovascular diseases (CVD), type II diabetes, and certain body site- specific cancers. The study aimed at determining the predictive capacity of waist-to-hip ratio measures and cardiorespiratory fitness levels of female students. The ex-post facto design was used in this study. The population comprised all 200 level female students that offered 'Fitness for Life' (HKE 210) for the 2014/2015 academic session numbering 60. The waist –to- hip ratio and the Cooper 12 minute walk/run test were used to collect data for this study. Percentage was used to answer research questions while the PPMC and Multiple Regression analysis were used to test the hypotheses at 0.05 alpha level of significance. The findings showed that (94.9%) were between 17-29 years, (58.3%) had waist-to-hip ratio (WHR) measures detrimental to health while (60.3%) needed improvement in their cardiorespiratory fitness (CRF). A significant positive relationship existed between WHR and CRF. 60.2 % of CRF was predicted by WHR alone. The study concluded that participants did not have the minimum fitness level and WHR was a significant predictor of CRF. It was recommended that assessment of fitness levels should be a regular feature in the events of the HKE department among others.

Keywords: predictors, waist-to-hip ratio, cardiorespiratory fitness, cardiovascular disease

Introduction
Researches have shown that being overweight is a major risk factor a variety of chronic ailments and injuries including cardiovascular diseases (CVD), type II diabetes, and certain body site- specific cancers like colorectal and breast cancers (Conolly, Barnett, Vogt, Li, Stone, & Boyd, 2002; Chouraki, Wagner, Ferrieres, Kee, Bingham, Haas & Daltongeville, 2008) [6, 5] with the categorization done with body mass index (BMI). Obesity increases the risk of cardiovascular diseases, metabolic disorders and certain types of cancers (Hainer, Toplak, & Mitrakou, 2008) [11].
Srikanthan, Seeman and Karlamangla, (2009) [20] stated that the fat distribution pattern in a person's body determines the levels of risks associated with obesity because increased risks are associated with torso and abdominal fat. Body fat centrally located (android obesity) has a higher correlation with abnormal health issues including abnormal blood lipids, increasing risk of diabetes type II, cardiovascular disease (Ness- Abramof & Apovian, 2008) [16].
Ness- Abramof and Apovian (2008) [16] explained that human body fat can be divided into visceral (torso), subcutaneous (under the skin) and intramuscular found in small amounts in the heart, liver, pancreas and within the skeletal muscles (used as substrate during exercise). Ness and Apovian further stated that visceral body fat is vital for the maintenance of free fatty acid levels in the blood and ensures the normal regulation of blood insulin, while (Attie & Scherer, 2009) [2] averred that the infiltration of visceral body fat by macrophages, may prompt insulin resistance. In line with this, the US Department of Health and Human Services, (2008) [21] recommended a 30-minute a day for 5 days in a week physical activity as a good intervention for the prevention and delay of diabetes by nearly 60 percent.
Abdominal fat constitute a high health risk because fat cells secrete cytokines that regulate the body's responses to infection, immune reactions, inflammation and trauma. Furthermore, cytokines can damage arterial walls and initiate atherosclerotic plaque build -up

(Dinarello, 2000) [10]. Though fat cells can produce and secrete adiponectin, visceral fat obesity accumulation reduces the levels of adiponectin and therefore results in an elevated cardio-metabolic health risk (Ness-Abramof & Apovian, 2008) [16]. With good knowledge in stress management, increased levels of blood cortisol (a stress hormone) that is directly related with elevated visceral fat accumulation can be neutralized and its effects counteracted (Kravitz, 2009) [14].

The BMI has been the traditional body composition measure in many epidemiological studies. However, alternative field measurements like the waist-to-hip ratio (WHR) has been suggested as a more accurate assessor of adiposity than the BMI in predicting cardiovascular disease risk (Jansses, Katzmarzyk, & Ross 2004; Bigaard, Frederiksen, Tjonneland, Thomsen, Overvad, Heitmann, & Sorensen 2005) [13, 3].

Waist-to-hip ratio (WHR) is a measure of the quotient of waist circumference (taken at the narrowest part of the waist, between the lowest rib and iliac crest) and the hip circumference (taken at the widest area of the hips at the greatest protuberance of the gluteal muscle) (Kravitz, 2009) [14]. The WHO (2000a, 2000b) sees a ratio greater than .85 in women as one of the benchmarks for metabolic syndrome.

Cardiorespiratory endurance which otherwise could be referred to as cardiovascular endurance or aerobic fitness is defined as the ability of the heart, lungs and vascular network to deliver oxygen to the working muscles and the ability of the muscles to utilize the oxygen to sustain moderate to high intensity activity (Hewitt, 2007) [12]. Perry (2012) [18], defined cardiorespiratory endurance as the ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity. Caspersen *et al*., (1985) [4], explained cardiorespiratory endurance as a health-related fitness component that relates to the ability of the circulatory and the respiratory systems to supply fuel during sustained physical activity and to eliminate fatigue products after supplying fuel.

ACSM (2005) [1], stated that cardiorespiratory endurance (CRE) is considered health related because low levels of that have been consistently linked with markedly increased risk of premature death from all causes, especially heart disease. High levels of CRE indicate a high physical work capacity, which also shows the ability to release relatively high amounts of energy over an extended period of time. Hence the serious importance many fitness leaders attach to CRE.

One of the indicators of cardiorespiratory fitness is the amount of oxygen the human body is able to utilize per minute of physical activity, which shows the oxygen carrying capacity of the cells (Otinwa, 2005) [17]. Quinn (2009), reported that maximal oxygen uptake (VO2max) is the maximum amount of oxygen that an individual can utilize during maximal or exhaustive exercise and also considered generally as the best indicator of cardiorespiratory endurance and aerobic fitness. Perry (2012) [18] explained that improved cardiorespiratory endurance increases lung capacity so the heart does not have to work as hard to pump blood to the muscles and also very vital for overall heart health and prevention of lifestyle diseases. Therefore cardiorespiratory endurance is the best measure for a person's physical fitness and overall health.

Low cardio-respiratory fitness in young females has emerged as an important factor for developing cardiovascular co-morbidities later in middle age. Increased body fatness as predicted by body mass index is an additional factor for developing cardiovascular diseases. Cardiovascular diseases are a leading cause of morbidity and mortality worldwide. The prevalence of cardiovascular disease (CVD) has increased substantially over the past few decades in younger population. Unfavorable cardiovascular risk profiles are found in young females with low levels of cardiovascular fitness and high percentage of body fat. Numerous clinical studies have established a strong association between low cardio respiratory fitness and mortality. Numerous risk factors for CVD including hypertension, diabetes and hypercholesterolemia are suspected to be influenced by fatness and these factors may mediate the association between low cardio-respiratory fitness and mortality (Perry, 2012) [18].

de Konning, Merchant, Pogue and Ammand (2007) [9] conducted a meta-analysis of fifteen cohort studies on the association between WHR and cardiovascular outcomes with information from over 250,000 participants. Eight of the studies reported that there was an association between WHR and CVD. The study concluded that a unit appreciation of 0.01 WHR increased the risk of CVD in women by 5%.

Lee *et al*., (2008) [15] in a meta-analysis determined which of the four obesity indices (BMI, WC, WHR and WHtR) was the best discriminator of major risk factors and concluded that in both men and women, the WHR was superior to the BMI even though the differences were too small and unlikely to be of clinical relevance.

Czernichow *et al*., (2011) [7] compared the strength of associations and discriminatory capability of BMI, WC, and WHR with cardiovascular disease risk in individuals with type-2 diabetes using a sample of Eleven thousand, one hundred and forty men and women. The study employed the Cox proportional hazard models and concluded that the strengths of associations and discrimination statistics suggested that the WHR was the best predictor of cardiovascular events and mortality in patients with type-2 diabetes.

Davison, Bircher, Hill, Coates and Buckley (2010) [8] investigated the relationship between CRF, body fatness and markers of arterial function using BMI and DEXA to assess body composition, while the bicycle ergometer submaximal exercise test was used to estimate cardiorespiratory fitness in VO_{2max}. The study used twenty seven obese and twenty six lean sedentary male and female volunteers (40-65 years) in Adelaide, Australia. The study concluded that reduced CRF with associated decrease in arterial compliance may lead to increased offload and in turn, led to ventricular hypertrophy, reduced coronary perfusion and increased cardiovascular mortality risk.

Welborn and Dahlia, 2007; [22] Srikanthan, Seeman and Karlamangla, 2009 [20] confirmed the WHR as a clinical measurement for predicting all cause and cardiovascular disease mortality, while (Srikanthan, Seeman and Karlamangla, 2009) [20] concluded that the WHR was a superior health-risk categorization indicator.

The researcher observed that there is energy imbalance in female students of the Human Kinetics Department, University of Ilorin where the amount of energy being consumed by the female is greater than the amount of energy being expended due to low levels of physical activity engagements. The researcher also realized that majority of the female students took a longer time to recover from moderate to vigorous intensity physical activity. This has been attributed to many factors including fat accumulation especially in the midriff. Majority of epidemiologic studies (Jansses *et al*., 2004) [13] have utilized BMI for measuring body composition (obesity). However, ectopic body fat is found to relate with a wide variety of metabolic abnormalities that affect cardiorespiratory endurance even though, BMI categorization of the same participants showed normal levels. Again, to the best of

knowledge of the researcher, no study utilizing WHR as predictor of CRF has been carried out in the department of Human Kinetics Education of University of Ilorin hence the study. The purpose of the study was to examine whether WHR was a significant predictor of the cardio-respiratory fitness levels of female students in Human Kinetics Education, University of Ilorin.

2. Materials and methods

The research design adopted for this study was the ex-post facto. This was used because the researcher did not intend to manipulate the variables of the study as it is believed that the characteristics to be measured have already manifested in the participants. The population for the study consisted of all 200 level female students that offered (HKE 210) in the Department of Human Kinetics Education for the 2014/2015 academic session (rain semester). A total of 60 female 200 level students that offered Fitness for Life (HKE 210) in the Department of Human Kinetics Education were purposively selected for the study. Standardized measurements of the Cooper 12 minute walk/run test and the Waist-to-Hip Ratio were used to collect data for the study. The standard instruments (non-elastic measuring tape, stopwatch, and whistle) were used by the researcher and the research assistants in order to familiarize themselves with the usage of the instruments, and to also ensure they were in good working condition. These instruments were already validated. The standardized instruments were recalibrated and used several times to ensure that it produced similar results. The researcher and 2 research assistants collected the data. The participants were briefed on the data collection procedure after which the waist and hip circumferences were measured. The participants carried out the 12 minute walk/run test after a short warm up. The distances run in meters were converted to miles and used to calculate VO_2 max. Standardized for test measurement of the cooper 12 minutes' walk/run test was used to address cardio-respiratory endurance while waist to hip ratio was used to measure body composition. For the Cooper Test the participants warmed-up and then run the race. After 12 minutes, their distance run in meters was converted into VO_2 max by using the formula

VO2 max = 0.0268 X distance in meters – 113 and categorized as excellent (5), very good (4), average (3), below average (2) and poor (1) and compared with standard set by (Cooper, 1973) using age and gender. The data collected was subjected to descriptive statistics of frequency counts and percentage while the inferential statistics of Pearson Product Moment Correlation (PPMC) was used to test the hypotheses at 0.05 alpha level of significance. To determine the predictive capacity of BMI to CRF, the multiple regression analysis was used.

3. Results & Discussions

3.1 Tables

Table 1: Frequency Distribution of Participants by Age, Waist-to –hip Ratio and Oxygen Consumption (VO_{2max})

Variable	Frequency	Percentage
Age		
17- 29	57	94.9
30- 39	1	1.7
40- 49	1	1.7
50- 59	1	1.7
Waist-to –hip Ratio		
Very High	8	13.3
High	27	45.0
Moderate	22	36.7
Low	3	5.0
Oxygen Consumption (VO_{2max})		
Poor	7	11.7
Below Average	29	48.8
Average	22	36.7
Above Average	2	3.2

Results in table 1 shows that majority (94.9%) of the participants are aged between 17 and 29 years. On waist-to-hip ratio measurements of the participants 8 (13.3%) showed very high, 27 (45.0%) high, 22 (36.7%) moderate and 3 (5.0%) low. The oxygen consumption ($VO2_{max}$) revealed that 60.5% of the participants performed below average and therefore require improvement looking at the age range.

Table 2: Correlation 'r' Between Oxygen Consumption (VO_{2max}) of Participants and their Waist-to- Hip Ratio Measurements

Variable	Waist-to- Hip Ratio
Oxygen Consumption (VO_{2max})	
Pearson Correlation 'r'	.776
Sig. (2 –tailed)	.000
N	60

Correlation is significant at the 0.05 level (2-tailed)

Table 2 shows that oxygen consumption has a strong and positive relationship with waist-to-hip ratio (.776)

Table 3: Regression Analysis for Waist-to-Hip Ratio and Oxygen Consumption (VO_{2max}) of 200 Level Female Human Kinetics Students

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.776[a]	.602	.595	.46123
• **Predictors: (Constant), waist to hip ratio**				

Table 3 indicates that 60.2% of oxygen consumption (VO_{2max}) can be predicted by waist-to- hip ratio alone (R square of 0.602) which means that WHR ratio plays a bigger role in predicting the oxygen consumption among female human kinetics students of University of Ilorin.

This study was carried out to examine whether WHR was a significant predictor of the cardio-respiratory fitness levels of female students in Human Kinetics Education, University of Ilorin. Specific analyses of the relationship between WHR levels and cardiorespiratory fitness of female students in the department of Human Kinetics. Cardiorespiratory fitness was assessed with the Cooper 12 minute walk/run test and

categorized into: poor, average, above average, good, and excellent. Sixty 200 Level female students that offered "Fitness for Life" (HKE 210) for the 2014/2015 academic session were purposively selected for the study.

The results from table 1 indicated that majority (94.9%) of the participants were between the age range 17-29 years; 35 (58.3%) had waist-to-hip ratio measures that increases the risk levels for developing cardiovascular disease and therefore needed improvement, while more than fifty percent (60.3%) of the participants performed below the minimum levels of cardiorespiratory fitness needed for the development of health and well-being. The result has a serious implication on the health of the participants in that being overweight (poor body composition) was a major risk factor for chronic ailments including CVD, type-2 diabetes and certain cancers (Conolly *et al*. 2002; Chouraki *et al*., 2008 ; Hainer *et al*., 2008) [6, 5, 11]. The results from table 1 also confirmed the assertions of (Ness- Abramof and Apovian, 2008; Srikanthan *et al*., 2009) [16, 20] that the fat distribution pattern in a person's body determined their risk levels with increased risks associated with torso and abdominal fat. Dinarello, (2000) [10] corroborated this through the aversion that abdominal fat constituted a high risk for CVD.

Low levels of CRF have consistently been linked with markedly increased risk of premature death from all causes, especially heart diseases (ACSM, 2005; Perry, 2012) [1, 18]. The low levels of CRF obtained by the participants in this study therefore increased their risk levels for developing metabolic disorders, cardiovascular problems and other health conditions that reduces life expectancy. Critical look should be look at the results because with the current age profile of the participants, a more devastating results and health issues will crop up with advancement in age.

Results from table 2 revealed a strong and positive correlation between WHR and CRF ('r' = .776) of female 200 level students of Human Kinetics Education. The significant (2 – tailed) value of .000 was less than 0.05. Therefore the null hypothesis 1 which states that there is no significant relationship between WHR and CRF of 200 level female students of Human Kinetics was rejected suggesting that there is a significant relationship between WHR and CRF of 200 level female students of human Kinetics.

The finding is in conformity with de Konning *et al*., (2007) [9] who concluded that a unit increase of 0.01 WHR measure elevated the risk of CVD in women by 5%. This was corroborated by Davison *et al*., (2010) [8] who confirmed that reduced CRF with associated decrease in arterial compliance may lead to increased offload and in turn, left ventricular hypertrophy, reduced coronary perfusion and increased cardiovascular mortality risk.

Results from table 3 tested the null hypothesis 2 which states that WHR will not be a significant predictor of CRF among 200 level female students of human Kinetics Education. The result indicated that WHR was a significant predictor of CRF (60.2%). The finding is in cognizance with many other studies; Lee *et al*., (2008) [15] who averred that WHR was the best discriminator of major health risk factors; Czernichow *et al*., (2011) [7] who suggested that WHR was the best predictor of cardiovascular events and mortality among patients with type-2 diabetes; Welborn & Dahlia, 2007; [22] Srikanthan, Seeman & Karmangla, 2009) [20] who concluded that WHR was a superior health risk categorization indicator.

4. Conclusions

The study clearly reported that majority of the 200 level female students in the department of Human Kinetics Education do not have the minimum levels of WHR and CRF needed for the development of health and well-being, WHR correlated strongly and positively with CRF and WHR was a significant predictor of CRF among 200 level female students of Human Kinetics Education department of University of Ilorin, Nigeria.

Based on the findings of this study, the following recommendations are made:

1. The assessment of fitness and health levels of students should be a permanent feature in the department of human Kinetics Education in order to reveal the levels of health and fitness of students so that appropriate interventions could be prescribed to improve the levels revealed.
2. Education on the need to engage in regular and appropriate levels of physical activity should be given to students at regular interval so that health risks associated with physical inactivity will be reduced
3. Increased physical activity outside practical courses should be given to female students in particular to improve their fitness levels.
4. The study should be replicated in other departments to see if similar results will be obtained

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