Nutrient Intake Adequacy and Anthropometric Characteristics of In-School Female Adolescents in Abeokuta South Local Government Area, Ogun State

***[1]Popoola B.O., [1]Abdussalaam R.O., [1]Sanni S.A., [1]Onabanjo O.O., and [2]Shittu T.A.**

[1]Department of Nutrition and Dietetics, Federal University of Agriculture, Abeokuta, Ogun State, P.M.B 2240, Abeokuta, Nigeria.
[2] Department of Food Science and Technology, Federal University of Agriculture, Abeokuta, Ogun State, P.M.B 2240, Abeokuta, Nigeria.

***Corresponding author:** popoolabarakat@yahoo.com **Phone number:** 08160244877

ABSTRACT

Background: *The period of adolescence presents a second window of opportunity to lay a solid foundation for a healthy life, however, increased nutrient requirements during this life stage may heighten the risk of under-nutrition and micronutrient deficiencies.*
Objective: *This cross-sectional study assessed the nutrient intake adequacy and anthropometric characteristics of in-school female adolescents*
Methodology: *A multi-stage random sampling procedure was used to select 250 students from four public secondary schools in the study area. Anthropometric characteristics were measured using standard methods. Dietary intake was assessed using a 24-hour diet recall. Nutrient Adequacy Ratio (NAR) was evaluated by comparing respondents' intakes to the recommended dietary intake. Data were analysed using SPSS version 23, and the association between variables was tested at $p<0.05$.*
Results: *Two-third (66%) of the respondents were early adolescents, and in senior secondary classes (53.6%). Both the early and older adolescents had high intake of carbohydrate (77.3% and 74.6%) and fat (59.1% and 69.5%), but inadequate protein (48.5% and 72.9%), iron (33.0% and 83.1%), and calcium (100%) intake respectively.Eighty-four per cent of the adolescents had normal BMI-for-age, 4.0% were thin, and 56% had a waist-to-hip ratio greater than 0.8cm. Significant associations (X^2 = 27.5, p = 0.036) were found between Fathers' educational qualification and BMI-for-age z-scores of respondents. Significant association (X^2 = 14.381, p = 0.022) was also reported between energy intake adequacy and fathers' academic qualification.*
Conclusion: *Female adolescents showed nutrient inadequacies despite normal BMI-for-age. Interventions aimed at improving overall nutrient intake are recommended to address this*

Keywords: Nutrient intake adequacy, In-school female adolescents.

Doi: https://dx.doi.org/10.4314/njns.v47i1.10

INTRODUCTION

Adolescence is a time of rapid personal growth because of the physical, psychological, hormonal, cognitive, and social transformations that take place throughout this era, which cause changes in eating preferences (1). These alterations have a significant impact on the alarming prevalence of non-communicable diseases, such as obesity, hypercholesterolemia, and elevated blood sugar, which are growing public health concerns in developing nations and around the world (2). This era of life is connected with increased

socioeconomic pressures and schooling, which leads to meal skipping, increased intake of refined and quick foods, and decreased consumption of fruits and vegetables (3).

Adequate nutrition is the foundation for the maintenance of good health and the prevention of diseases across all stages of life (4). Menstruation is an integral part of the female reproductive cycle and indicates a girl's maturity from the time of puberty. Iron requirement increases sharply in girls during this life stage to meet increased needs related to menstruation. Poor diets providing insufficient iron may increase the girl-child's risk of developing iron-deficiency anaemia. Iron-deficiency anaemia is described as the most common micronutrient deficiency worldwide and accounts for 75% of all anaemia cases globally (5). Adolescent females who are iron-deficient experience impaired growth, decreased cognitive performance, and lowered immunological function (5)

Recent studies on the health of teenagers have shown that malnutrition is prevalent, especially in female adolescents (1). According to (3), undernutrition remains a public health problem among adolescents in Nigeria. Despite reported knowledge of good nutrition, almost half of the respondents (46.8%) were underweight (3). Existing literature from population-based surveys suggests that adolescents commonly fall short of dietary requirements for both specific nutrient intakes and general nutritional status (6, 7). Substantial evidence exists suggesting that catch-up growth can be achieved during the period of adolescence if sufficient nutrient is consumed (8). The adolescent period is therefore a second window of opportunity to lay a solid foundation for a healthy life. Adequate nutritional knowledge and its authentic sources can reduce adolescent malnutrition (9).

According to (10), there is a dearth of information in the literature regarding the nutritional health of teenage girls in Nigeria. Schools are potential settings for a diverse range of interventions targeting adolescents, and school-based interventions, such as school meals, have the potential for long-term, multisectoral impacts (8). Empirical data on the nutritional status of in-school adolescents is important to guide policy decisions and plan interventions. This study, therefore, aims to determine nutrient intake adequacy and anthropometric characteristics of in-school female adolescents in Abeokuta, Ogun State.

METHODS

Sampling procedure

This study employed a descriptive, cross-sectional study design. Respondents were apparently healthy female adolescents between 10 and 19 years of age attending public secondary schools in the study area.

This study was carried out in Abeokuta South Local Government Area of Ogun State. Abeokuta South is a Local Government Area (LGA) in Ogun State, Nigeria, with its headquarters situated at Ake Abeokuta, the state capital. It is an urban area with fifteen wards. The area comprises a mix of residential, educational, and commercial activities, making it a suitable choice for research involving Adolescents. According to a 2025 population estimate, Abeokuta South LGA has a population of approximately 446,985 residents (11).

The sample size was determined using $n = z^2 * p(1-p)/e^2$. With the prevalence of 16.7% according to (12), the calculated sample size was 213.7, and it was increased to 250 to account for attrition.

A multi-stage sampling technique was used for this study. The first stage involves a simple random selection of four public secondary schools from the list of 20 public secondary schools in the LGA, obtained from the state ministry of education. The second stage involves stratification by classes. Two classes were selected in each school, and 17, 16, 83, 80, 25, and 29 students were selected from JSS 1 – SSS 3, proportional to class size. The third stage involves simple random sampling of respondents in each class using random numbers generated in Excel. The class registers of female students were used as a sampling frame, which was sorted in ascending order of the generated random numbers, and the first *n* participants were selected.

Method of data collection

Participants were asked to fill out a pre-tested self-administered questionnaire to obtain information on socioeconomic and demographic characteristics of respondents.

Dietary intake assessment

Nutrient intake information was obtained from two non-consecutive 24-hour dietary recalls (a weekday and weekend) (13) and converted to nutrient intake using Nutrisurvey 2007, an international software that allows customization of food composition tables. All foods and beverages ingested in the 24 hours before the study were recalled by the respondents using standard household measures and food models, average

weight of each type of food and its equivalent was estimated to the nearest gram (13).

Weight and height measurement

The weights of respondents were measured using a calibrated SECA Model 880 digital weighing scale to the nearest 0.1kg while respondents had light clothes on with bare feet, and participants standing upright. Heights of respondents were measured using a standard SECA Model 213 stadiometer while respondents stood barefoot and upright to the nearest 0.1cm.

The weight and height were used to calculate the body mass index-for-age z-score (BAZ) using the WHO AnthroPlus software version 1.0.4. BMI-for-age > 2 Standard Deviations (SD) above the WHO growth standard median was considered obese; Overweight was defined as having a BMI > 1 SD above the median, whereas moderate thinness was described as having a BMI <-2 SD below the median, while severe thinness was described as having a BMI<-3 SD. A height-for-age index that was less than two standard deviations below the median was considered as moderate stunting, while height-for- age less than three standard deviations below the median was considered as severe stunting (14).

Waist circumference was measured using a non-elastic tape with the adolescents standing upright and relaxed. Measurements were taken by placing the measuring tape around the middle of the body, halfway between the bottom of the ribs and top of the hip bones, at the end of normal expiration to the nearest 0.1cm (15).

Hip circumference was measured using a non-elastic measuring tape by placing the measuring tape at the maximum extension of the buttocks with the adolescents standing upright to the nearest 0.1cm (15).

Waist-to-Hip Ratio (WHR) was calculated as the ratio of the respondent's waist circumference to the hip circumference. A WHR greater than 0.8 in females has been shown to predispose to complications arising from obesity (15).

Ethical approval

Ethical Approval was obtained from the Ogun State Ministry of Education (PL545/Vol.IV^{T3}/56), and permission was also obtained from the zonal education officers and principals of selected schools. Informed and written consent was obtained from the adolescents after thoroughly explaining the objective of the research.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 23 was used for data analysis. Data were descriptively summarised and presented using mean and standard deviation, frequencies and percentages. Chi-square tests were used to determine the associations between variables. P-values were considered significant at $p \leq 0.05$.

RESULTS

Socio-demographic characteristics of respondents

Table 1 provides data on the socio-demographic characteristics of the in-school female adolescents. Sixty-six percent were early adolescents (10-14 years), mainly of Yoruba descent (91.2%) and in senior secondary classes (53.6%). The highest level of education for most parents was secondary school (53.2% of mothers and 49.6% of fathers). The majority (87.2%) of them lived with their parents, and 78.4% acknowledged both parents as being responsible for their needs.

Nutrient intake adequacy of respondents

Tables 2 and 3 show the average nutrient intake of respondents compared to their RDA. Median value for energy and protein was below the RDA. Among early and older adolescents, only 16.7% and 6.8% were found to consume adequate calories, highlighting a significant gap in meeting daily energy needs. The majority (77.3%) of early adolescents and 86.4% of older ones had insufficient caloric intake. Despite this, a large proportion of both groups consumed excessive amounts of carbohydrates (77.3% and 74.6%) and fats (59.1% and 69.5%). In contrast, nearly half of the early adolescents (48.5%) and 72.9% of the older adolescents did not meet the recommended protein intake, pointing to a nutritional imbalance that may affect their growth and development.

Gross inadequacies in intake of vitamins and minerals were noted across both stages of adolescence, with greater than 80% recording inadequate consumption of vitamins A, B, C, and E, magnesium, and Phosphorus. None of the respondents met the recommended intake of potassium and calcium. Median intake for iron and zinc was slightly below recommendations among respondents; however, 83% of the older adolescents were observed to have inadequate iron intake.

Table 1: Socio-demographic characteristics of respondents

Variable	Frequency (250)	Percentage (%)
Age (years)		
10 – 14	165	66
15 – 19	85	34
Mean =13.84±1.88		
Ethnicity		
Yoruba	228	91.2
Igbo	5	2.0
Hausa	5	2.0
Others	12	4.8
School grade		
JSS 1-JSS 3	116	46.4
SSS1- SSS3	134	53.6
Mothers' educational qualification		
No education	8	3.2
Primary education	27	10.8
Secondary education	133	53.2
Tertiary education	82	32.8
Fathers' educational qualification		
No education	8	3.2
Primary education	22	8.8
Secondary education	124	49.6
Tertiary education	96	38.4
Family structure		
Monogamy	186	74.4
Polygamy	64	25.6
Respondent living with		
Parents	218	87.2
Grandparents	21	8.4
Relatives	11	4.4
Persons responsible for needs		
Both father and mother	196	78.4
Only my father	10	4.0
Only my mother	34	13.6
My uncle or aunt	5	2.0
My grandparents	3	1.2
My sister or brother	2	0.8

Table 2: Nutrient intake adequacy of early adolescents (10-14 years old)

Variables	Median	RDA	Inadequate (< 60% of RDA)	Adequate (60%-80% of RDA)	Excess intake (> 80% of RDA)
Energy (kcal)	770.02	1600.0	77.3	16.7	6.1
Protein (g)	22.28	34.0	48.5	16.7	34.8
Fat (g)	13.56	10.0	18.2	22.7	59.1
Carbohydrate (g)	129.56	130.0	19.7	3.0	77.3
Dietary fibre (g)	8.79	22.4	80.3	15.2	4.5
Vitamin A (μg)	187.18	600.0	83.3	12.1	4.5
Vitamin E (mg)	1.46	11.0	98.5	-	1.5
Vitamin B1 (mg)	0.32	0.9	84.8	6.1	9.1
Vitamin B2 (mg)	0.20	0.9	80.3	3.0	16.7
Vitamin B6 (mg)	0.37	1.0	81.8	18.2	-
Vitamin C (mg)	10.80	45.0	86.4	4.5	9.1

Table 2 contd.

Variables	Median	RDA	Inadequate (< 60% of RDA)	Adequate (60%-80% of RDA)	Excess intake (> 80% of RDA)
Sodium (mg)	544.99	2200.0	90.9	4.5	4.5
Potassium (mg)	634.40	4500.0	100	-	-
Calcium (mg)	94.59	1300.0	100	-	-
Magnesium (mg)	80.48	240	89.4	9.1	1.5
Phosphorus (mg)	441.73	1250.0	81.8	12.1	6.1
Iron (mg)	5.71	8.0	33.33	33.33	33.33
Zinc (mg)	6.52	8.0	37.9	18.2	43.9

RDA: Recommended Dietary Allowance (RDA) Institute of medicine (2006).

Table 3: Nutrient intake adequacy of older adolescents (15-19 years old)

Variables	Median	RDA	Inadequate (< 60% of RDA)	Adequate (60%-80% of RDA)	Excess intake (> 80% of RDA)
Energy (kcal)	688.35	1800.0	86.4	6.8	6.8
Protein (g)	19.92	46.0	72.9	8.5	18.6
Fat (g)	12.13	10.0	11.9	18.6	69.5
Carbohydrate (g)	115.81	130.0	15.3	10.2	74.6
Dietary fibre (g)	7.86	25.2	81.4	8.5	10.2
Vitamin A (μg)	167.33	700.0	86.4	6.8	6.8
Vitamin E (mg)	1.30	15.0	96.6	1.7	1.7
Vitamin B1 (mg)	0.28	1.0	93.2	5.1	1.7
Vitamin B2 (mg)	0.18	1.0	79.6	5.1	15.3
Vitamin B6 (mg)	0.33	1.2	84.7	10.2	5.1
Vitamin C (mg)	9.66	65.0	100	-	-
Sodium (mg)	487.19	2300.0	91.5	5.1	3.4
Potassium (mg)	567.11	4700.0	98.3	1.7	-
Calcium (mg)	84.56	1300.0	100	-	-
Magnesium (mg)	71.95	360	98.3	-	1.7
Phosphorus (mg)	394.87	1250.0	79.7	11.9	8.5
Iron (mg)	5.10	15.0	83.1	11.9	5.1
Zinc (mg)	5.82	9.0	40.7	18.6	40.7

RDA: Recommended Dietary Allowance (RDA) Institute of medicine (2006).

Anthropometric characteristics of respondents

Majority (84.4%) of respondents had normal BMIs for their age, however, 9.6% were stunted (Figure 1). Stunting was more common among the late adolescents (10.6%) than in early adolescents (9.1%). More than half (55.6%) of the respondents are at risk of complications from obesity, having a waist-to-hip ratio greater than 0.8 (Figure 2).

Association between socio demographic characteristics and energy and fat intake adequacy of respondents

Fathers' educational qualification was significantly associated with energy intake at (X^2 = 14.831, p= 0.022). Significant association was found between fat intake adequacy and mothers' educational qualification at (X^2 = 23.868, p=0.001); no significant associations were seen between other socio demographic characteristics and energy/fat intake adequacy (Table 4).

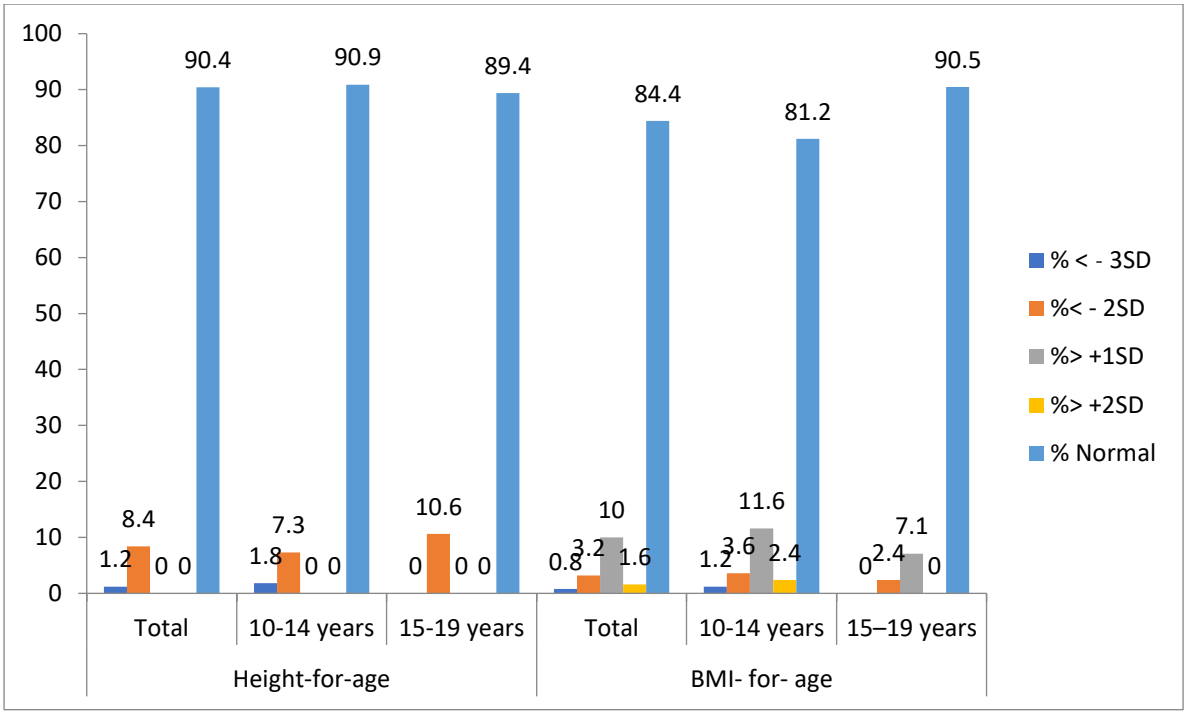

Figure 1: Anthropometric characteristics of respondents

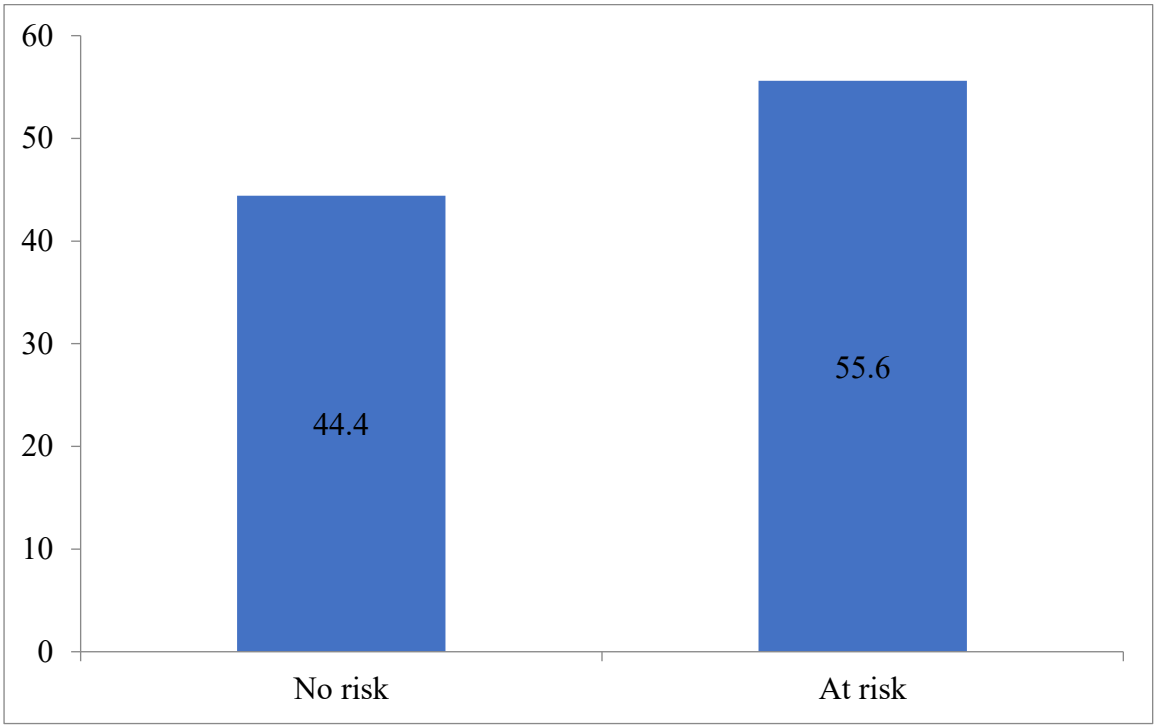

Figure 2: Waist-to-hip ratio of respondents

Table 4: Association between socio-demographic characteristics and energy and fat intake adequacy of respondents

	Energy intake adequacy				Fat intake adequacy			
Variable	Inadequate (%)	Adequate (%)	Excess (%)	X^2 (p-value)	Inadequate (%)	Adequate (%)	Excess (%)	X^2
Age group				1.723 (0.423)				1.728 (0.422)
10-14 years	23.29	30.14	46.57		6.8	2.7	90.4	
15-19 years	21.15	21.15	57.70		1.9	1.9	96.2	
Mothers education				5.476 (0.484)				23.868 (0.001)*
No education	50	50	-		-	50	50	
Primary education	25	-	75		-	-	100	
Secondary education	22.22	26.39	51.39		6.9	-	93.1	
Tertiary education	20.93	30.23	48.84		2.3	4.7	93	
Fathers education				14.831 (0.022)*				7.021 (0.319)
No education	-	100	-		-	-	100	
Primary education	18.18	36.36	45.45		-	9.1	90.9	
Secondary education	15.63	25	59.37		3.1	-	96.9	
Tertiary education	34.04	21.27	44.68		8.5	4.3	87.2	
Family structure				2.352 (0.671)				3.230 (0.520)
Monogamy	21.2	27.1	51.8		3.5	1.2	95.3	
Polygamy	25	25	50		7.5	5	87.5	
Mothers occupation				5.535 (0.477)				1.541(0.957)
Civil servant	25	31.2	43.8		6.2	-	93.8	
Trader	22.6	29	48.4		4.3	3.2	92.5	
Housewife	33.3	0	66.7		-	-	100	
Artisan	15.4	7.7	76.9		7.7	-	92.3	
Fathers occupation				11.684 (0.069)				9.042 (0.171)
Civil servant	18.5	44.4	13.7		7.4	-	92.6	
Trader	23.8	4.8	71.4		9.5	-	90.5	
Housewife	25.9	27.6	46.6		3.4	1.7	94.8	
Artisan	15.8	21.1	63.2		-	10.5	89.5	
Persons responsible for needs				7.804 (0.453)				3.883 (0.867)
Parent	21.1	26.3	52.6		5.3	2.1	92.6	
Only my father	50	16.7	33.33		16.7	-	83.3	
Only my mother	15	25	60		-	5	95	
Uncle or aunt	50	50	-		-	-	100	

*: indicates significant associations at $p \leq 0.05$

Association between socio-demographic characteristics and anthropometric characteristics of respondents

A significant association was discovered between "Persons responsible for need" (X^2 = 20.968, p = 0.002) and height - for -age z - score of respondents. Other socio-demographic characteristics do not significantly associate with the respondent's height-for-age z-score at p ≤ 0.05. (Table 5). A significant association was discovered between "fathers educational qualification" (X^2 = 27.500, p = 0.036) and BMI - for- age z- score of respondents. Other socio demographic characteristics do not significantly associate with BMI - for - age z -score of respondents at p ≤ 0.05.

Table 5: Association between socio-demographic characteristics and anthropometric characteristics of respondents

	Height-for-age z-score of respondents			BMI -for- age-z score of respondents				
Variable	**Stunting (%< -3SD)**	**Normal (%)**	**X^2 (p value)**	**Thinness (%)**	**Overweight (%)**	**Obesity (%)**	**Normal (%)**	**X^2 (p value)**
Age group			0.703 (0.145)					5.078 (0.279)
Total	9.6	90.4		4.0	10.0	1.6	84.4	
10-14 years	9.1	90.9		4.8	11.6	2.4	81.2	
15-19 years	10.6	89.4		2.4	7.1	-	90.5	
Mothers education			2.943 (0.400)					14.737 (0.256)
No education	-	3.54		-	12.5	-	87.5	
Primary education	4.17	11.50		-	11.11	-	88.89	
Secondary education	66.67	51.77		2.26	12.78	3.01	81.95	
Tertiary education	29.16	33.19		8.54	4.89		86.57	
Fathers education			2.279 (0.685)					27.5 (0.036)*
No education	4.17	3.10		12.5	-	-	87.5	
Primary education	16.67	7.96		-	13.64		86.36	
Secondary education	45.83	50		1.61	14.52	1.61	82.26	
Tertiary education	33.33	38.94		7.3	4.17	2.08	86.45	
Family structure			2.444 (0.295)					3.267 (0.917)
Monogamy	87.5	73		4.84	10.22	2.15	82.79	
Polygamy	12.5	27		1.56	9.38	-	89.06	
Mothers occupation			3.543 (0.617)					13.561 (0.852)
Civil servant	12.5	17.26		-	9.52	4.76	85.71	
Trader	66.67	69.91		5.17	10.92	0.58	83.33	
Housewife	-	2.21		-	20	-	80	
Artisan	20.83	10.62		3.45	3.45	3.45	89.65	
Fathers occupation			2.361 (0.670)					9.245 (0.903
Civil servant	12.5	22.57	22.57	5.56	11.11	-	83.33	
Trader	16.67	15.04	15.04	2.63	13.16	-	84.21	
Housewife	45.83	46.46	46.46	3.45	11.21	2.59	82.75	
Artisan	25	15.93	15.93	4.76	2.38	2.38	90.48	
Persons responsible for needs			20.968 (0.002)*					13.187 (0.963)
Parent	75	78.76		4.6	9.69	1.53	84.18	
Only my father	-	4.42		-	20	-	80	
Only my mother	16.67	13.27		2.94	8.82	2.94	85.29	
Uncle or aunt	-	2.21		-	-	-	100	
Grandparents	-	1.33		-	-	-	100	
Sister or brother	8.33	-	-	-	-	50	50	

*: indicates significant associations at p ≤ 0.05

DISCUSSION

This study sought to assess, nutrient intake adequacy and anthropometric characteristics of female adolescents. The prevalence of stunting in this study is consistent with the 10% reported in Abeokuta among female adolescents (19) but lower than the 22.9% reported by in a study among school going adolescent girls in Awash town, Afar region Ethiopia (1). The majority of participants had normal BMI-for-age. Prevalence rates for thinness, overweight, and obesity were comparable to earlier studies, such as 9.6% overweight in Northeastern Nigeria (10), and 13.4% overweight and 7% obesity in the Southwest (17). However, thinness was less prevalent than the 19.5% reported in Abeokuta by (15). More than half of the respondents are at risk of obesity, which is higher compared to 47.9% reported in a study across Geopolitical zones in Nigeria (18). Increased waist-to-hip ratio predisposes the individual to the risk of metabolic complications (15). The variations noted in this research can be linked to differences in geographical location, and the study area is in the urban part of the city, which can enhance access to information on adequate nutrition.

Most of the respondent had energy and protein intake less than RDA, fat and carbohydrate intake was above RDA in both age group i.e., young and older adolescents, this is in accordance with a study in Tanzania amidst boarding school adolescents where carbohydrate and fat intake was above RDA, energy intake below RDA but contrasts where protein was lesser than RDA (19) and previous study from Nigeria where excess intake of carbohydrates and fat was reported amidst adolescents (20). This disparity could be attributed to the inability of the adolescents to fully recollect foods consumed with their quantity, and also the difference in study setting, where they are day students, while the Tanzanian study was among boarding school students, where little or no input is required from adolescents in making food choices. Study location being in an urban area where students have unrestricted access to junks and fast foods can be a contributing factor to excess consumption of fat, as adverts for these foods are appealing and intriguing to this age group. High intake of fat during adolescence is linked with increased risks of overweight and obesity, thus increasing chances of nutrition-related diseases in the future (21).

Micronutrient inadequacy was noted among respondents of this study, this is similar to the findings of(16) where inadequacy was noted in micronutrients such as Vitamin A, B1, B2, C, calcium, phosphorus and potassium, however, Iron and zinc intake was found to be excess which contrasts with this study where inadequate intake was noted in both age groups, this is also in consonance with the study of (19) where micronutrient intakes were below RDA especially among females. Deficiency of micronutrient during adolescence can lead to impaired growth, delayed sexual maturation, and poor reproductive outcomes later in life, especially among females (22). Anaemia is caused by multiple factors, with iron deficiency being its major cause (23). Poor intake of iron in adolescents may be a result of changes in dietary habits and insufficient iron in the diet owing to poor bioavailability (24). It could also be a result of physiological changes in female adolescents (25).

Results of this study should be considered in light of some limitations, such as the recruited respondents being from a geopolitical zone and not adequate to represent the nation's female adolescent, biochemical samples were also not taken to corroborate the nutrient inadequacy found from dietary intake. There is a need for wide investigations capturing all geopolitical zones to further have a better representation of the nutrient adequacy of in-school female adolescents.

Macro and micro nutrient inadequacy exists in this study, especially for energy, protein, iron, calcium, and zinc. This study has further corroborated previous research where micronutrient inadequacy is on the increase among adolescents, especially females; this calls for urgent public health intervention targeted at this age group. Although the majority of the respondents in this study had normal BMI for age, with low prevalence of overweight and obesity, excess consumption of fat could increase the risk of overweight and obesity, as predicted by WHR.

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