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Health Interventions in Adolescents: The Combined Effects of Iron-Folic Acid Supplementation and Deworming on Micronutrient Status of Adolescent Girls in Abuja, Nigeria

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Abstract

Purpose: This study assessed the combined effects of iron-folic acid supplementation and deworming on the micronutrient status of adolescent girls in a Government Secondary School, Abuja, Nigeria.

Materials and Methods: A quasi-experimental design was employed, and a total of 67 adolescents who met the inclusion criteria were recruited for the study. The adolescent girls were given weekly iron-folic acid containing 60 mg of elemental iron and 0.04 mg of folic acid for 12 weeks. A one-off deworming tablet (400 mg of Albendazole) was administered a week prior to the commencement of the weekly iron-folate intervention. Baseline data of heamoglobin (Hb), iron and folate level were collected. Malaria and parasitological tests were also conducted. End-line assessment of anaemia, serum ferritin, serum folate and parasitology test was conducted after the 12-week to determine the effect of the weekly iron-folic acid intervention on the adolescents. Statistical analysis of frequencies, mean, percentages, paired sample t-test and correlations, was carried out using IBM-SPSS, version 22. Differences were inferred to be significant at p<0.05.

Findings: The adolescents were within the age-range of 10-14 years (64.2%) and 15-19 years (35.8%). Worm infestation was low (7.5%), while prevalence of anaemia was 17.5% at baseline. After the 12 weeks intervention, all the subjects had normal Hb level. At baseline, a total of 7.5% and 2.5% of the subjects had deficient serum ferritin and folate levels, respectively. However, at the end of the intervention 100% of the adolescents were free from worm infestation and had normal level of serum ferritin and folate level. Malaria status significantly correlated with Hb, ferritin and folate status ($p < 0.05$).

Implications to Theory, Practice, and Policy: The findings reinforce the effectiveness of school-based iron-folic acid supplementation and deworming programs in improving micronutrient status and eliminating worm infestation among adolescents. These results support the need for routine implementation of similar interventions in schools to address micronutrient deficiencies and anaemia in low-resource settings. Policymakers should integrate such programs into national adolescent health strategies, ensuring adequate funding and sustainability to optimize adolescent health outcomes.

Keywords: *Adolescents, Micronutrient Supplementation, Iron, Folic Acid, Deworming*

JEL Code: *I12, I18, J13*

INTRODUCTION

Adolescence was defined by WHO as the period between ages 10 and 19 years. This is a critical period of growth and development bridging childhood and adulthood (WHO, 2017). It is marked by increased nutrient needs to support rapid growth and development, particularly for energy and micronutrients like vitamin A, vitamin D, calcium, iron, and zinc (Das et al., 2017). Iron is especially crucial during adolescence, as iron (IDA) is the leading cause of disability-adjusted life years (DALYs) loss among adolescent girls globally (WHO, 2017). IDA often results from insufficient iron intake, poor dietary bioavailability, parasitic infections, diseases, and excessive menstrual blood loss. The onset of mensuration (menarche) further escalates the need for iron and other micronutrients essential for growing bone and muscle mass.

Despite the high prevalence of anemia, there is a paucity of data on adolescent's' nutritional status particular regarding iron (Owolabi et al., 2015). This data gap complicates the formulation of effective interventions strategies. In Nigeria, adolescents constitute approximately 23% of the population with 20% in the Federal Capital Territory (National Population Commission, 2020). Malnourished adolescent girls are at higher risk of giving birth to low-birth-weight children, perpetuating the cycle of malnutrition (FGoN & IITA, 2024). A recent survey indicated that about 21% of adolescents aged 10 - 14 years are stunted and 15% are thin. Additionally, 14.1% of women of reproductive age (15-49 years) are thin, highlighting the intergenerational cycle of malnutrition (FGoN & IITA, 2024). According to FGoN & IITA, (2024) 41% of adolescents aged 10 -14 years have anemia, with the prevalence increasing to 55% among women age 15 - 49 years and 86% among pregnant women in the same age group. This classification is based on WHO cut-off values for anemia, which define mild anemia in adolescent girls as Hb 11.0–11.9 g/dL, moderate anemia as Hb 8.0–10.9 g/dL, and severe anemia as Hb <8.0 g/dL (WHO, 2011).

Early marriage and child bearing are prevalent among Nigeria adolescents, particularly in the Northern regions, with approximately 19% of adolescent females (15 -19 years) having begun childbearing (NDHS, 2018). Adolescent pregnancy increases the risk of anemia due to higher iron demands for fetal growth, increased blood volume, and the risk of inadequate maternal nutrition before and during pregnancy. Repeated pregnancies at a young age, short birth intervals, and insufficient prenatal care further exacerbate iron deficiency and anemia risk (Eze et al., 2024). Complications from pregnancy and childbirth have been reported among the leading causes of death for adolescent girls aged 15-19 years in Africa (UNICEF, 2012). Investment in adolescent health and nutrition is essential for achieving the Sustainable Development Goals (SDGs) by 2030. These goals include ending of forms of malnutrition and addressing the nutritional needs of adolescent girls, pregnant and lactating women and older persons (United Nations Sustainable Development Goals). One of the six World Health Assembly (WHA) global national targets is a 50% reduction in anemia among women of reproductive age (WHO, 2017). Given the high susceptibility of adolescents to anemia, achieving this target necessitates targeted strategies for adolescent girls. The consequences of malnutrition especially anaemia warrant urgent public health action. In the Federal Capital Territory (FCT), there is a paucity of data on the prevalence of anaemia and its associated factors among adolescents. Expanding health and nutrition intervention for adolescent girls before conception is therefore crucial.

Despite the critical importance of adolescence as a period of growth and development, this age-group is often overlooked and underfunded in health and nutrition interventions. Existing policies and interventions have traditionally focused on the first 1,000 days of life, with less attention to adolescents. During surveys and data collection, adolescent girls aged 15-19 years are frequently grouped with women of reproductive age (15-49 years), masking their specific needs (NDHS, 2018). Anemia in adolescents has significant implications, including reduced physical and mental capacity and impaired educational performances. Prolonged untreated anemia can lead to severe complications such as heart failure and poor immunity (Melkam et al., 2015). These issues pose a threat to future safe motherhood, emphasizing the need for interventions to address the root cause of anaemia. The WHO recommends weekly iron folic acid (IFA) supplementation to prevent iron deficiency and improve pre-conception iron reserves and folate status in adolescent and women, particularly where the prevalence of anemia exceeds 20% and food fortification programs are insufficient (WHO, 2018). Although Nigeria mandates the fortification of wheat and maize flour with iron and folic acid, consumption levels of fortified flour remain low (FMOH, 2022). In light of this assessing the effects of iron folic acid supplementation (IFAS) and deworming on the nutritional status of adolescent girls in Abuja, Nigeria, becomes imperative.

Adolescent anemia and micronutrient deficiencies remain significant public health concerns in Nigeria (Ibeanu et al., 2020, 2022), particularly among adolescent girls who experience increased nutritional demands due to rapid growth and menstrual losses. While previous studies have highlighted the high prevalence of anemia among adolescents, data specific to the FCT, Abuja, are limited. The existing national surveys often group adolescents (15-19 years) with women of reproductive age (15-49 years), masking their distinct nutritional needs. Again, while iron-folic acid supplementation and deworming programs have been implemented in various settings, there is limited evidence on their combined impact on the micronutrient status of adolescent girls in Nigeria. This study addresses these gaps by evaluating the effects of a school-based weekly iron-folic acid supplementation program combined with deworming on adolescent girls in Abuja. By providing evidence on the effectiveness of such interventions, the study will inform policies aimed at improving adolescent nutrition and preventing anemia-related complications. The beneficiaries of this study include adolescent girls, policymakers, school health programs, and public health practitioners seeking effective strategies to address adolescent malnutrition.

The Health Belief Model (HBM) (Rosenstock, 1974) provides a strong theoretical foundation for this study by explaining the factors that influence adolescent girls' adherence to iron-folic acid supplementation and deworming interventions. The HBM suggests that individuals are more likely to adopt health-promoting behaviors when they perceive themselves as susceptible to a health risk, recognize the severity of its consequences, and understand the benefits of taking preventive action while minimizing perceived barriers. In the context of this study, adolescent girls may be more likely to adhere to supplementation and deworming if they perceive a high risk of anemia and its effects, such as fatigue, poor academic performance, and pregnancy complications. Recognizing the benefits of supplementation such as improved iron stores, better health outcomes, and enhanced cognitive function can motivate adherence. However, potential barriers, including fear of side effects, misconceptions about supplementation, or lack of access to resources, could hinder compliance. The model also highlights the importance of cues to action, such as school-based health education and peer influence, which can encourage uptake, while self-efficacy, the belief in one's ability to follow through with supplementation plays a critical role in sustained adherence. The application of HBM in this study reinforces the need for structured health interventions that not only provide supplementation but also address awareness, accessibility, and behavioral reinforcement to optimize adolescent health outcomes.

MATERIALS AND METHODS

Study Area

The study was carried out in FCT, Nigeria. FCT has a rapid population growth, which is facilitated by the expansion of satellite towns in the suburban areas. It is located at latitude 9.07°N with a population of 3,100,000 (NPC, 2020). Abuja the capital of Nigeria is a cosmopolitan city with diverse ethnic groups including Hausa, Gbagi, Igbo, Yoruba, Edo and other ethnic nationals and internationals. The residents of FCT consist of civil servants, private sectors, international NGO workers, business owners, teachers, traders, farmers, engineers etc. The indigenous people of FCT are Gbagi, whose primary occupations are farming and trading. The FCT has a total of 223 government secondary schools. Of which only three are girls-only secondary schools.

Study Design

The study adopted a quasi-experimental design.

Study Population

The population of the study consist of all the female adolescent` enrolled in two hundred and twenty-three (223) government secondary school in the FCT.

Sample Size and Sampling Techniques

The study purposively used girls-only secondary schools because adolescent girls are more susceptible to iron deficiency and anaemia than boys. The three girls-only schools (Abaji Government Girls Secondary School, Government Secondary School Dutse and Government Girls Science Secondary School Kuje) were initially considered.

Before the study commenced, the Government School Management Board was visited to seek approval. While Government Secondary School Dutse and Government Girls Science Secondary School Kuje were cleared by the relevant regulatory board, Abaji Government Girls Secondary School was not approved due to security concerns. Subsequently, the school authorities of the two approved schools were visited for preliminary discussions about the study. However, final approval to commence the study was granted only by Government Girls Science Secondary School Kuje.

There were 759 students enrolled in Government Girls Science Secondary School Kuje. Only 67 students who met the inclusion criteria and gave consent were recruited for the study. Others were excluded due to illness, pregnancy, inability to ascertain their age, absence during the research team's visit, or unwillingness to participate in the study.

Ethics Approval and Consent to Participate

Ethical approval for the study was obtained from the Federal Capital Territory, Health Research Ethics Committee. Written informed consent was obtained from the adolescent girls. Neither the students nor teachers were paid to participate in the study as participation was voluntary. The study was conducted in accordance with the ethical standards stated in the most recent version of the Declaration of Helsinki.

Recruitment and Training of Research Assistants

Three research assistants were recruited based on their proficiency in English and previous experience in data collection. They underwent a one-day training on the study protocol.

Nutrition Intervention

A single-dose deworming tablet, Albendazole (400 mg), was administered to the adolescents to control helminth infections. Deworming was conducted one week before the commencement of the WIFAS intervention. The adolescent girls received weekly iron-folic acid supplementation (WIFAS) for 12 weeks. A "fixed-day" approach was adopted for supplement distribution, which was on Fridays. This day was designated as "Nutrition Day." On this day, the adolescents received nutrition education and counseling.

Before administering the supplements, a baseline assessment was conducted to collect data on the adolescents' nutritional status, including anthropometric measurements, hemoglobin levels, ferritin levels, and folate status. An endline assessment was then carried out after the supplementation period to evaluate the impact of the WIFAS intervention. Class teachers were trained to supervise the ingestion of the IFA tablets, while each class identified a focal adolescent girl responsible for maintaining attendance records and tracking compliance. The adolescents were educated on possible side effects, such as nausea and stomach discomfort, along with strategies to mitigate them. The supplementation regimen followed WHO (2018) guidelines, using a single tablet containing 60 mg of elemental iron and 400 µg (0.04 mg) of folic acid, intended for adolescent girls and non-pregnant, non-lactating women in Nigeria.

Methods of Data Collection

Data was collected using questionnaires, anthropometric measurements, biochemical analysis, and dietary assessment. A validated and pre-tested questionnaire was used to collect background information and food consumption patterns of the adolescents. Data on their nutrition knowledge, including awareness of iron-rich and iron-fortified foods, consumption of foods that enhance or inhibit the absorption of non-heme iron from plant-based sources, and the special dietary needs of adolescents, were also gathered.

Adolescent girls who provided consent for the study were assembled in classrooms. The questionnaires were distributed for self-completion, while the researcher monitored the process to further make clarifications where necessary. Upon completion, the questionnaires were retrieved, and anthropometric measurements of height and weight were conducted.

Anthropometric Measurements

Weight was measured with minimal clothing using a SECA 881 U electronic personal scale (Seca GmbH & Co., Hamburg, Germany). Participants were instructed to empty their bladders before weighing. The scale was calibrated daily, and weight was measured twice. A third measurement was taken if the difference between the first two readings exceeded 0.2 kg. In this case, the mean of the two closest readings was used for analysis.

Height was measured using a wall-mounted lightweight portable tape. Participants stood with feet parallel, heels, buttocks, shoulders, and the back of the head touching the vertical surface. The head was positioned comfortably straight, arms hanging naturally at the sides. The measurement was taken to the nearest 0.1 cm by lowering the headpiece until it touched the top of the head. Height was measured twice, with a third measurement taken if the difference between the first two exceeded 0.5 cm. The mean of the closest two readings was used for analysis.

Body Mass Index (BMI) was calculated using the formula:

$$BMI = \frac{\text{Weight (kg)}}{Height\ (m)^2}$$

The BMI values were used to assess the adolescents' nutritional status, considering their age, and were compared against the WHO Growth Standards (WHO, 2017).

Biochemical Analysis

Biochemical analysis of haemoglobin concentration (Razavi et al., 2015), serum ferritin levels (WHO, 2020), and serum folate levels (O'Broin & Kelleher, 1992) and were conducted. These biochemical tests were performed at baseline (before supplementation) and at endline (after the weekly iron-folic acid supplementation).

Stool Sample Collection and Parasitological Analysis

Eligible students were provided with labeled sterile plain bottles for stool sample collection. Upon receipt, the samples were immediately suspended in a saline solution. The stool samples were examined for helminthic infections within one hour of staining, using a modified formol-ether and ethyl acetate concentration technique (Allen & Ridley, 1970). Helminths observed under the microscope were recorded as positive for worm infestation.

Parasitological test was conducted before and after the supplementation to assess the presence of helminthic infections and determine the effect of the deworming intervention on worm infestation among the adolescents.

Dietary Intake Assessment

Adolescents' dietary intake was assessed using weighed food intake method. The weighed food intake was conducted over three days (two weekdays and one weekend) to capture variations in consumption patterns. Nutrient intake was estimated using food composition tables and compared with the recommended nutrient intake (RNI) standards (FAO, 2018).

Statistical Analysis

Data analysis was conducted using IBM SPSS Statistics, version 22. Descriptive statistics, including frequencies, percentages, and means, were used to summarize the data. Inferential statistics were applied to assess differences between baseline and endline measurements. Paired sample t-tests were used to evaluate changes in haemoglobin, serum ferritin, and serum folate levels before and after the intervention. Correlation analysis was performed to explore relationships between malaria status and other variables. Statistical significance was set at $p < 0.05$, and percentage differences were computed to assess changes over time.

FINDINGS

Table 1 presents the background information of the adolescent girls. Most (64.2%) were aged 10–14 years, while 35.8% were 15–19 years old. The ethnic group distribution included Hausa (4.5%), Yoruba (10.4%), Igbo (29.8%), Fulani (1.5%), and other northern tribes (53.7%). On menstruation, 19.4% began at ages 9–11 years, 67.2% at 12–14 years, while 13.4% had not yet started menstruating. Menstrual duration was 2–4 days for 49.3% and 5–7 days for 29.8%, while 6.0% had periods lasting less than two days and 3.0% reported durations beyond seven days. Sanitary pad use varied, with 55.2% changing pads 3–4 times daily, 30.0% changing 1–2 times, and 2.9% changing 5 times or more daily.

Table 1: Background Information of the Adolescent Girls

Variables		Frequency	Percentage
Age range	10-14 years	43	64.2
	15-19 years	24	35.8
	Total	**67**	**100.0**
Ethnic group	Hausa	3	4.5
	Yoruba	7	10.4
	Igbo	20	29.8
	Fulani	1	1.5
	Others (Igala, Ebira, Nupe etc.)	36	53.7
	Total	**67**	**100.0**
Age menstruation started	9-11 years	13	19.4
	12-14 years	45	67.2
	Not yet started	9	13.4
	Total	**67**	**100.0**
Frequency of times sanitary pad was changed in a day	Not yet started	8	11.9
	1-2 times	20	30.0
	3-4 times	37	55.2
	5 times and above	2	2.9
	Total	**67**	**100.0**
Frequency of days menstruation last	Not yet started	8	11.9
	Less than 2days	4	6.0
	2-4 days	33	49.3
	5-7 days	20	29.8
	Above 7days	2	3.0
	Total	**67**	**100.0**

Table 2 presents the iron/folic acid supplementation (IFAS) and deworming tablet intake among adolescent girls. IFAS use was reported by 67.2%, while 20.9% had not taken it, and 11.9% were unsure. Among users, 44.8% took IFAS the previous month, 4.5% the previous year, and 17.9% could not recall. Sources included health clinics (31.3%), pharmacies (10.4%), and school clinics (20.9%), with 4.5% taking it routinely at home. Deworming tablets were taken by 94.0% of the girls, with 40.3% having taken them in the past month, 22.4% within 3–6 months, and 17.9% unsure. The sources of deworming tablets included hospitals/health clinics (37.3%), pharmacies (37.3%), school clinics (14.9%), and routine supplementation (6.0%).

Table 2: Iron/Folic Acid Supplementation and Intake of Deworming Tablet

	Variables	Frequency	Percentage
Taken iron/folic acid supplementation	Yes	45	67.2
	No	14	20.9
	Not sure	8	11.9
	Total	**67**	**100.0**
Date IFAS was taken last	Previous month before the study	30	44.8
	Previous year before the study	3	4.5
	Can't remember	12	17.9
	Didn't take IFAS	22	32.8
	Total	**67**	**100.0**
Place IFAS was obtained	Hospital/health clinic	21	31.3
	Pharmacy	7	10.4
	School clinic	14	20.9
	Routine supplementation	3	4.5
	Didn't take IFAS	22	32.8
	Total	**67**	**100.0**
Taken deworming tablets	Yes	63	94.0
	Didn't take deworming tablet	4	6.0
	Total	**67**	**100.0**
Last time deworming tablet was taken	Previous month	27	40.3
	3-6 months before the study	15	22.4
	Previous year before the study	9	13.5
	Can't remember	12	17.9
	Didn't take deworming tablet	4	6.0
	Total	**67**	**100.0**
Place deworming tablet was gotten	Hospital/health clinic	25	37.3
	Pharmacy	25	37.3
	School clinic	10	14.9
	Routine supplementation	4	6.0
	Didn't take deworming tablet	3	4.5
	Total	**67**	**100.0**

IFAS = iron/folic acid supplementation

Figure 1 illustrates the nutrition knowledge of adolescent girls, revealing that 33.3% had good knowledge, while 65.0% and 1.6% had moderate and poor knowledge, respectively. Regarding their understanding of anaemia, 55.2% correctly identified it as a lack of blood or low iron levels, while 44.8% did not. Most participants (70.4%) recognized poor iron intake as a cause of anaemia, though 29.6% disagreed. A total of 35.1% linked anaemia to blood loss, whereas 64.9% did not. Majority (82.1%) dismissed worm or blood parasite infestation as a cause, while 17.6% acknowledged it as a potential factor.

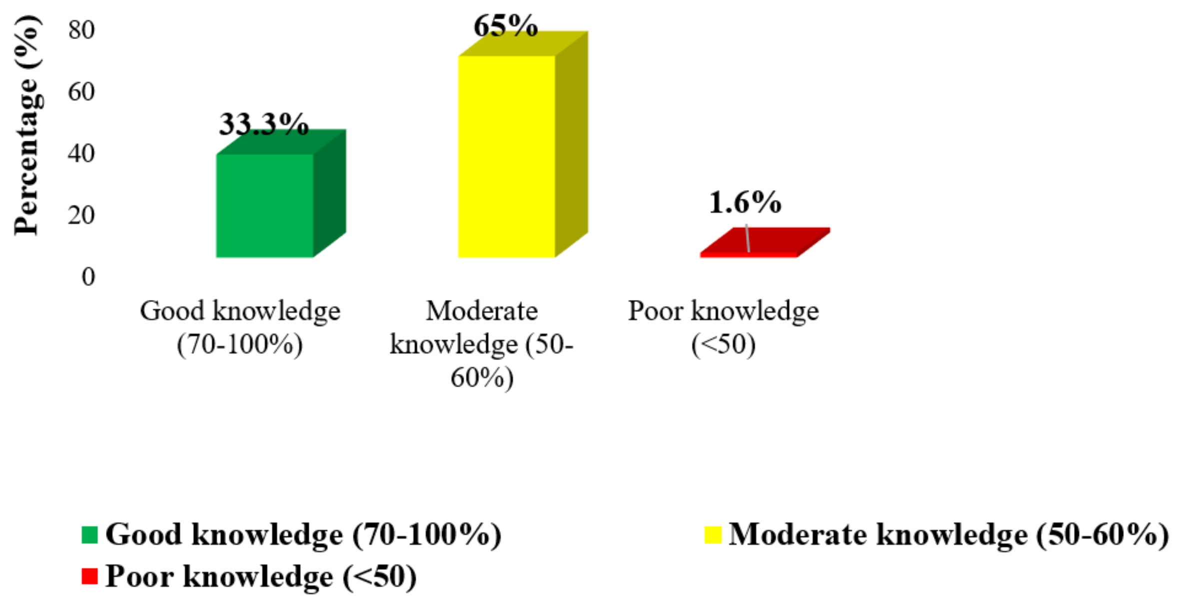

Figure 1: Nutrition Knowledge of the Participants

Table 3 presents the vitamin and mineral intake of adolescent girls as a percentage of FAO/WHO recommendations. Across both age groups (10–14 and 15–19 years), nutrient intake varied, with folate, vitamin A, thiamin, and calcium meeting approximately 80–90% of the recommended values. However, vitamin C intake was notably low, contributing only 30–35% of the requirement, while zinc intake was the lowest at 54.2% and 68.1% for younger and older adolescents, respectively.

Table 3: Vitamins and Mineral Intake of the Adolescent Girls as a Percentage Contribution to Fao/Who Requirements.

Age/ Freq.	Nutrients	Folate (µg/day)	Vitamin C (mg)	Niacin (mg)	Thiamin (mg)	Vitamin B_{12}	Vitamin A (RE)	Selenium (µg/day)	Iron (mg)	Calcium (mg)	Zinc (mg)
10-14	Mean intake	330.5	11.84	10.20	1.0	2.0	505.0	20.0	20.5	1070.0	3.9
	SD±	5.21	1.34	0.47	0.02	0.05	11.46	2.45	2.47	21.89	0.10
(21)	Requirement	400.0	40.0	16.0	1.1	2.4	600.0	26.0	27.7	1300.0	7.2
	Intake as per % requirement	83.0	30.0	64.0	91.0	83.3	84.1	77.0	74.0	82.3	54.2
15-19	Mean intake	350.0	13.98	12.1	1.05	2.2	543.0	21.5	22.1	1005.0	4.9
	SD±	4.92	2.09	2.03	0.04	0.10	13.54	2.66	2.91	14.78	1.21
(19)	Requirement	400.0	40.0	16.0	1.1	2.4	600.0	26.0	25.8	1300.0	7.2
	Intake as per % requirement	87.5	35.0	76.0	95.5	77.0	90.5	83.0	86.0	77.3	68.1
10-19	Mean intake	340.25	12.91	11.15	1.025	2.1	524	20.75	21.3	1037.5	4.4
(40)	SD Mean ±	5.065	1.715	1.25	0.03	0.075	12.5	2.555	2.69	18.335	0.655
	Requirement	400	40	16	1.1	2.4	600	26	26.75	1300	7.2
	% Mean intake requirement	85.25	32.5	70	93.25	80.15	87.3	80	80	79.8	61.15

(Figures in parenthesis show the number of subjects in each age group). FAO/WHO (1998).

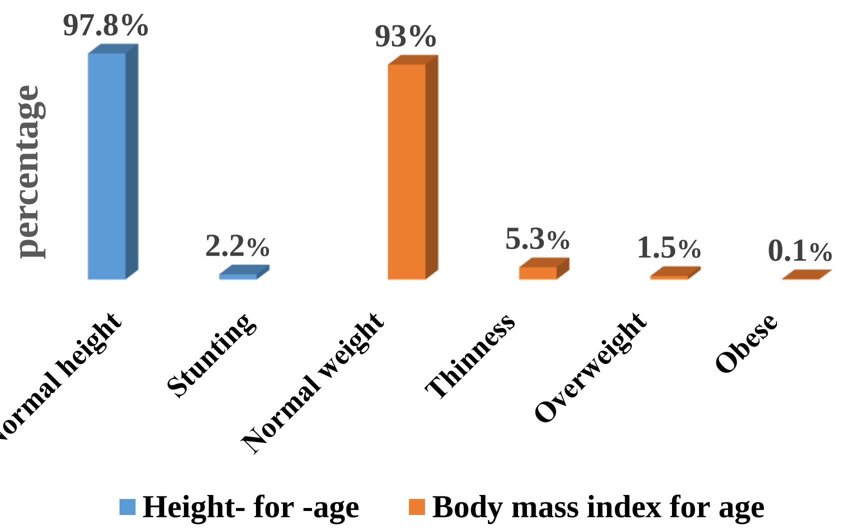

Figure 2: Anthropometric Status of the Adolescent Girls

Figure 2 shows the anthropometric status of the adolescent girls. The majority (97.8%) of the adolescent girls had a normal height for their age, while 2.2% were stunted, with a mean height of 160.5 cm. In terms of BMI-for-age, 93.0% had a normal weight, 5.3% were classified as thin, 1.5% were overweight, and 0.1% were obese. The mean weight of the adolescent girls was 51.2kg.

The majority (85.0%) of the adolescent schoolgirls tested positive for malaria, while 15.0% had no malaria parasites (figure 3).

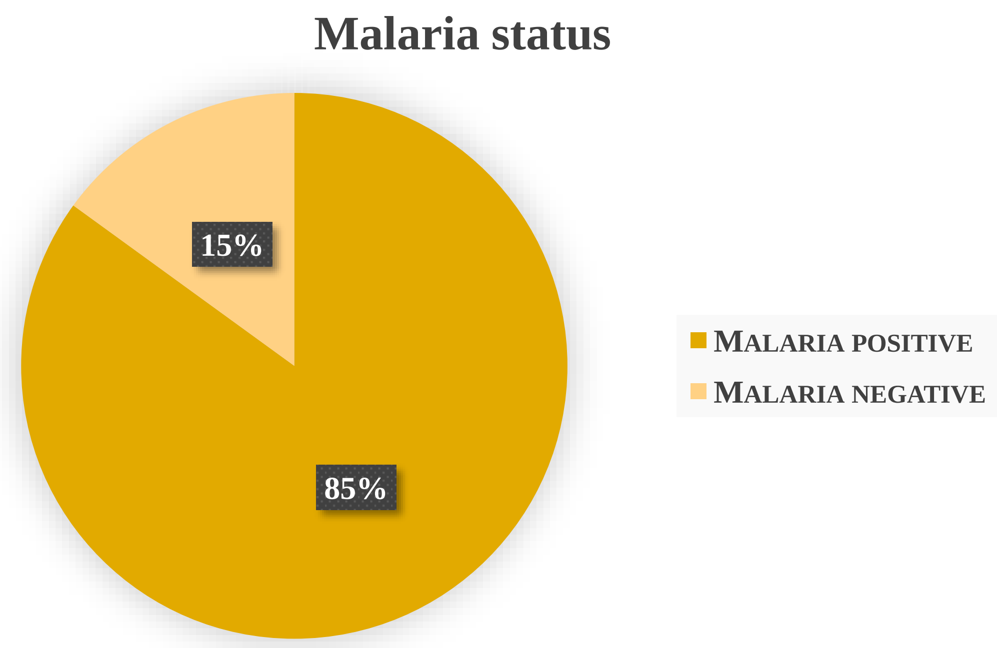

Figure 3: Malaria Status of the Adolescent Girls

Table 4 presents the serum haemoglobin, ferritin, and folate status of the participants at baseline and endline. At baseline, 82.5% had normal haemoglobin levels, while 10% had mild anaemia and 7.5% had moderate anaemia. By the endline, all participants (100%) had normal haemoglobin, with no cases of anaemia. Similarly, normal ferritin levels increased from 92.5% to 100%, while ferritin deficiency (7.5%) was eliminated. Folate levels also improved, with normal levels rising from 97.5% to 100%, and folate deficiency (2.5%) completely resolved. Worm infestation, present in 7.3% at baseline, was eliminated by the endline, with all participants being worm-free.

Table 4: Serum Haemoglobin, Ferritin, and Folate Status of the Participants

Variables		Baseline (%)	Endline (%)
Haemoglobin status	Normal	82.5	100
	Mild anaemia	10	0
	Moderate anaemia	7.5	0
Ferritin status	Normal	92.5	100
	Ferritin deficient	7.5	0
Folate status	Normal	97.5	100
	Folate deficient	2.5	0
Worm infestation	Worm present	7.3	0
	Worm not present	92.7	100

Table 5 presents the effect of weekly iron-folic acid supplementation on haemoglobin, serum ferritin, and serum folate levels among the adolescent girls. Haemoglobin levels increased from 12.55 ± 1.08 g/dL to 13.90 ± 0.79 g/dL, while serum ferritin rose from 68.06 ± 30.18 µg/mL to 96.19 ± 30.42 µg/mL. Serum folate levels also improved from 11.94 ± 4.81 ng/mL to 17.80 ± 7.00 ng/mL. These increases, with percentage changes of 10.76%, 41.33%, and 49.08%, respectively, were all statistically significant ($p < 0.001$).

Table 5: Effect of Weekly Iron-Folic Acid Supplementation on Serum Haemoglobin, Ferritin and Folate Status of the Adolescents

Variables	Baseline	End-line	MD	Std. error	t (p-value)	%D
Haemoglobin (g/dl)	12.55 ± 1.08	13.90 ± 0.79	-1.35± 0.75	0.12	-11.40 (0.000)	10.76
Serum ferritin (µg/ml)	68.06 ±30.18	96.19 ±30.42	-28.13± 17.63	2.79	-10.09 (0.000)	41.33
Serum folate (ng/ml)	11.94 ± 4.81	17.80 ± 7.00	-5.86 ± 3.64	0.57	-10.20 (0.000)	49.08

MD = mean difference; Std. error = standard error; DF = degree of freedom; t = t-test; %D = percentage difference; P < 0.05 is significant.

Table 6 presents the correlation between malaria status, haemoglobin levels, serum ferritin, serum folate, and worm infestation among the adolescents. A statistically significant correlation was observed between malaria status and haemoglobin levels ($r = 0.542$, $p < 0.001$). Malaria status showed a significant negative correlation with serum ferritin ($r = -0.412$, $p = 0.008$), while a significant positive correlation was found between malaria status and serum folate levels ($r = 0.381$, $p = 0.015$). No significant correlation was observed between malaria status and worm infestation ($r = 0.120$, $p = 0.462$).

Table 6: Correlation between Malaria, Haemoglobin, Serum Ferritin, Serum Folate and Worm Infestation among the Adolescent Girls

(n = 40)	Malaria Status	Haemoglobin Status	Serum Ferritin Status	Serum Folate Status	Worm Status
Malaria status					
r	1	0.542**	-0.412**	0.381*	0.120
p-value		0.000	0.008	0.015	0.462

** = correlation is significant at 0.01: * = correlation is significant at 0.05: r = Pearson correlation: n = number of sample

FINDINGS

The study revealed that greater number of the adolescents were within the 10-14 years age range, a critical period for the catch-up growth and development as reported by Georgiadis & Penny (2017). Regarding menarcheal age, most (67%) of the adolescent girls started mensuration between 12-14 years, aligning with previous studies (Goon et al., 2010; Kabiru et al., 2019) that reported a mean menarcheal age of 13-14 years among adolescent girls. WHO recommended intermittent (once a week) IFA supplementation for at least three months or could be given throughout the school calendar year as a public health intervention in menstruating adolescents and women (WHO, 2011). However, the irregular intake of iron-folic acid supplements observed in this study may have contributed to the recorded cases of anaemia.

Lack of adequate nutrition knowledge and awareness of iron deficiency anaemia has been identified as a major contributing factor to malnutrition and anaemia among adolescents (Tiyuri et al., 2017; Agustina et al., 2021). In the present study, only 33.3% of the adolescent girls had good nutrition knowledge. This is consistent with Pederson et al. (2012), who reported that 34.8% of adolescents in Abuja municipal area had good knowledge of nutrition. Similarly, Essien et al. (2014) found that only 29% of adolescents in Sokoto, Nigeria, had good nutrition knowledge.

Interestingly, despite a high deworming rate (94%) among the adolescents, a significant proportion (82.1%) were unaware that worm infestation could cause anaemia. This highlights a critical knowledge gap and underscores the urgent need for comprehensive nutrition and health education interventions for adolescents in the study area. Effective health education programs have been shown to enhance nutritional knowledge and encourage healthy eating habits and lifestyles (Kameshwary et al., 2020).

The dietary intake assessment showed that the mean daily intake of folate and iron met approximately 80% of the FAO/WHO recommendations, while vitamin C intake met only 32.5%. These findings on dietary intake indicate that while most micronutrient intakes were fairly adequate, certain nutrients, particularly vitamin C and zinc, may require dietary improvements to meet recommended levels. Given that vitamin C enhances iron absorption, its inadequate intake likely contributed to the suboptimal iron status observed in the study.

The prevalence of stunting (2.2%) in the present study was significantly lower than the 21% stunting rate reported by the National Food Consumption and Micronutrients Survey (FGoN & IITA, 2024) for adolescent girls aged 10–14 years. Majority (93.0%) of the adolescents had normal BMI-for-age, while 5.3% were thin, this is lower (23.4%) compared to that reported among adolescent girls in Ibadan (Omobuwa et al., 2014) and 49.1% in Sokoto (Yusuf et al., 2021). The malnutrition prevalence in the present study was also lower than the 45.6% reported among adolescent girls aged 15–19 years in Bauchi State (Uba et al., 2020). One possible explanation for this disparity could be that the anthropometric assessment was conducted at the beginning of the school term, when students may have returned well-nourished. Regarding overweight and obesity, this study recorded a 1.5% and 0.1% prevalence of overweight and obesity, respectively which is lower than the national prevalence of 3.1% overweight and 1.1% obesity among adolescent girls aged 10–14 years (FGoN & IITA, 2024). Although the prevalence is low, it is important to implement strategies to prevent further increases in overweight and obesity to reduce the risk of diet-related non-communicable diseases (NCDs) such as diabetes and hypertension.

The prevalence of anemia was 17.5%, this rate was significantly lower than the 41.0% recorded among adolescent girls aged 10–14 years and the 55% among women of reproductive age (15–49 years) in Nigeria (FGoN & IITA, 2024). Gosdin et al. (2020) reported a similar anaemia prevalence (22%) among in-school adolescents in Nigeria, confirming that anaemia remains a public health concern among adolescent girls. After 12 weeks of iron-folic acid supplementation, all (100%) adolescent girls achieved normal haemoglobin levels. This is consistent with findings from Warner et al. (2020), which showed a rapid rise in haemoglobin levels after 14 days of iron supplementation, with a minimum of three months needed to restore iron stores. This result also aligns with findings from Aguayo, Paintal & Singh (2013) in India, where anaemia prevalence declined by 30% in pilot regions and by 5–24% during national scale-up following IFA supplementation. All adolescent girls had normal levels of serum ferritin and serum folate after 12 weeks of supplementation, similar to findings from Handiso et al. (2020), where no adolescent girls had depleted iron stores or folate deficiency at the end of an iron-folic acid supplementation program. Likewise, E-Siong et al. (1999) observed a significant increase in mean plasma ferritin levels after weekly iron-folic acid supplementation.

Worm infestation is a major contributor to anaemia, as it leads to the destruction of red blood cells and iron loss. In this study, deworming effectively eradicated parasitic infections, reinforcing the effectiveness of deworming interventions in anaemia prevention. Weekly iron-folic acid supplementation (WIFAS) combined with biannual deworming has been recognized as a cost-effective strategy for anaemia prevention in adolescent girls (Vir et al., 2008). The significant improvements observed in haemoglobin, serum ferritin, and serum folate concentrations further confirm the effectiveness of this intervention, in line with previous studies (Joshi & Gumashta, 2013; Handiso et al., 2021).

Adolescent girls undergo intense physical, psychological, and emotional changes during their transition to adulthood. However, nutritional deficiencies during adolescence can have long-term consequences, affecting growth, cognitive development, and overall health. Ensuring adequate nutrition during adolescence is important for promoting optimal health and well-being. With the onset of menstruation iron requirements double, yet the local diet which predominantly contains non-heme iron, is insufficient to meet these demands. This deficiency contributes to the high anaemia prevalence among adolescent girls.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Weekly iron-folic acid supplementation and biannual deworming are effective strategies for improving haemoglobin levels, serum ferritin, and serum folate concentrations. A significant knowledge deficient was observed regarding the relationship between worm infestation and anaemia, despite the high deworming rate. The study also highlighted the need for improved dietary intake of vitamin C, which plays a crucial role in iron absorption. Continuous monitoring and intervention are necessary to sustain and improve adolescent health outcomes.

Recommendations

Comprehensive nutrition education should be integrated into school curricula to enhance awareness of anaemia, proper nutrition, and the benefits of supplementation and deworming. Efforts should be made to promote the consumption of vitamin C-rich foods to enhance iron absorption. Government and health agencies should incorporate these interventions into national policies, ensuring consistent funding, regular monitoring, and evaluation for long-term impact. Further research is needed to determine the extended benefits of these interventions on cognitive development and academic performance among adolescents.

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