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RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND BODY FAT DISTRIBUTION AMONG UNIVERSITY STUDENTS IN UGANDA

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ABSTRACT

Physical activity and lifestyle choices together influence the accumulation and distribution of body fat. University students are particularly at a heightened risk of body fat accumulation due to lifestyle changes associated with their academic environment. These changes include irregular meal patterns, increased consumption of high-calorie fast foods and reduced physical activity. Accumulation and distribution of body fat is concerning because it contributes to a rise in obesity rates, increasing the risk for metabolic disorders and chronic illnesses such as heart disease, diabetes and hypertension. The sedentary nature of university life, characterized by long hours spent attending lectures, completing assignments and studying for exams, further limits opportunities for regular physical exercise. This study aimed to establish physical activity levels and body fat distribution patterns among university students in Uganda, as well as the relationship between the two. A cross-sectional study was conducted among 302 students in the second semester of the 2018/2019 academic year. The study assessed four key variables: waist circumference, total body fat percentage (TBF%), abdominal fat level and physical activity levels. Chi-square analysis, and multinomial logistic regression were used to establish the relationship between physical activity and body measurements. Prevalence of obesity was found to be 58.9% and 5.6% on the basis of TBF and abdominal fat, respectively, suggesting a substantial risk of obesity related conditions. Regarding physical activity, only 31.5% engaged in vigorous-intensity physical activity, averaging 1.7 days per week, while 82.1% participated in moderate-intensity physical activity, averaging 4.3 days per week. The odds of having high abdominal fat were reduced by 59% among physically active individuals (OR = 0.41, 95% CI: 0.20–0.84, $p = 0.017$). Individuals who met physical activity recommendations had 62% lower odds of exhibiting central fat accumulation (OR = 0.38, 95% CI: 0.21–0.69, $p = 0.001$). This study highlights a high prevalence of obesity and abdominal fat accumulation among students and reveal beneficial effect of physical activity, particularly moderate-intensity exercise, in reducing body fat and associated health risks.

Key words: Obesity, Exercise, Abdominal Fat, Waist Circumference, Body Fat Percentage

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INTRODUCTION

University students undergo significant changes in body composition due to lifestyle shifts, making them vulnerable to unhealthy body fat accumulation and body fat distribution patterns [1,2]. The transition from secondary school to university is often marked by decline in physical activity and increased consumption of high-calorie foods [3,4,5,6], which subsequently lead to body fat accumulation. Although the initial increase in fat mass may look tiny and the weight gain may seem minimal, if left unchecked, it can tend to build and persist into old age [7] and over time leading to progressive accumulation of body fat and increased metabolic health risk. Adherence to physical activity guidelines is associated with reduced total body fat accumulation and improved metabolic health [8,9,10]. The World Health Organization (WHO) estimates that about 7– 8% of all cases of metabolic syndrome including cardiovascular disease, hypertension and type-2 diabetes could be prevented if more people were engaged in physical activity to a certain degree [11]. Several studies have shown that engaging in regular physical activities leads to reduction in body mass index, total body fat percentage and thus reducing the risks of developing metabolic disorders such as obesity and type 2 diabetes [2,12,13,14,15].

Despite the documented benefits of physical activity, WHO estimates that about 27% of adults do not meet the global recommended levels of physical activity and that about 5 million deaths per year could be averted if the global population was more active [16]. In the sub-Saharan African region, it is estimated that 22% of adults do not meet physical activity recommendation [15], while in Uganda, about 22% of adults are either overweight or obese [17].

University students reportedly engage in insufficient physical activity compared to the general adult population [14,18], largely due to the academic environment, making them more susceptible to increased body fat accumulation. University students have been reported to register a gradual increase in the body fat percentage every year during their time at the university [19]. A study conducted in Canada by Deforche *et al.* [20] found that university students' physical activity also decreased over time, with the steepest decline occurring in the first year of university. In Uganda, Uganda Bureau of Statistics (UBOS) reported that overweight increases with education level among both men and women with higher than secondary education [17]. This highlights the need for early intervention to establish lifelong healthy habits, as evidence suggests that maintaining a healthy lifestyle in adulthood is easily achievable when beneficial habits are formed early in life [21,22]. Encouraging university students to develop and maintain healthy nutritional and activity habits may, therefore, help to prevent lifestyle-related disorders later in life [23,24].



World Health Organization (WHO) recommends that adults aged 18–64 years engage in at least 150–300 minutes of moderate-intensity aerobic physical activity, or at least 75–150 minutes of vigorous-intensity aerobic physical activity per week, or an equivalent combination of both [16]. Research has demonstrated that increasing physical activity levels can significantly reduce the amount of body fat accumulation [25,25], and lower the risk of obesity and mortality from non-communicable diseases (NCDs) such as diabetes and heart disease [27,28].

Despite these WHO global physical activity recommendations, trends show that physical inactivity and obesity are rising globally, including in Uganda. The prevalence of obesity increased from 4.2% in 2010 to 8% in 2022, a rise that outpaces the global trend [17]. Given the ongoing dietary transition and lifestyle change, it is important to investigate the prevalence of excessive body fat and inadequate physical activity among university students in Uganda, given that this population segment is at high risk of adopting unhealthy lifestyles. This study, therefore, sought to determine the association between physical activity levels and body fat distribution among university students in Uganda.

MATERIALS AND METHODS

Study area and population

The research was conducted at Kyambogo University, Uganda's second-largest public university, located in Uganda's capital city, Kampala. The University has over 30,000 students across eight faculties (Faculties of Arts and Social Sciences, Education, Science, Special Needs and Rehabilitation, Vocational Studies, Engineering, School of Management and Entrepreneurship and School of Graduate Studies). Kyambogo University offers 161 academic programs approved by the National Council for Higher Education.

Kyambogo University has a diverse student population drawn from all over the country.

Study design

The study was cross-sectional, with data collected in the second month of the second semester of the 2018/2019 academic year. The study population included Kyambogo University students aged 18-35 years.

Sampling procedure

The sample size of 302 students for the study was calculated using Fisher's equation, based on a 26.5% prevalence of under and over nutrition among people aged 20-29 from 2018 UBOS data at a 95% confidence interval.

Multistage sampling was used to obtain the sample size. Three faculties: Faculty of Vocational Studies, the School of Management and Entrepreneurship, and Faculty



of Science were selected by simple random sampling. Within the three randomly selected faculties, one department each was chosen (Department of Accounting and Finance from the School of Management and Entrepreneurship, the Department of Physics from the Faculty of Science, the Department of Human Nutrition and Home Economics from the Faculty of Vocational Studies) through simple random sampling. From each of the above Departments, one course was randomly selected (Bachelor of Accounting and Finance (BAF) from the Department of Accounting and Finance and Bachelor of Physics with Education from the Department of Physics). In the Department of Human Nutrition and Home Economics, two courses (Bachelor of Human Nutrition and Dietetics (HND) and Bachelor of Institutional Catering (BHIC) were randomly selected.

After identifying the final programs, a list of students was compiled, and participants were randomly selected using random numbers, ensuring equal representation across faculties and departments.

Data collection and measures

Data collection was conducted by three enumerators, all with degree-level training in Human Nutrition and proficiency in nutritional status assessment. They received additional training to ensure accurate data entry and protocol adherence. A pilot was conducted with 10 respondents, and the data were analysed for reliability. The study had 4 dependent variables, that is, TBF%, abdominal fat, WC and waist hip ratio.

Total Body Fat percentage and abdominal fat were measured using a Tanita scale, while hip and waist circumference were recorded to the nearest 0.1cm using a Seca tape measure. All relevant data were entered into the Tanita scale following the manufacturers guidelines, and body fat percentage and abdominal fat readings were recorded.

The main independent variables were physical activity, and socio-demographic characteristics. The social demographic characteristics considered included gender, age, marital status, year of study, program of study, place of residence, university sponsorship, and participating in an income-generating activity.

Data on socio-demographic characteristics were collected once using a structured questionnaire, while physical activity was assessed using the Global Physical Activity Questionnaire which also captured the age and gender.



Data analysis

Total body fat percentage, HC, WC, waist-hip ratio and abdominal fat were described using percentages and descriptive statistics. Total Body Fat percentage was categorized as low-fat accumulation (healthy/essential), moderate fat accumulation (fitness/average), and high fat accumulation (obesity).

The abdominal fat was categorized as normal when it was between <12 mm and very high-fat accumulation when it was >12 mm. The WC was measured and classified as low-fat accumulation/low risk, when it was ≤ 80 cm for women and ≤ 94 cm for men, high fat accumulation /high risk when it was 81–88 cm for women, 94–102 cm for men and very high fat accumulation / very high risk, when it was >88 cm for women and >102 cm for men. The WC was also classified dichotomously by combining two categories, that is, high fat accumulation and very high-fat accumulation to form high fat accumulation and low-fat accumulation retained.

The hip and waist circumferences were used to compute the waist- hip ratio which was categorized as low-fat accumulation/ low risk, that is WHR <0.90 for men and WHR <0.80 for women, moderate fat accumulation / moderate risk that is WHR 0.90–0.99 for men and WHR 0.80–0.85 for women and high-fat accumulation/ high risk that is WHR ≥ 1.00 for men and WHR ≥ 0.86 for women.

Physical Activity (PA) data were converted into Metabolic Equivalent (METs) to quantify the intensity of the PA. The MET of the different physical activities was obtained from the Ainsworth Compendium of physical activity. The MET minutes were then calculated by multiplying the MET score by the number of minutes the students reported exercising. This was categorized as low physical activity if the student met <600 met-min/week, moderate physical activity if the student achieved 600–1500 met-min/week and high physical activity if the student met ≥ 1500 met-min/week (vigorous) or ≥ 3000 met-min/week. This classified dichotomously by combining moderate physical activity and high physical activity to form met recommended physical activity level and changed low physical activity to below recommended physical level.

Multinomial logistic regression was used to examine the relationship between body fat distribution and physical activity levels among Kyambogo University students. Students with below-recommended physical activity levels served as reference category for this analysis. Odds ratios were computed to determine the likelihood of fat distribution patterns across activity levels using STATA 14 at 95% confidence interval.

Ethics approval and consent to participate

The study was approved by Makerere University's Research Ethics Committee (MAKSS REC 10.18.2018) and the Uganda National Council for Science and



Technology (SS 5058). Participation was voluntary, with written informed consent obtained from students. Each participant received UGX 2500 (USD 0.7) after completing the questionnaire and body composition assessment.

RESULTS AND DISCUSSION

Socio-demographic characteristics of the respondents

Table 1 shows that most participants were female students (67.2%, n=203), while 32.8% (n=99) were male. Most students (89.1%, n=269) were aged 18-23 years, followed by 8.9% (n=27) aged 24-29 years and 2% (n=6) aged 30 years or older. Most students (94.7%, n=286) were unmarried, while 5.3% (n=16) were married. Student housing distribution was as follows: 35.1% (n=106) of the students lived in dorms, 23.1% (n=70) rented housing, 22.5% (n=68) lived with parents or guardians, 14.2% (n=43) resided in university halls, and 5% (n=15) owned homes.

Regarding sponsorship, 67.9% (n=205) were funded by parents or guardians, 24.2% (n=73) were government-sponsored and 7.9% (n=24) were self-funded. Students' distribution among academic programs was as follows: 41.7% (n=126) in Bachelor of Science in Hotel and Institutional Catering, 27.5% (n=83) in Bachelor of Science in Human Nutrition, 15.9% (n=48) in Bachelor in Accounting and Finance, and 14.9% (n=45) in Bachelor of Science with Education Physics. Most students were in their second year of study (57.6%, n=174), followed by first-year students (34.1%, n=103), and third year (8.3%, n=25).

Physical activity patterns of the students

Table 2 shows that 31.5% (n=95) of students participated in vigorous-intensity physical activity (PA), while the majority, 68.5% (n=207), did not. On average, students engaged in vigorous-intensity PA for 1.7 days per week (SD=2.3). Most 82.1% (n=248) of students had moderate PA, while 17.9% (n=54) did not. The average frequency of moderate-intensity PA for 4.3 days per week (SD=2.7).

Regarding walking, 59.9% (n=181) of students walked for more than 10 minutes at a time, while 40.1% (n=121) did not. This aligns with previous research indicating that walking is the most common physical activity among university students [29]. Overall, 39.4% (n=119) of students had low physical activity (<600 MET minutes per day), 35.4% (n=107) had moderate physical activity (601-1500 MET minutes of physical activity per day), and 25.2% (n=76) had high physical activity levels. These results suggest that many students did not meet the recommended levels for optimal health benefits.

The body fat distribution of the students

Table 3 shows that most students (58.9%, n=178) had high total body fat accumulation, classified as obesity. A small proportion (3.0%, n=9) had a low or



healthy total body fat accumulation, while 38.1% (n=115) had a moderate total body fat accumulation. The mean total body fat percentage was 28.6% (SD=9.6).

Regarding abdominal fat, 94.4% (n=285) of students had normal levels, while 5.0% (n=15) had excessive fat accumulation, placing them at moderate risk of metabolic disorders. A small fraction (0.7%, n=2) of students had very high abdominal fat accumulation, indicating a high risk of metabolic complications. The mean abdominal fat level was 4.5 (SD=3.3).

Waist circumference measurements showed that most students (89.4%, n=270) had normal abdominal fat accumulation. However, 5.0% (n=15) exhibited high abdominal fat accumulation, and 5.6% (n=17) had very high accumulation in abdominal areas, suggesting an increased risk of obesity-related conditions. The mean waist circumference was 74.3 cm (SD=8.9).

Peripheral fat was the most common pattern of fat distribution, observed in 89.4% (n=270) of students. Moderate central fat distribution was observed in 8.3% (n=25), while only 2.3% (n=7) of students had high central fat distribution, indicating a higher risk of central obesity. The average waist-to-hip ratio was 0.77 with a standard deviation of 0.06.

Determinants of body fat distribution

a) Relationship between physical activity and body fat distribution

Multinomial regression results indicated a significant association between abdominal fat accumulation and physical activity levels, Table 4. The findings revealed that individuals who met the recommended physical activity guidelines were significantly less likely to exhibit high levels of abdominal fat accumulation. Specifically, the odds of having high abdominal fat were reduced by 59% among physically active individuals (OR = 0.41, 95% CI: 0.20–0.84, p = 0.017). This suggests a strong inverse association between physical activity and abdominal fat, highlighting the importance of regular exercise in reducing central obesity risk. This study agrees with findings of a study by Colberg *et al.* [34], which found that individuals who adhere to recommended guidelines for physical activity, such as moderate to vigorous exercise, are significantly less likely to accumulate excessive belly fat compared to individuals who do not participate in the exercise interventions.

Similarly, a significant protective effect was observed for total body fat percentage. Meeting recommended PA levels was associated with a 47% reduction in the odds of having high body fat percentage (OR = 0.53, 95% CI: 0.29–0.96, p = 0.039). This finding supports the role of physical activity in maintaining healthy body composition and preventing excess fat accumulation. These findings were also consistent with findings from Lee *et al.* [35], which found that overweight or obese individuals who

participated in exercise interventions achieved reduced body weight, BMI and visceral fat accumulation. The most pronounced effect was noted in the waist-hip ratio, a key indicator of central fat accumulation. Individuals who met physical activity recommendations had 62% lower odds of exhibiting central fat accumulation (OR = 0.38, 95% CI: 0.21–0.69, $p = 0.001$). This result indicates a robust and statistically significant relationship between regular physical activity and reduced central adiposity, which is particularly important given the established link between central fat and cardiometabolic risk [37].

On the other hand, the association between physical activity and waist circumference (as an indicator of low-fat accumulation) was not statistically significant (OR = 1.12, 95% CI: 0.93–1.48, $p = 0.111$). While the odds ratio suggested a slight increase in the odds of low-fat accumulation among active individuals, the result was likely due to chance and should be interpreted with caution.

b) Moderate-intensity physical activity and body fat distribution

The analysis examined the association between engaging in moderate-intensity physical activity and various indicators of low body fat accumulation (Table 5). The findings suggest a significant relationship between moderate PA and healthier body fat distribution.

Individuals who engaged in moderate-intensity physical activity were significantly more likely to have low abdominal fat accumulation (with an odds ratio (OR) of 1.95 (95% CI: 1.05–3.62, $p = 0.039$). This indicates that engaging in moderate PA nearly doubles the likelihood of having lower abdominal fat compared to those who do not engage in such activity. This result was consistent with findings from Strasser [36], which found that engaging in moderate physical activity (PA) significantly reduces abdominal fat compared to a sedentary lifestyle. In addition, the association between moderate PA and low-fat accumulation based on waist circumference was not statistically significant (OR = 0.97, 95% CI: 0.36–2.67, $p = 0.958$). Although the OR is close to 1, suggesting little to no effect, the wide confidence interval and high p -value indicate that this result could be due to chance, and no meaningful conclusion can be drawn from this indicator.

There was also a strong and statistically significant association observed between moderate PA and low total body fat accumulation. Individuals reporting moderate physical activity had an OR of 2.96 (95% CI: 1.32–6.38, $p = 0.017$), meaning they were nearly three times more likely to have low total body fat compared to inactive individuals. These findings suggest that moderate exercise helps maintain optimal body composition by enhancing fat metabolism and promoting lean muscle



development. These findings align with a study which reported that exercise increases fat breakdown, reducing total body fat percentage [32].

These findings support the World Health Organization physical activity guidelines, which recommend at least 30 minutes of moderate-intensity PA most days of the week to reduce body fat accumulation [16].

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

This study demonstrated a clear association between physical activity levels and body fat distribution among university students. Engaging in moderate-intensity physical activity was significantly associated with lower abdominal fat accumulation and reduced total body fat percentage. These findings explain the importance of regular physical activity in improving body composition and lowering the risk of central adiposity linked to metabolic disorders. Although the association between physical activity and waist circumference was not statistically significant, the overall evidence suggests that moderate physical activity contributes positively to healthier fat distribution. Contrary to expectations, students with central fat distribution were not more likely to meet physical activity recommendations, indicating a gap between health needs and behavior. Based on these findings, universities and health institutions should encourage moderate-intensity activities like walking, cycling, or aerobics, raise awareness about the benefits of regular exercise, improve physical activity infrastructure, and integrate physical activity into academic life through extracurricular and wellness programs. These efforts support WHO's recommendation of at least 30 minutes of moderate physical activity most days to maintain healthy body composition and reduce the risk of non-communicable diseases.

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Data availability statement

The anonymized database will be provided by the corresponding author on reasonable request.

Competing interests

The authors declare that they do not have any conflict of interest.



Table 1: Socio-demographic characteristics of the respondents

Parameters		Frequency(n=302)	Percentage
Sex	Female	203	67.2
	Male	99	32.8
Age category	18-23 Years	269	89.1
	24-29 Years	27	8.9
	30 Years and above	6	2.0
Marital status	Single	286	94.7
	Married	16	5.3
Place of residence	University hall of residence	43	14.2
	Hostel	106	35.1
	Own home	15	5.0
	Parents/guardians home	68	22.5
	Rental	70	23.1
Education sponsor	Parents/guardian	205	67.9
	Self-sponsored	24	7.9
	Government-sponsored	73	24.2
Programme pursued	ESP	45	14.9
	BHIC	126	41.7
	HND	83	27.5
	BAF	48	15.9
Year of study	Year 1	103	34.1
	Year 2	174	57.6
	Year 3	25	8.3

*ESP =Bachelor of Science with Education Physics, BAF = Bachelor of Accounting & Finance, HND = Bachelor of Human Nutrition and Dietetics, BHIC = Bachelor of Hotel and Institutional Catering



Table 2: Physical activity level and categorization

Categories		Frequency (302)	Percentage
Vigorous intensity PA	No	207	68.5
	Yes	95	31.5
Mean no of days per week of vigorous PA	Mean (SD)	1.7(2.3)	
Mean no of days per week of Moderate intensity PA	No	54	17.9
	Yes	248	82.1
Mean weekly moderate intensity PA		4.3(2.7)	
Walked for more than 10 minutes	No	121	40.1
	Yes	181	59.9
Physical activity level	Low physical activity	119	39.4
	Moderate physical activity	107	35.4
	High physical activity	76	25.2

Table 3: Body fat distribution among the students

Indicators		Frequency (n=302)	Percentage
Total body fat%	Low-fat accumulation/healthy	9.0	3.0
	Moderate fat accumulation	115.0	38.1
	High-fat accumulation/obesity	178.0	58.9
Mean total body fat%	Mean (SD)	28.6(9.6)	
Abdominal fat	Normal-fat accumulation	285	94.4
	High fat accumulation/moderate risk	15	5.0
	Very high-fat accumulation/high risk	2	0.7
Mean abdominal fat	Mean (SD)	4.5(3.3)	
Waist circumference	Normal fat accumulation	270	89.4
	High-fat accumulation	15	5.0
	Very high-fat accumulation	17	5.6



Mean waist circumference	Mean (SD)	74.3 (8.9)	
Waist hip ratio	Peripheral-fat distribution	270	89.4
	Moderate central fat distribution	25	8.3
	High central fat distribution	7	2.3
Mean waist hip ratio	Mean (SD)	0.77(0.06)	

Table 4: Physical activity level and body fat distribution

Body Fat Indicator	Sig.	Odds Ratio (OR)	95% CI
Abdominal fat (high-fat accumulation)	0.017	0.41	0.20 – 0.84
Waist circumference (low-fat accumulation)	0.111	1.12	0.93 – 1.48
Total body fat % (high-fat %)	0.039	0.53	0.29 – 0.96
Waist-hip ratio (central fat accumulation)	0.001	0.38	0.21 – 0.69

The reference category is: Below recommended PA

Table 5: Moderate-intensity physical activity and body fat distribution

Body Fat Indicator	Sig.	Odds Ratio (OR)	95% CI
Low abdominal fat accumulation	0.039	1.95	1.05 – 3.62
Low-fat accumulation – waist circumference	0.958	0.97	0.36 – 2.67
Low total body fat accumulation	0.017	2.96	1.32 – 6.38

Reference category: "No low-fat accumulation"; p < 0.05 denotes statistical significance

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