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# Lipid Profiles and Body Mass Index of Senior High School Students in Northern Ghana

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## Abstract

The study investigated the lipid profiles and body mass index (BMI) levels among senior high school students in Ghana. Participants were 411 students (64.96% male and 35.04% female) from two senior high schools in a municipality in the northern sector of Ghana. They comprised 41.60% Grade 10 (SHS Form 1) and 58.40% Grade 11 (SHS Form 2) students. Lipid tests and anthropometric measures were utilized to assess students' lipid profiles and BMI. The response variables were total cholesterol (TCHOL), HDL, LDL, triglycerides (TRIG), and BMI. Students' sex, grade level, and program of study served as predictor variables. Overall, 29.68% of the students were classified as thin or underweight, 5.60% overweight or obese, and 64.72% were in the normal BMI category. Additionally, 50.12% of the students had abnormal levels of functioning in one category, with 21.17% showing abnormal levels of functioning in at least two categories. Males had significantly higher TCHOL and LDL scores than females, while females had significantly higher BMI scores. There were significant grade-level differences for LDL and BMI. Grade 10 students had higher LDL levels than those in Grade 11, and Grade 11 students had significantly higher BMI scores than those in Grade 10. Furthermore, there were significant differences in the programs of study for TCHOL, LDL, TRIG, and BMI. The findings of this study underscore the need for targeted health initiatives across all programs in senior high schools, emphasizing regular health screenings for Ghanaian adolescents aimed at reducing risk for metabolic disease later in life.

## How to Cite

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## INTRODUCTION

Approximately 2.6 million people die each year due to being overweight and obese (World Health Organization [WHO], 2005). Overweight and obesity lead to metabolic effects on blood pressure, cholesterol, triglycerides, and insulin resistance (Ferrannini et al, 2007). For example, the prevalence of coronary heart disease, stroke, and type II diabetes increases with an increase in Body Mass Index (BMI). WHO (2013) reports that 90% of early deaths from non-communicable diseases occur in middle-income countries annually. Africa bears a significant proportion of the global burden of chronic diseases (Bigna & Noubiap, 2019; WHO, 2005). This exacerbates the continent's health problems, where already, 69% of deaths result from infectious diseases (Young et al., 2009). The co-existence of chronic diseases with communicable diseases has created a double burden of diseases in the country (de Graft, 2018). Health ministries in Africa have historically focused on communicable diseases and diseases of environmental degradation and pollution (Okesanya et al., 2024). Consequently, there is a paucity of chronic disease research and policy in Ghana (de-Graft Aikins et al., 2010). Little is known about the prevalence of the risk factors for metabolic disorders among upper-level senior high school students, and in relation to programs of interest, in the northern part of Ghana.

Metabolic functioning disorders encompass a myriad of interrelated risk factors, including abdominal obesity, dyslipidemia, elevated blood pressure, and insulin resistance, which collectively heighten the risk for cardiovascular diseases and type II diabetes (Alberti et al., 2009). The presence of metabolic disorders among Ghanaian adults has been steadily increasing over the past few decades due to rapid urbanization, which is associated with the presence of a more sedentary lifestyle and nutritional changes. Research attributes the increase in noncommunicable diseases in Sub-Saharan Africa to an increase in cardiovascular factors such as declined physical activity, obesity, hypertension, and dyslipidemia. Additionally, it projected that noncommunicable diseases would surpass communicable diseases nutritional, maternal and neonatal diseases combined as the leading cause of deaths in Sub-Saharan Africa by the year 2030 (WHO Regional Office of Africa, 2014).

Research focused on metabolic disorders in young Ghanaian individuals is limited but growing. Recent research has shown that 16.4% of Ghanaian adolescents (8-11 years old) (Adom et al., 2019) and 8.6% and 1.2% of Ghanaian senior high school students (16-20 years old) (Seneadza, 2008) were overweight and obese, respectively. Additionally, a systematic review by Akowuah and Kobia-Acquah (2020) reported that the prevalence of childhood (ages 5-19) obesity and overweight was 8.6% and 10.7% respectively. These findings support the need for widespread health interventions aimed at alleviating this public health issue at an earlier stage of life.

Metabolic disorders in older Ghanaian adults have been shown to present a substantial public health concern due to the aggregate effect of developing associated risk factors. More specifically, as the prevalence of overweight and obesity develops at earlier stages in life, it is anticipated that Ghanaian adults will experience more significant health issues at an earlier stage of life and/or possibly decrease overall life expectancy. Lartey et al. (2020) found that Ghanaian adults aged 50 years and above exhibited losses in life expectancy of 2.2 years (overweight) and 4.85 years (obese) compared to healthy weight. Furthermore, Amponsem-Boateng et al. (2019) reported a 19% to 48% prevalence of hypertension, adding that it was among the leading causes of death in Ghana. Therefore, the purpose of the present study was to investigate the lipid profiles and body mass index (BMI) levels among senior high school students in the northern sector of Ghana. The study attempted to answer the following research questions:

1. What are the lipid profiles and BMI levels among senior high school students?
2. To what extent do male and female high school students' lipid profiles and BMI levels differ?
3. What are the effects of grade level on high school students' lipid profiles and BMI?
4. What are the effects of program of study on high school students' lipid profiles and BMI?

## METHOD

The study utilized a cross-sectional quantitative research design. The participants were 411 students (64.96% male and 35.04% female) from two senior high schools in a municipality located in the northern sector of Ghana. The participants were 41.60% Grade 10 (SHS Form 1) and 58.40% Grade 11 (SHS Form 2) students. The students' ages ranged from 16.07 to 26 years (M=19.19; SD=1.77). The programs of study students were pursuing at the time of data collection were: Agriculture (21.17%), General Arts (19.95%), Business (10.46%), Home Economics (19.95%), Science (17.52%), and Technical Education (10.95%). Overaged students is a common phenomenon in Sub-Saharan Africa senior secondary schools (Arendse, 2021; Erasmus & Fourie, 2025). Common reasons for over-aged students in senior secondary schools include late entry, repetition of grade level, and internal conflicts resulting in the displacement of entire communities (Erasmus & Fourie, 2025; Wasioya et al., 2024).

The Human Subjects Committee at the researchers' institution approved the study. Parental consents were obtained through the Parent-Teacher Associations of the two senior high schools. In addition, the students verbally agreed to participate in the study. The researchers informed the students that their participation was voluntary and that they could withdraw from the study at any time without consequences.

Body weight and height measurements were used to calculate BMI. Body weight was measured with a Tefal Glass Classic bathroom scale to the nearest 0.1 kilogram. Students stood on the bathroom scale barefoot, wearing light clothing. Height was measured to the nearest 0.1 centimeter, with a wall-mounted wooden tape. The students stood barefoot on a flat surface with their backs against a wall. Each participant's BMI was calculated using the formula (kg/m2). The researchers used the 5-19 years BMI-for-age cut-offs (WHO, 2007) to classify the BMI for participants. For participants 20 years and older, the researchers used BMI values of <16.00 (thin), <18.00 (underweight), 18.50-24.99 (normal), 25.00-29.99 (overweight), and ≥30.00 (obese) (WHO, 2007).

Non-fasting lipid testing was utilized for the study. The town that served as the study site had a government-accredited Municipal Hospital. Blood samples from the participants were collected at the school by certified laboratory personnel from the municipal hospital. The samples were sent to the hospital laboratory for standard hospital assays to measure TCHOL, HDL, LDL, and TRIG. The laboratory results were placed in sealed envelopes and returned to the lead author. The researchers used the abnormal cut-off points for non-fasting lipid levels recommended by Nordestgaard et al. (2016): TCHOL (≥ 190 mg/dL), LDL (≥115 mg/dL), HDL (≤40 mg/dL for men, and 50 mg/dL for women), and TRIG (≥175 mg/dL). This study used non-fasting lipid testing because it was impractical for the researchers to monitor the student if they fasted.

We analyzed the data using descriptive and inferential statistics. Data were analyzed using SPSS for Windows Version 27. First, the researchers calculated frequencies and conditional percentages for normal and abnormal values for the five response variables. Second, the researchers computed the number of categories in which students had abnormal levels of lipids and BMI. Third, the researchers calculated the frequencies and percentages of students by sex for the five response variables. Fourth, the researchers conducted an Independent t-Test for sex, lipid profiles, and BMI. Fifth, we run an Independent t-Test for grade level, lipid profiles, and BMI. Sixth, the researchers computed a One-Way ANOVA for programs of study, lipid profiles, and BMI, with a Bonferroni follow-up test.

## RESULTS AND DISCUSSION

### Lipid profiles and BMI levels

To address the first research question, the researchers examined the lipid profiles and BMI levels among senior high school students in Ghana. **Table 1** presents data on lipid profiles for total cholesterol (TCHOL), HDL, LDL, TRIG, and BMI levels. The highest percentage of normal levels was for TRIG (98.30%), followed by HDL (79.08%). Conversely, the highest percentage of participants with abnormal levels was for TCHOL (37.96%), followed by LDL (29.93%).

**Table 1.** Frequencies and Percentages of Students' Lipid Profiles and BMI

| Category | Abnormal | Normal |
|---|---|---|
| | f/% | f/% |
| TCHOL | 156(37.96) | 255(62.04) |
| HDL | 86(20.92) | 325(79.08) |
| LDL | 123(29.93) | 288(70.07) |
| TRIG. | 7(1.70) | 404(98.30) |
| BMI | 145(35.28) | 266(64.72) |

**Table 2** presents the frequencies and percentages of students with abnormal levels of TCHOL, HDL, LDL, TRIG, and BMI. The data indicated that slightly over 50% of the students had abnormal levels of functioning in one category. Additionally, approximately 21% of the students had abnormal levels of functioning in at least three categories.

These findings reveal concerning levels of lipid and BMI abnormalities amongst Ghanaian senior high school students. Early signs of dyslipidemia were present in the form of abnormal lipid values (e.g., TCHOL, HDL, and LDL) in

20 to 37.96% of the sample population. While most students exhibited normal lipid values, the number of abnormal TCHOL samples (37.96%) could be interpreted as significant, given the long-term risk associated with heart disease.

In addition, slightly more than one-third of the students (35.28%) were classified as overweight or obese, supporting a growing shift toward unhealthy weight patterns among young Ghanaian students. These findings support earlier studies (Adom et al., 2019; Akowuah & Kobia-Acquah, 2002) which link rising overweight rates to lifestyle choices associated with reduced physical activity and increased consumption of high-calorie foods.

More than half of the students exhibited one abnormal health value, and approximately 20% had three or more, suggesting that signs of metabolic imbalance are already appearing at a young age. Overall, these patterns highlight the pressing need for early lifestyle change and school-based interventions which focus on physical activity, balanced nutrition, and overall health to potentially prevent detrimental metabolic syndrome symptoms later in life (WHO Regional Office of Africa, 2014).

**Table 2.** Frequencies and percentages of students with abnormal lipid and BMI levels

| Category | f/% |
|---|---|
| Abnormal in 0 category | 118(28.71) |
| Abnormal in 1 category | 206(50.12) |
| Abnormal in 2 categories | 83(20.20) |
| Abnormal in 3 categories | 3(0.73) |
| Abnormal in 4 categories | 1(0.24) |
| Abnormal in 5 categories | 0(.00) |
| Total | 411(100) |

**Sex, Lipid Profiles, and BMI**

To address the second research question, the researchers examined whether there were significant differences in the mean scores in lipid profiles and BMI levels between male and female students. **Table 3** presents BMI data on the frequencies and conditional percentages of students who were thin, underweight, normal, overweight, or obese. Overall, 52.73% of the students were underweight, 5.60% overweight or obese, and 64.72% in the normal category. Additionally, the data in Table 3 revealed that a higher percentage of females (76.39%) had BMI scores in the normal category than males (58.43%). However, more females (8.33%) were either overweight or obese than males (4.11%), whereas more males (37.45%) were underweight than females (15.28%).

The prevalence of overweight/obesity in the present study (5.60%) is lower than the 16.40% reported by Adom et al. (2019), but a higher percentage of females than males were overweight or obese. This finding is consistent with previous research on obesity in Ghana.

Most students (64.72%) fell within the normal BMI range, with a higher proportion of females (76.39%) than males (58.43%) classified as normal weight. Notably, a greater percentage of males compared to females were classified as thin or underweight. Conversely, being overweight and obese were slightly more common among females than males. These results suggest that undernutrition remains a significant concern, even as signs of overnutrition begin to emerge, which reflects Ghana's nutritional transition.

Males exhibited elevated early dyslipidemia risk based upon higher TCHOL and LDL scores, which is supported by past research on similar adolescent (Al-Hazzaa et al., 2022). Conversely, females exhibited higher adiposity, in the form of higher BMI levels, which is supported by large-scale adolescent data (Wells, 2012) For the most part, HDL and TRIG levels were comparable across sexes, suggesting an overall similar lipid metabolism, apart from cholesterol subtypes.

**Table 3.** Frequencies and percentages for Sex and BMI

| Category | Male | Female | Overall |
|---|---|---|---|
| | f/% | f/% | |
| Thin | 35(13.11) | 9(6.25) | 44(10.71) |
| Underweight | 65(24.34) | 13(9.03) | 78(18.97) |
| Normal | 156(58.43) | 110(76.39) | 266(64.72) |
| Overweight | 10(3.74) | 9(6.25) | 19(4.63) |
| Obese | 1(0.37) | 3(2.08) | 4(0.97) |
| TOTAL | 267(100.00) | 144(100.00) | 411(100.00) |

**Table 4** presents data on the lipid and BMI levels in males and females. There were significant sex differences for TCHOL, LDL, and BMI. Males had higher TCHOL and LDL scores than females. Conversely, females had a higher BMI mean score than their male counterparts. However, the HDL and TRIG levels for males and females were similar.

**Table 4**. Independent t-Test for Sex, Lipid Profiles, and BMI

| Variable | Males | | Females | | t-value | p-value |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | t | p |
| TCHOL | 175.89 | 48.57 | 164.24 | 42.87 | 2.42 | .016* |
| HDL | 60.76 | 20.14 | 58.86 | 18.76 | .94 | .348 |
| LDL | 93.55 | 51.09 | 76.43 | 41.19 | 3.47 | .001** |
| TRIG | 103.01 | 51.11 | 102.67 | 45.70 | .06 | .947 |
| BMI | 19.94 | 2.69 | 21.41 | 3.09 | -5.00 | .000*** |

*p<0.05 level; **p<0.01 level; ***p<0.001 level

### Grade Level, Lipid Profiles, and BMI

To address the third research question, the researchers examined the effects of grade level on high school students' lipid profiles and BMI. **Table 5** presents data for grade level, mean scores, and standard deviations for lipid levels and BMI. The results indicated grade-level differences in LDL and BMI. Students in Grade 11 had higher LDL and BMI scores than those in Grade 10.

Grade-level comparisons revealed that Grade 11 students exhibited significantly greater LDL and BMI values compared to Grade 10. This trend offers support for older adolescent individuals at a higher risk for metabolic disorders, potentially associated with reduced physical activity, high caloric/poor nutrition intake, and/or overall health maintenance (Agyemang-Yeboah et al., 2019; Amponsem-Boateng et al., 2019).

**Table 5.** Independent t-Test for grade level, lipid profiles, and BMI

| Variable | Grade 10 | | Grade 11 | | t-value | p-value |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | t | p |
| TCHOL | 169.77 | 45.43 | 173.13 | 47.88 | -.719 | .473 |
| HDL | 60.42 | 19.36 | 59.71 | 19.89 | .361 | .718 |
| LDL | 77.13 | 43.11 | 94.72 | 50.96 | -3.679 | .000*** |
| TRIG | 98.67 | 47.46 | 105.78 | 50.50 | -1.438 | .151 |
| BMI | 19.91 | 2.43 | 20.81 | 3.09 | -3.171 | .002** |

**p< .01; ***p< .001

### Program, Lipid Profile, and BMI

To address the fourth research question, the researchers examined the effects of programs of study on high school students' lipid profiles and BMI. **Table 6** presents the One-Way ANOVA data for lipid and BMI mean scores for each program of study. Additionally, the data presents results from a Bonferroni follow-up test showing multiple comparisons of statistical significance (indicated by +).

The data revealed that students in the Science program had the highest mean TCHOL score, followed by those in the Technical Education program. The mean score for the Science students was significantly higher than that of the Business and Technical programs. The data for HDL did not show significant differences by program. Science students had the highest mean score for LDL. The Bonferroni follow-up test indicated a significant mean difference between Arts and Science. The Science students had a significantly higher LDL score than their counterparts in the Arts program. Home Economics students had the highest TRIG mean score, followed by the Agriculture students. Conversely, students in the Technical Education program had the lowest mean score, followed by students in the Science program. However, the significant mean differences were between Agric and Technical, and Home Economics and Technical. The mean score for Technical was significantly lower than that of both Agric and Home Economics.

Science students had the highest mean BMI score, followed by Business. The BMI mean score for the Science students was significantly higher than that of Agriculture Arts, Business, and Home Economics, but not Technical. Students in the Technical program had the lowest BMI means score, followed by Agriculture.

Science students exhibited the highest TCHOL, LDL, and BMI values, while Technical Education students exhibited the lowest TRIG and BMI values. These differences may be, at least partially, due to increased sedentary study time and increased dietary risk behaviors associated with academically intensive programs (Adom et al., 2019; Ofori-Asenso et al., 2016). According to Muthuri et al. (2014), school subjects like technical, vocational, or agriculture have practical hands-on activities that are likely

**Table 6.** One-Way ANOVA for Program, Lipid Profiles, and BMI

| Variable | Agriculture | Arts | Business | Home Economics | Science | Technical | F | p-value |
|---|---|---|---|---|---|---|---|---|
| | M/SD | M/SD | M/SD | M/SD | M/SD | M/SD | | |
| TCHOL | 180.30(53.08) | 164.18(41.43) | 150.23(40.36) | 165.51(45.65) | 183.94(39.98) | 183.70(51.48) | 4.90 | .000*** |
| HDL | 59.71(19.36) | 57.66(20.19) | 58.88(19.44) | 61.99(19.14) | 60.72(20.38) | 62.58(19.43) | .624 | .682 |
| LDL | 90.12(61.59) | 75.45(41.99) | 95.26(37.29) | 75.71(39.98) | 109.87(45.76) | 86.32(48.33) | 5.45 | .000*** |
| TRIG | 108.41(50.26) | 102.43(42.68) | 106.47(52.52) | 112.26(40.95) | 100.93(53.05) | 80.08(55.45) | 3.12 | .009** |
| BMI | 18.91(3.22) + | 20.61(2.42) + | 21.55(2.65) + | 21.37(2.69) + | 21.74(2.57) + | 18.74()2.11 | 16.36 | .000*** |

+Statistically significant difference
**p< .01; ***p< .001

to increase physical activity and reduce the incidence of obesity.

Overall, these results highlight the disproportionate blood lipid and BMI results for Ghanaian senior high school students. The need for targeted health initiatives is relevant across all programs, which should emphasize proper nutrition, increased physical activity, and regular health screenings for Ghanaian adolescents aimed at reducing risk for metabolic disease later in life.

This study measured the lipid and BMI levels of senior high school students. There is a need for further research to gain insight into the underlying factors that affect lipid and BMI levels among this group. First, future research should measure the students' mode of transport to and from school. Because some of the participants studied were day students, who commute to and from school daily, while others lived in boarding facilities in the school. Second, students' socioeconomic status would be a valuable variable in explaining the programmatic differences in lipid and BMI levels. Research shows that African parents in higher socioeconomic status would more likely direct their children to subjects like science and business, while those in the low-income bracket would guide their children to courses such as vocational and technical education (Donatus et al. 2023; Mwaa, 2016).

## CONCLUSION

The study investigated the lipid profiles and body mass index (BMI) levels among senior high school students in Ghana. A little over two-thirds of the participants were in the normal BMI category. Males had significantly higher TCHOL and LDL scores than females, while females had significantly higher BMI scores. There were significant program-level differences in TCHOL, LDL, TRIG, and BMI, with science students exhibiting the highest TCHOL, LDL, and BMI values, while Technical Education students exhibited the lowest TRIG and BMI values. There is the need for targeted health initiatives across all programs in senior high schools, emphasizing proper nutrition, increased physical activity, and regular health screenings for Ghanaian adolescents aimed at reducing risk for metabolic disease later in life.

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