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Anthropometric variables, physiological parameters and physical activity levels of undergraduate students from the University of Fort Hare, South Africa

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Abstract

The aim of this study was to evaluate the anthropometric variables, physiological parameters and physical activity levels of undergraduate students. 132 undergraduate students aged 18 – 25 years from the University of Fort Hare who signed the consent forms participated in this cross-sectional study. Anthropometric variables were assessed using the International Society for the Advancement of Kinanthropometry (ISAK) standard procedures. Physical activity (PA) levels were evaluated using the international physical activity questionnaire – long form (IPAQ-LF). Blood pressure (BP) was measured using a digital BP monitor (Omran Corporation, model no-IA2 HEM 7001-c-1). 8 %, 59.8 %, 28.0 % and 11.4 % are underweight, normal weight, overweight and obese, respectively. The skinfolds, percentage body fat and body mass index (BMI) of female participants were significantly ($p < .001$) higher than the male participants with a large effect sizes ($d \leq -2.3$). Likewise, the waist-to hip ratio was significantly ($p < .001$) higher in male participants with a large effect size ($d = 1.2$). The result also showed that 59.8 % participants had normal BP, 13.6 % had high systolic blood pressure (SBP), 6.8 % had high diastolic blood pressure (DBP), 7.6 % had prehypertension and 12.1 % had hypertension, respectively. Male participants had higher SBP while female participants had higher DBP which had no significant ($p > 0.001$) effect and with low effect sizes ($d = 0.1$). Again, 72.1 % of participants do not engage in sufficient PA of 300 mins per week which is reflective of less physical activities as compared to the recommended standard (of 300 minutes of moderate-intensity aerobic PA per week) by the world health organization (WHO). We recommend an urgent intervention programs that will help improve the PA levels, reduce unhealthy BMI and BP levels of university students.

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1. Introduction

In recent years, there has been a growing interest in understanding the health and well-being of university students, particularly with regard to their physical activity (PA) and lifestyles. Undergraduate students who are in a crucial phase of their lives often face multiple challenges such as academic stress, long hours of sedentary behaviour, and irregular dietary patterns. These factors

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contribute to the deterioration of physical health which can lead to long-term consequences for both academic performance and overall quality of life [1]. The aim of carrying out studies with respect to the anthropometric, physiological, and PA assessment of people is to provide a cue of their physical health status. This will in turn help to discover at an initial stage the danger associated to non-communicable diseases (NCDs) at a metabolic and cardiovascular level [2]. Non-transferable diseases/NCDs can be chronic because they can linger for a long time due to some factors [3]. More than three quarters of the global non-transferable/NCDs deaths (31.4 million) occurs as a result of cardiovascular diseases (CVDs), cancers, chronic respiratory diseases, and diabetes mellitus. This is a worrisome statistics as individuals both in low and middle income nations are affected [3]. The risk of NCDs can lead to some metabolic changes such as hyperglycemia (high blood glucose levels), overweight(OW)/obesity (OB), hyperlipidemia (high level of fat in the blood) and elevated blood pressure (BP) [3]. Furthermore, 19% of global deaths are ascribed to elevated BP, followed by higher blood glucose and OW/OB [3]. Similarly, WHO [4] also reported that one-third (19 %) of core sources of deaths in South Africa excluding cancer are caused by NCDs.

Physiological parameters such as systolic blood pressure (SBP) and diastolic blood pressure (DBP) are generally employed to evaluate cardiovascular ailment of individuals [5]. As a general rule of thumb, a SBP of <120 mmHg and DBP < 80 mmHg is regarded as normal, while BP ≥ 140/90 is categorized as a hypertensive condition. Conversely, isolated SBP of ≥140 is categorized as isolated systolic hypertension, while isolated DBP of ≥ 90 is categorized as isolated diastolic hypertension [6]. The physiological reactions of a person are interconnected to the anthropometric pointers due to the fact that insalubrious weight gain is associated with high BP values which is caused as a result of physique fat wedged in the arteries producing a resistance in the peripheral section [7].

One of the commonly used anthropometric procedure to classify the level of OW and OB in people is the body mass index (BMI), as this forms the connection between body mass. However, the major demerit of using BMI to evaluate OW and OB levels in people is the inability to differentiate between the dissemination of body fat. Meanwhile, percentage body fat percentage (% BF), waist circumference (WC), waist–hip ratio (WHRatio), and waist–height ratio (WHtRatio) are pointers that indicate the extent and spreading of adipose tissue in the human physique and they are better predictors of cardiovascular diseases [8]. A healthy BMI is reportedly ranged from 18 to 25 kg/m^2 while a BMI exceeding 26 kg/m^2 is seen as unhealthy.

Factors influencing the development of NCDs are multifaceted, with lifestyle choices playing a pivotal role. Among these are unhealthy weight gain, physiological profiles and physical sedentariness been acknowledged as key threats. Epidemiological, clinical, and basic research evidence established the fact that the existence of constant PA participation serves as a tool to circumvent lifelong diseases and to improve the overall health of adolescents [9]. WHO [10] reported that PA plays a vital role towards the general well-being of adolescents, thus contributing to their current and future physical, social, emotional, psychological development and enhanced academic and cognitive performance. The transition from adolescence to middle age which mostly falls to the period when young people are expected to be in the higher institution of learning represents a precarious age where several behavioural choices are often made and any wrong behavioural choice that affects their PA may implicitly influence their health in the long run [11]. University students, due to the challenges of academic responsibilities and demands may experience changes in their PA levels and lifestyles which could negatively impact the risk of developing NCDs [12].

Several factors signifying cardiovascular risk complications have been identified to be associated with the physiological status, anthropometrics and PA levels in young people. For instance, the values of some anthropometric characteristics (e.g. increase value of subcutaneous adipose tissue) of adolescence are risk indicators and pointers to hypertension, gallstones, CVD, adult on-set diabetes mellitus and other diseases in humans. Previous studies on the risks factors that is associated with the evaluation of anthropometric variables, physiological traits and physical fitness among adult men and women have been carried out [13, 14]. However, there are paucity of information regarding the study of anthropometric variables, physiological traits and PA levels of undergraduates in the institution of higher learning in South Africa. This investigation addresses a breach in the literature by way of providing a wide-ranging evaluation of anthropometric variables, physiological parameters, and PA levels of undergraduate students as a risk indicator to OW and OB or hypertensive condition. Understanding the health status of this demography and people group will provide valuable insights for developing effective NCDs prevention strategies tailored towards university students.

2. Materials and methods

2.1. Research design and sampling technique

This study employed a cross-sectional approach from a random sample using a quantitative technique. This research design included an inclusion criteria in the selection process. A population size of students between the range of 16000 – 20000 with error margin of 5 % and a significant level of 95 % was used for this study. A response distribution of 50 % that yielded a sample size of 377 participants was determined for this study using the raosoft sample calculator. Three hundred and seventy seven sample size was selected, however, only 132 participants gave their consents and signed the informed consent form.

2.2. Study population

The population for this research consisted of 132 undergraduate students (91 males and 41 females) who are enrolled in the University of Fort Hare, Eastern Cape province of South Africa (SA). These participants showed willingness in participating in the research by signing the consent form. Selection criteria includes:

i. Inclusion Criteria: male and female students, undergraduate students, registered as students in University of Fort Hare, and are between 18 – 25 years of age were included in the study.
ii. Exclusion Criteria: students with known chronic illnesses, pregnant students, and students above 25 years of age were excluded from the study.

2.3. Instrumentation used in the study

2.3.1. Anthropometric assessments

Standardized standiometer was employed to measure stature (cm), and body mass (kg) using a clinical digital balance scale (SECA Model 812). All measurements were made with light clothing on and bare feet, respectively. Girth measurements (waist and hip circumference) was taken using a measuring tape while a caliper was employed to measure the triceps and subscapular sites of participants. Standard methods as described by the International Society for the Advancement of Kinanthropometry (ISAK) were adhered to when carrying out the measurements [15]. The weight (kg) to height (cm) ratio of undergraduates who participated in the study was employed to determine their BMI. Percentage body fat was calculated using the skinfold equation as described by Slaughter *et al*. [16]. Waist circumference (cm) divided by hip circumference (cm) was used to determined the waist-to-hip ratio (WHR).

2.3.2. Physiological measurements

The BP of the participants was determined using a digital BP monitor (Omran Corporation, model no-IA2 HEM 7001-c-1). Participants sat comfortably in a chair and in a calm position as measurement was done [17]. All participants was seated with the arm cuff and zero indicator on the monitor at the level of the examiner's eye. Readings was taken in duplicate on the right arm. Apposite cuff sizes was employed and cuff inflated and deflated once. The readings at the first and third BP monitors was taken as SBP and DBP, respectively. The mean of the two BP measurements was documented and incorporated in the analysis.

2.3.3. Physical activity

The international physical activity questionnaire – long form (IPAQ, 2010) was used to assess the PA levels of the participants in this study. The IPAQ questions focuses in the discovery, types and levels of PA that people engages in on a daily basis and this helps in determining the levels of their PA. The IPAQ is a self-reported measurement means for PA that is appropriate for evaluating PA and sedentariness in a wide range of people [18]. IPAQ measures the PA levels of people aged 15 - 69 years, which evaluates action levels through five spheres (job-related, transportation, housework, recreation and time spent sitting). The questionnaires require information on the time spent on PA over the past one week. The IPAQ is hence thought of to be an unswerving and certified means for evaluating PA amid young adults at higher institution of learning [19]. The IPAQ score produces two types of results. The first was presented as an unremitting variable (metabolic equivalent of task [MET] minutes per week) and the second as categories (low, moderate, or high activity levels). The number of MET minutes is a measure of the energy used in PA. A multiple of the predicted resting energy expenditure were recorded as MET. The stanndard recommendation of WHO for regular PA of 300 minutes of moderate-intensity aerobic PA was used to categorize PA levels of the participants [20].

2.4. Ethical concerns

Ethical clearance and permission to carry out this investigation was approved by the ethical committee of the University of Fort Hare (REC-100118-054). A consent form was provided to all participants and they were given sufficient time to make their decisions. Participants signed the consent forms and then return it to the researchers. Anonymity and confidentiality of the participants was sustained by not demanding for any identification in the questionnaires.

2.5. Data analysis

Data was analysed using SPSS data analysis software. All variables as data used in this study was analyzed using descriptive statistics, i.e. means and standard deviations. A probability level of 0.05 or less was employed to specify statistical importance. Effect size was worked out for each analysis using the Cohen'd to assess the practical connotation of outcomes. Cohen's guidelines was used to interpret $?^2$ effect size: 0.01 = small, 0.06 = medium and 0.14 = large [21].

3. Results

Sample distribution of the participants showed that 132 undergraduates participated in the study. The mean age of the participants was 21.72 ± 1.80 years.

Table 1 displayed more male participants (68.9%) than female participants (31.1%).

Table 2 showed the anthropometric variables, physiological parameters and body composition of the participants.

Skinfolds (Triceps + Subscapular); %BF = Percentage body fat; WHR = waist-to hip ratio; BMI = Body mass index; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; WC = waist circumference; HC = hip circumference

Table 1. Sample distribution.

Sex	n (%)
Male	91 (68.1)
Female	41 (31.1)
Total	132 (100)

Table 2. Anthropometric variables, blood pressure and body composition of the participants.

Variables		N	Mean ± SD
Anthropometric	Weight (kg)	132	69.58 ± 13.87
	Stature (cm)	132	167.80 ± 9.71
	Triceps (mm)	132	12.41 ± 6.33
	Subscapular (mm)	132	12.75 ± 6.71
	WC (cm)	132	75.67 ± 8.79
	HC (cm)	132	99.62 ± 10.46
Blood pressure	SBP (mmHg)	132	124.40 ± 15.6
	DBP (mmHg)	132	76.20 ± 14.4
Body composition	Skinfolds- Boys	91	14.10 ± 6.28
	Skinfolds- Girls	41	29.47 ± 7.39
	Body fat %	132	25.16 ± 12.48
	WHR (cm)	132	0.76 ± 0.05
	BMI (kgm^{-2})	132	24.78 ± 5.19

Skinfolds (Triceps + Subscapular); %BF = Percentage body fat; WHR = waist-to hip ratio; BMI = Body mass index; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; WC = waist circumference; HC = hip circumference.

Table 3. Classification of BMI and blood pressure among participants.

BMI classification	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	
	1 (8)	79 (59.8)	37 (28.0)	15 (11.4)	
Blood pressure category	Normal BP	High SBP	High DBP	Pre-hypertension	Hypertension
	79 (59.8)	18 (13.6)	9 (6.9)	10 (7.6)	16 (12.1%)

Table 3 clearly showed the occurrence of underweight, OW and OB following the WHO BMI based cut-off points for adults and the blood pressure category for all participants. The result showed that 1 (8%) participant was underweight, 79 (59.8%) had normal weight, 37 (28.0%) overweight and 15 (11.4%) were obese (Table 3). Also, 79 (59.8%) had normal blood pressure, 18 (13.6%) high SBP, 9(6.8%) high DBP, 10 (7.6%) pre-hypertension and 16 (12.1%) hypertension, respectively (Table 3).

Table 4 displayed the independent samples t-test that was employed to define the significant dissimilarity in the mean scores between male and females in the anthropometric variables and the blood pressure parameters. Also, the Cohen'd was used to determine the effect sizes of the variables. The skinfolds, % body fat and BMI of female participants were significantly ($p < .001$) higher than the male participants with a large effect sizes ($d \leq -2.3$) (Table 4). Waist to hip ratio was significantly ($p < .001$) higher in male participants than in female participants with a large effect size ($d = 1.2$). The physiological parameters of male and female participants revealed that male participants had higher SBP than female participants while female participants had higher DBP than male participants which is not statistically significant ($p > 0.001$) and with low effect sizes ($d = 0.1$) (Table 4).

The PA categories of the participants according to the WHO threshold are displayed in Table 5 below. The results revealed that majority of the participants are not meeting up with the 300 min per week PA. 93 (72.1%) are not doing enough PA while 36 (27.9%) of the participants are doing enough PA following the recommended threshold from WHO.

4. Discussion

In this present study, skinfolds (triceps and subscapular), BF %, and BMI were significantly higher in females than in males with large effect sizes. Consistent with our result is the study of Ugbenyen and Ajayi [22] who reported female university participants to have significantly higher BMI than male university participants. Likewise, Rodríguez-Montero *et al.* [13] reported BF % to be higher

Table 4. t-test and effect sizes of anthropometrics, body composition and blood pressure variables among males and females participants.

Variables	Males (n = 91) Mean ± SD	Females (n = 41) Mean ± SD	p-value	D
Skinfolds	14.10 ± 6.28	29.47 ± 7.39	<.001	-2.311
% BF	20.18 ± 8.03	36.21 ± 13.55	<.001	-1.594
WHR (cm)	0.77 ± 0.04	0.73 ± 0.05	<.001	1.223
BMI (kgm^{-2})	23 67 ± 4.74	27.25 ± 5.37	<.001	-.726
SBP	125.18 ± 14.29	122.93 ± 18.53	.448	.143
DBP	75.42 ± 13.62	77.95 ± 16.29	.355	-.175

Skinfolds (Triceps + Subscapular); %BF = Percentage body fat; WHR = waist-to hip ratio; BMI = Body mass index; SBP = Systolic blood pressure; DBP = Diastolic blood pressure

Table 5. Total PA categories – according to the WHO threshold = 300 min per week.

Variables	Frequency	Percentage
Not enough PA	93	72.1
Enough PA	36	27.9
Total	129	100

PA = Physical activity

in females than in males, a result that is in line with the present study. Several studies have reported that females have a tendency to store more fatty tissue due to biological processes [23–25] which may explain the reason for this observation. Conversely, these findings was in contrast with the findings of Shah *et al.* [26] who reported a higher prevalence of overweight/obesity in males than in females. Also, the present study showed that male participants had significantly higher WHR than female participants which is in line with the study of Ugbenyen and Ajayi [22]. WHR is said to be negatively associated to the female sex hormone called estradiol, and positively associated to the male sex hormone called testosterone, which clearly explains why WHR is smaller in women than in men [27]. According to WHO, a WHR of 0.85 or less for females and 0.9 or less in males is ideal and moderate. The low ratio of WHR size in women as compared to men serves as a distinctive human features, however, numerous adaptive mechanisms may have contributed to this development [28]. Meanwhile, a high WHR in women can be concomitant with health conditions such as CVDs, diabetes, menstrual abnormality, lung impairment, gallbladder ailment, hormonal imbalances which may lead to anovulatory cycles [27].

In this study, 8 % of the participants are underweight, 59.8% were normal weight, 28.0 % were overweight and 11.4 % were obese. In accordance with the present study, Peltzer *et al.* [29] reported that 10.8 % of the participants in their study were underweight, 64.4 % fell within healthy weight, 18.9 % were OW and 5.8 % were obese among the total population of 15,746 undergraduate students from 22 countries. These findings suggests that undergraduate students are not left out from the prevalent trends of OW and OB incidences in the world. Chukwudi [30] also reported the prevalent of OW and OB amongst 338 university students enrolled in the university of Venda in the Limpopo province of South Africa. From their findings, it was revealed that 20 % and 9.5 % of the participants were OW and obese, respectively [30]. Likewise, amongst 110 undergraduate female students at the University of the Witwatersrand that participated in a study, the OW and OB levels were reported to be 37.3 % and 17.3 %, respectively [31]. Furthermore, Sartorius *et al.* [32] reported in their findings that 3 out of 10 South Africans are OW. Study has it that, there is an increasing occurrence of OW and OB in the Sub-Saharan region of Africa [33] including the Central, Eastern, Western and Southern regions of Africa. The World Health Organization also reported that within the past 25 years, the number of OW/OB people in Africa had increased from 5.4 million to 10.3 million [34]. According to Lee *et al.* [35] obesity is said to be an ailment that is caused by various factors that involves biological factors, beliefs, genetic, consumption lifestyles, social, environmental, behavioural, and sedentariness in people.

In this study, 59.8 % of the participants had normal BP, 13.6 % had high SBP, 6.8 % of the participants had high DBP, while 7.6 % and 12.1 % had prehypertension and hypertension, respectively. Male participants in this study had an insignificant ($p > .05$) higher SBP than female participants while female participants had an insignificant ($p > .05$) higher DBP than male participants. In line with this study, Kessler and Rayman [36] reported that 52 % of undergraduate students had high SBP, 30 % had high DBP and male students had high SBP and DBP compared to female students. Also Ugbenyen and Ajayi [22] reported a significantly higher SBP in male participants than female participants while no differences in the DBP between male and female students was noticed in that study. Ghadhban and Habib [37] also reported a high SBP and DBP (1.8 % and 3.6 %, respectively) among university students aged 18 – 25 in the university of Basrah in Iraq.

The risk of cardiovascular disease has been reportedly seen to be extensively more in the presence of high SBP as compared to high DBP. The impact of high SBP can result to stroke, coronary heart disease, cardiac failure as well as myocardial infarction, angina, and unexpected demise in people. All of these outlined conditions have the risks to be greater for people with high SBP than

those of DBP. Hypertension and prehypertension are likely to display further atherosclerosis threats on people with the condition which equally stimulate the incidence and significantly effect its influence on CVDs [38].

Based on the report by the World Health Organization, 18 – 64 years old adults are required to take part in at least 150 – 300 minutes of moderate-intensity aerobic PA throughout the week for substantial health benefits [20]. With respect to the present study, 72.1 % of the participants did not meet this recommendation. In line with our findings, the study of Pengpid *et al*. [39] who also reported the incidence of physical sedentariness amongst university students from twenty-three low, middle and high-income nations, observed that the incidence of physical sedentariness was high with a proportion of 50.5 % in Southeast Asia, 37.2 % in South America and 37.1 % in sub-Saharan Africa, respectively. According to the findings of Pengpid *et al*. [39], four out of ten students are reportedly to be physically inactive which calls for deliberate intervention by all stakeholders from those higher institutions. Physical activity levels amongst undergraduate students in the university varies generally, with 22 % reported in Malaysia [40] and 31.2% in Brazil [41] to have low PA levels. Pengpid and Peltzer [42] had 4460 participants conscripted from various universities within Central, South, East, and West Africa. Their findings revealed that 37.1% of the undergraduate students had low PA. Engaging in more PA promotes healthier lifestyle than sedentary lifestyle. To lessesn the unfavourable influence of inactivity, people should purposefully and intentionally engage in physical activities and outdo the recommended levels of MVPA [20].

5. Study limitations and future research

This study had a quite lesser sample size of 132 participants. Future research could target a bigger sample size in order to improve the ascertions and recommendations of the findings. Furthermore, another limitations observed from the study is an unbalanced representation of gender and age groups which can be looked into in future studies to better understand variations in health metrics across different populations. To get reliable results, future research could include a diversity of participants from diverse campuses and institutions. This approach will help to make sure the findings apply to a wide range of students. Finally, the psychological impact of obesity e.g. low self-esteem, depression and health consequences in relation to hypertension and diabetes mellitus was not part of this study. Hence, future research could aimed at the psychological impact of obesity on the academic performance and general well-being of undergraduate students. Also, seeking medical services and counselling sections from sports psychologist, exercise physiologist and sports nutritionist could be recommended as a way out.

6. Conclusions

Observations from the findings revealed that skinfolds (triceps and subscapular), body fat percentage and BMI are significantly higher in females than in males with large effect sizes. Waist-to-hip ratio is significantly lower in females than in males with large effect size. Systolic blood pressure is higher in males than in females, although, not statistically significant while the reverse was the case for diastolic blood pressure which was also not statistically significant. Majority of the participants are inactive.

Data availability

Data will be made available upon reasonable demand from the corresponding author.

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