NUTRITIONAL STATUS, DETERMINANTS, AND CONSUMPTION OF IRON AND FOLATE-RICH FOODS AMONG FEMALE ADOLESCENTS IN SELECTED SCHOOLS OF ZARIA LGA, KADUNA STATE

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ABSTRACT

Adolescent girls face challenges in meeting their nutritional needs due to biological, cultural, and economic factors, including inadequate intake, and also face a wide range of nutritional disparities across different socio-economic statuses. The current study assesses the nutritional status, determinants, and consumption patterns of micronutrient-rich food among female adolescents in selected schools. Exactly 318 healthy adolescent girls were recruited as the study participants. A validated semi-structured questionnaire (SSQ) was used to collect data on socio-economic and demographic characteristics, and determinants, while a food frequency questionnaire (FFQ) was used for food consumption patterns. Body Mass Index for-age z-score (BAZ) was used to evaluate the nutritional status of the adolescent girls. The result of the study found most private school adolescent girls to belong to small (36%), nuclear (62%), and monogamous (64%) families with higher weekly food expenditure (69%) compared to their public school's counterparts. The findings also suggest private school girls have more consistent access to heme sources of iron such as meat (36%), poultry (28%), and seafood (28%), than public school girls. Similar trends were also observed in the adolescent girls' consumption of legumes, fruits, and vegetables, which are good sources of iron and folate. Adolescent girls from public schools reported lower awareness, consumption, and access to iron- and folate-rich foods, with higher percentage (65.41%) being underweight compared to girls from private schools. Finally, private school girls consume higher iron and folate-rich diets, indicating socioeconomic factors impacting access and quality, resulting in higher undernourishment rates among public school girls.

Keywords: Nutritional status, Iron, Folate, Consumption, Adolescent girls

INTRODUCTION

Historically, adolescence has been recognized as a phase of significant change, which could be physical, social, cognitive, or hormonal (Gillespie *et al*., 2023). Recently, these changes are linked to a heightened requirement for nutrients such as iron and folate to support physical growth, cognitive development, and immune function (U.S. Department of Health and Human Services, 2018). Adolescents, particularly in developing countries, are vulnerable to nutritional deficiencies, leading to long-term health consequences, including undernourishment in future generations (Norris *et al*., 2022). Specifically, adolescent girls are more at risk due to societal and biological factors, including early marriage, early pregnancy, blood loss during menarche, and limited access to nutrient-rich food. In many regions, girls may suffer from iron deficiency anaemia and other micronutrient deficiencies due to inadequate intake (Beal *et al*., 2017; Sari *et al*., 2022; Wiafe *et al*., 2023).

Furthermore, cultural and economic factors influence dietary patterns, such as the increased reliance on low-cost, nutrient-poor foods among lower-income families, thereby exacerbating malnutrition (Madjdian *et al*., 2018; Wiafe *et al*., 2023). Several researches emphasize the dual burden of malnutrition in developing countries, where adolescents face both undernutrition and the rising prevalence of obesity due to urbanization and lifestyle changes (Caleyachetty *et al*., 2018; Liu *et al*., 2022; Wrottesley *et al*., 2023). Addressing these issues in adolescents, especially girls, is crucial for national development as it promotes healthier future generations.

Adolescent girls have specific nutritional needs, particularly for iron, and are at an increased risk of iron deficiency and anaemia (Mwangi *et al*., 2021; Wiafe *et al*., 2023). Globally, data on the prevalence of anaemia among adolescents does not exist (WHO, 2024), while the prevalence of anaemia in non-pregnant women of reproductive age (15 to 49 years) is 29.9% (WHO, 2021). There is also no accurate data on the prevalence of anaemia among adolescent girls, especially iron deficiency anaemia, in Nigeria and Africa (Mwangi *et al*., 2021). Furthermore, the prevalence of overweight and obesity is increasing among adolescents in low and middle-income countries (LMICs), therefore masking the undernourishment of adolescent girls (Irache *et al*., 2022). The situation subjects them to further nutritional insults as society fails to recognize them as malnourished. Therefore, they could enter into marriage, become pregnant, and suffer a double burden of iron demands. Hence, the current study aimed to assess the nutritional status, determinants, and consumption pattern of Iron and Folate-rich foods among female adolescents in selected public and private schools in Zaria LGA.

MATERIALS AND METHODS

Chemical, Reagents and Equipment

Measurement tools used were calibrated to zero to avoid error. Equipemnts used for the study includes: Adult height measuring device (stadiometer), UNICEF SECA electronic weighing device, marker, questionnaires, hand gloves, and writing materials.

Study Design and Sampling

The study employed a descriptive, cross-sectional research design. The schools were selected by convenience sampling, while simple random sampling technique was used to select participants. The selected schools were Baba Ahmad College

(a private school) and Sheik Ibrahim Arab Secondary School (a public school).

Study Population
The study was conducted on apparently healthy female adolescents aged 10-18 years attending secondary schools, who consent to participate.

Exclusion Criteria
Pregnant adolescents, adolescents treated for infectious diseases such as tuberculosis, malaria, etc, and those who did not give consent.

Study Area
The research was conducted in selected public and private secondary schools in Zaria LGA, Kaduna State. The local government is one of the four LGAs comprising the Zaria metropolis, Kaduna State Nigeria.

Sample Size Calculation
The sample size was determined using Biswas's (2013) formula, which factors in a 95% confidence level, an estimated anaemia prevalence of 29.9% among women of reproductive age (WHO, 2021), and a margin of error of 5%. The calculated sample size was 322. Adding 5% non-response, the sample size (n) was 338 adolescent girls.

$$n = \frac{z^2 pq}{d^2}$$

Data Collection Methods
Data on socio-economic and demographic information, knowledge of nutrients in food, and dietary practices were collected using a semi-structured questionnaire, while food frequency questionnaire (FFQ) was used for food consumption pattern. The anthropometric variables; weight, height, and age of the adolescents were measured and recorded immediately.

Weight and Height Measurement
Weight was measured using an electronic scale calibrated every 30 minutes, while height was recorded with a stadiometer, following protocols from the Food and Nutrition Technical Assistance (FANTA) guide.

BMI-for-age z-Score (BAZ)
Body mass index-for-age z-score was calculated using WHO Anthro-plus Software (2006). The calculated BAZ was used to assess the nutritional status of the adolescents using WHO categorization standards.

Statistical Analysis
Data was analyzed using SPSS version 22.0 and WHO Anthro-plus Software (2006). BMI-for-age z-score (BAZ) of the adolescent were gotten from their weight, height, and age. Descriptive statistics were applied, and significance was set at $p \leq 0.05$ were necessary.

RESULTS AND DISCUSSION
Socio-Demographic Characteristics of Adolescent Girls
The results on Table 1 shows that private school adolescent girls often come from smaller (36%), nuclear (62%), and monogamous (64%) families with higher weekly food budgets (69%). Public school girls, however, are more likely to belong to larger (52%), extended (60%) families with more limited food budgets. These findings suggest differences in socioeconomic status and family structure between the two groups.

The result of the current study aligns with findings from Madjdian *et al*. (2018), and Mwangi *et al*. (2021), which highlight the impact of socioeconomic disparities on dietary diversity and micronutrient deficiencies in adolescents. Studies have shown that low-income individuals are less likely to consume a balanced diet, often resorting to energy-dense, nutrient-poor foods diet. (Darmon and Drewnowski, 2008; Fisher *et al*. 2022). Beal *et al*. (2017) and Waziri *et al* (2025) emphasize the impact of economic and cultural factors in dietary micronutrient supplies. Thus, prepositioned that families with higher income (adolescent girls from private schools) are better positioned to meet minimum dietary diversity compared to larger, resource-poor families. Wiafe *et al*. (2023) argues that socio-economic factors often outweigh cultural ones in determining nutritional outcomes in adolescents. The disparity in food expenditure could explain the higher risk of inadequate intake among public school adolescent girls, as observed by Irache *et al*. (2022), and Wrottesley *et al*. (2023), where limited food budgets correlate with higher prevalence of anaemia and poor dietary quality. Acharya *et al.* (2025) also reported that average households spent less than what's required for a nutritionally adequate diet, which led to reliance on energy-dense but nutrient-poor foods, contributing to iron and vitamin deficiencies.

Table 1: Socio-Demographic Characteristics of Adolescent girls in Selected Public and Private School of Zaria LGA

Variable	Public n(%)	Private
Age		
10 – 14 years	57(36)	131(82)
15 – 19 years	102(64)	28(18)
Ethnicity		
Hausa	147(92)	140(88)
Fulani	12(8)	18(11)
Nupe	0(0)	1(1)
Religion		
Islam	159(100)	159(100)
Christianity	0(0)	0(0)
Marital status		
Single	157(99)	159(100)
Married	2(1)	0(0)
Age at marriage		
10 – 14 years	0(0)	0(0)
15 – 19 years	2(100)	0(0)

Variable	Public n(%)	Private
Type of family		
Nuclear	63(40)	98(62)
Extended	96(60)	61(38)
Family settings		
Monogamy	77(48)	101(64)
Polygamy	82(52)	58(36)
Family size		
2 to 4	25(16)	57(36)
5 to 9	54(34)	53(33)
>10	80(50)	49(31)
Food expenditure/ week		
<#1000	14(9)	0(0)
#1000 to #2999	80(50)	0(0)
#3000 to #4999	29(18)	50(31)
>#5000	36(23)	109(69)

Food consumption pattern of iron and folate-rich foods

Table 2 shows the frequency of consumption of iron- and folate-rich diet among adolescent girls in public and private schools. Private school girls show a higher frequency of consumption across most food categories, including heme iron sources like meat, poultry, and seafood. For instance, 36% of private school girls consume meat 1-3 times daily, while only 7% of public-school girls do the same. Similar trends are seen with poultry and seafood, where private school girls have higher regular intake rates. This corresponds with findings from Beal *et al*. (2017), and Wiafe *et al*. (2023), which highlight the limited access to heme-rich foods faced by adolescents from low-income earning background. Poor diets among adolescent girls especially high junk food intake—displace nutrient-rich foods, increasing anemia risk. (Soans et al. 2025) Limited awareness and affordability were major barriers to healthy eating. Thus, putting public school adolescents at greater risk of iron-deficiency anaemia, as emphasized by Mwangi *et al*. (2021).

For non-heme iron sources, both groups reported frequent consumption of grains, though private school adolescent girls

again have higher intake for legumes, fruits, and vegetables. The consistency in grains consumption reflects its role as staple foods in LMICs, as noted by Liu *et al*. (2022). While 44% of private school girls consume fruits daily, only 21% of public-school girls do so. This trend extends to dairy, with 45% of private school girls consuming it daily, compared to 28% in public schools who "never" consume it. These findings suggest that private school girls have more consistent access to a diverse diet, which is critical for micronutrient (like folate) intake and plays a vital role in adolescent growth and development, as emphasized by Norris *et al*. (2022). Public school girls however had lower dietary diversity, consumed fewer animal proteins, fruits, and vegetables, and were more prone to micronutrient deficiencies, especially iron. (Abubakar *et al*. 2024). They exhibit lower consumption rates in various food groups, highlighting a potential gap in dietary access and nutritional quality that exacerbates risks of iron-deficiency anaemia as highlighted by Sari *et al*. (2022) and further supported by Irache *et al*. (2022).

Table 2: Consumption of Iron- and Folate-rich Foods Among Secondary School Adolescents in Zaria LGA

Food group	School type	Frequency of consumption				
		1-3 times daily	1-3 times weekly	4 or more times weekly	4 or more times monthly	Never
Heme sources						
Meat	Public	11(7)	25(16)	34(21)	61(38)	28(17)
	Private	58(36)	32(20)	40(25)	23(15)	6(4)
Poultry	Public	3(2)	29(18)	25(16)	52(33)	50(32)
	Private	45(28)	43(27)	46(29)	21(13)	4(3)
Sea food	Public	8(5)	23(14)	22(14)	36(23)	70(44)
	Private	45(28)	33(21)	53(33)	20(13)	8(5)
Non-heme sources						
Grains	Public	83(52.2)	15(9.4)	61(38.4)	0(0)	0(0)
	Private	88(55)	6(4)	65(41)	0(0)	0(0)
Legumes	Public	44(28)	46(29)	31(19)	30(19)	8(5)
	Private	70(44)	17(11)	64(40)	8(5)	0(0)
Fruits	Public	33(21)	45(28)	40(25)	39(25)	2(1)
	Private	70(44)	25(16)	52(33)	12(7)	0(0)
Vegetable	Public	56(35)	36(23)	47(30)	17(11)	3(1)
	Private	96(60)	12(8)	51(32)	0(0)	0(0)
Dairy	Public	29(18)	26(16)	27(17)	33(21)	44(28)
	Private	71(45)	21(13)	43(27)	17(11)	7(4)

Table 3 shows the knowledge, consumption, and accessibility of micronutrient-rich foods by adolescent girls attending public and private schools in Zaria LGA, Kaduna State. The assessment results show that adolescent girls from private schools have a higher awareness (87%) of the importance of micronutrients compared to those from public schools. The greater awareness among private school adolescent girls reflects better health education and access to resources, as noted by Norris *et al*. (2022). Adolescent girls from private schools also reported sound knowledge (77%) of iron- and folate-rich foods, and good adherence to recommended dietary practices when compared with their public school counterparts. This is consistent with findings from Gillespie *et al*. (2023), which highlight the role of limited nutritional awareness in perpetuating micronutrient deficiencies among adolescents. Abubakar *et al*. (2024) also reported poor nutrition knowledge among adolescents in Nigeria contributes to meal skipping, low fruit and vegetable intake, and reliance on starchy staples. This results in widespread deficiencies in iron, zinc, calcium, and vitamins A, C, and D. Inadequate fruit and vegetable consumption among public school adolescent girls undermines their intake of minerals and vitamins such as folate and vitamin C, which are critical for reducing risk of anaemia, as discussed Madjdian *et al*. (2018) and Caleyachetty *et al*. (2018). The economic access of iron- and folate-rich is poor among public school adolescent girls, which is indicated by the higher frequency of self-buying practice. This supports findings from Wiafe *et al*. (2023), which empasize that financial constraints and competing households priorities often hamper access to nutrient-rich foods in LMICs.

Table 3: Knowledge, Consumption and Accessibility of Foods Rich in Micronutrients by Adolescent Girls in Selected Public and Private School, Zaria LGA

Variable	Public n(%)	Private
Awareness of the importance of micronutrients in the body		
Yes	126(79)	138(87)
No	33(21)	21(13)
Knowledge of obtaining iron and folate from food		
Yes	58(36)	122(77)
No	101(64)	37(23)
Knowledge of foods rich in iron and folate		
Yes	68(43)	124(78)
No	91(57)	35(22)
Daily Fruit Consumption		
Yes	64(40)	114(72)
No	95(60)	45(28)
Daily Vegetable Consumption		
Yes	84(53)	124(78)
No	75(47)	35(22)
Obtaining foods rich in iron and folate		
Parent/Guardians	132(83)	148(93)
Self-buying	27(17)	11(7)

Table 4 indicates the deworming status of school adolescent girls in Zaria LGA. The result shows private school girls to have slightly higher deworming coverage (53.46%) compared to public school girls (49.69%). However, nearly half of both groups remain uncovered, indicating significant gaps in deworming practices. Families of public schools adolescent girls may face challenges accessing healthcare services due to financial constraints while those of private schools may deprioritize routine deworming in the absence of immediate symptoms, reflecting findings by Sari *et al*. (2022). Other factors such as poor funding, logistics challenges, etc were highlighted by Caleyachetty *et al*. (2018), Irache *et al*. (2022), and Madjdian *et al*. (2018).

It is important to know whether deworming, and more specifically mass deworming can reduce parasite load, improve the nutritional status and other health outcomes of menstruating adolescent girls and adult women living in areas endemic for soil-transmitted helminths. (Tanjong Ghogomu et al. 2018; WHO, 2015). Among public school girls, a majority (53.46%) were dewormed within the past year, compared to 39.62% of private school girls. Overall, public school adolescent girls follow a stricter schedule for the deworming regimen of between 0 to 2 years, while over 32% of private school adolescent girls extend beyond 2 years. These stricter deworming schedules may be explained by WHO (2021) recommendation on annual or biannual deworming for school-age children in areas of high parasite prevalence. Also, Beal *et al*. (2017) noted that private schools may not prioritize public health interventions due to poor program delivery or over-reliance on parents to initiate preventive care. This gap is compounded by assumptions within private education settings that parents will initiate preventive care such as deworming, yet without coordinated school involvement, adolescent girls—particularly those nearing reproductive age—remain underserved. (Kuponiyi *et al*., 2016; WHO, 2022).

Table 4: Deworming Status of Adolescent girls in Public and Private School of Zaria LGA

Variables	Public n(%)	Private
Deworming status		
Yes	79(49.69)	85(53.46)
No	80(50.31)	74(46.54)
Time of last Deworming		
0 to 1 year	85(53.46)	63(39.62)
1 to 2 years	74(46.54)	45(28.30)
Above 2 years	0(0.00)	51(32.08)

Figure 1, represent the frequency distribution of weight status based on the BAZ of the adolescent girls in Zaria LGA. In public schools, 65.41% of girls are classified as underweight (below the 5th percentile), indicating a significant prevalence of insufficient weight. In contrast, no private school girls fall into the underweight category, highlighting a healthier weight status in this group. This high prevalence of underweight among public school adolescents aligns with findings of Liu *et al*. (2022), and Madjdian *et al*. (2018), which highlight socioeconomic challenges such poverty, and food insecurity, that are common among this group of adolescent girls, to contribute significantly to undernutrition in low-resource settings. In a similar finding in Uyo Nigeria, Public school girls had a higher prevalence of underweight (43.4%) compared to private school girls, with socioeconomic status and school resources playing a major role in nutritional disparities. (Udoh and Iyanam, 2016). Other findings that supported the current findings include Beal *et al*. (2017), and Caleyachetty *et al*. (2018).

Conversely, despite a higher prevalence of normal weight among private school adolescent girls compared to their public school counterparts. There is a slight prevalence of overnutrition (overweight and obesity; 6.92%) among private school adolescent girls. The trend of overnutrition among private school adolescents may result from increased consumption of high calorie, and low-nutrient foods, as highlighted by Caleyachetty *et al*. (2018), and Gillespie *et al*. (2023). Private school girls tend to have better nutritional outcomes, but may face rising risks of overweight and obesity. (Opara *et al.* 2010)
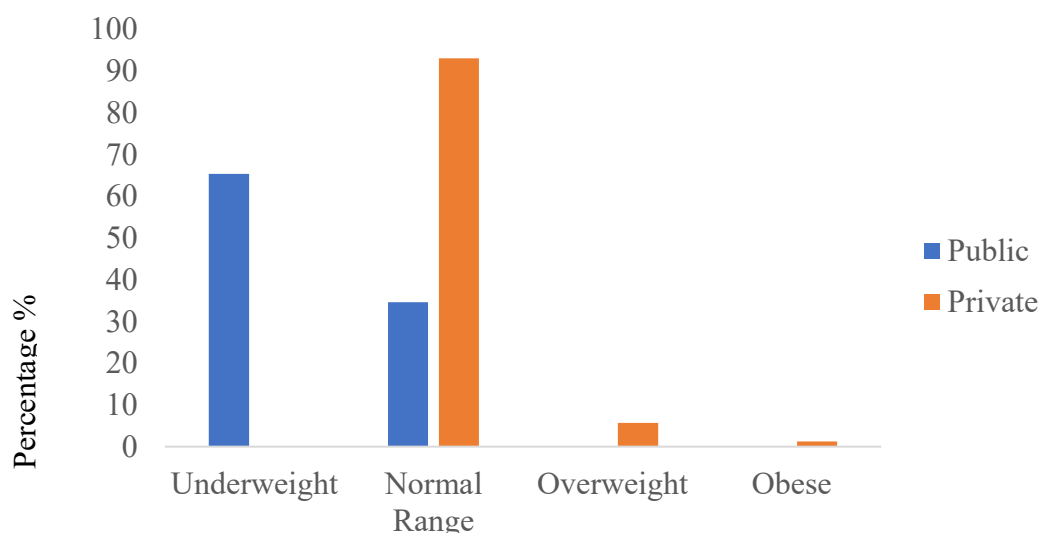

Figure 1: Frequency Distribution of Weight Status of Adolescent girls in Public and Private school

CONCLUSION

The frequency of consumption of iron- and folate-rich diets is markedly higher among private school adolescent girls, reflecting the influence of socioeconomic characteristics on dietary access and quality, resulting in higher undernourishment rates among public school girls.

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