Evaluation of Administration of Weekly Iron-Folic-Acid Supplements among In-School Adolescents in Zaria, Nigeria

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ABSTRACT

Background and Objectives: Anaemia is a serious public health issue and iron deficiency accounts for approximately half of the global burden. Adolescence encompasses a period of life with explicit health and developmental requirements; a period considered an opportunity to combat the intergenerational cycle of malnutrition.

Objective: The study was aimed at assessing the impact of weekly iron-folic-acid (IFA) supplements on haemoglobin levels among in-school adolescents in Zaria.

Methods: The study was a longitudinal design which involved 142 participants followed-up for a period of 12 weeks. Socio-demographic characteristics and haemoglobin levels of the participants was assessed before and after intervention. Focus-group-discussions were conducted among the participants to apprehend challenges/barriers to taking IFA supplements.

Results: The results indicated that the mean ± SD age of the adolescents was 17.5 ± 1.50 years, majority (80.3%) were female, 83.8% were Hausa and 93.7% were single. The results revealed that the major challenges/barriers to taking IFA supplements by the adolescents were lack of awareness, lack of encouragement, misinformation, phobia, unavailability and unaffordability of the IFA supplements. The prevalence of anaemia among the adolescents before intervention was found to be 76.8%, which reduced to 24.5% after the intervention; before intervention, the mean ± SD of haemoglobin concentration among the adolescents was 11.27 ± 1.33 g/dl which significantly ($p = 0.001$) increased to 12.60 ± 1.02 g/dl after intervention.

Conclusion: The study concluded that weekly IFA supplements for 12 weeks among the adolescents significantly increased their haemoglobin concentration and remarkably reduced the prevalence of anaemia among the adolescents. It is recommended that relevant stakeholders should initiate the weekly IFA supplementation among adolescents to reduce the consequences of anaemia and iron deficiency.

KEYWORDS:

- Adolescents;
- Anaemia;
- Iron-folic-acid supplements;
- Haemoglobin

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INTRODUCTION

Anaemia refers to a condition whereby the number of red blood cells (RBCs) or the level of haemoglobin within them is lower than normal which subsequently impairs the capacity of blood to transport oxygen to the body [1]. Anaemia is caused by various factors including deficiency of micronutrient (iron, folate,

and vitamins A and B12), chronic and parasitic infections, acute or chronic inflammation, blood loss and chronic diseases [2,3]. World Health Organisation (WHO) estimated that one-third of all women of reproductive age, equivalent to about 500 million women are anaemic worldwide [4]. In 2019, it was reported that among women of reproductive age in Nigeria, 55.1% were anaemic [5].

Iron deficiency occurs due to prolonged negative iron balance and the major causes include increased iron requirements (such as during periods of growth), inadequate iron intake, decreased iron absorption and chronic blood loss from menstrual bleeding or hookworm infection [6]. Globally, iron deficiency still remains the most common deficiency in women of reproductive age [7]. Anaemia and iron deficiency during adolescence causes irreversible adverse effects on cognitive, mental and growth improvement, work performance and physical capacity as well as serious impact throughout the reproductive years of life [8].

Intermittent iron-folic-acid (IFA) supplementation is recommended as a public health intervention for adolescent girls, living in settings where prevalence of anaemia is high (≥20%) among women to improve their haemoglobin concentrations and iron status and reduce the risk of anaemia and iron deficiency [9]. Oral iron intake is the first choice in the preventive treatment of iron deficiency/anaemia because of its low cost, safety and effectiveness [10]. Adolescence encompasses a period of life with explicit health and developmental requirements and time to develop knowledge and skills. This period has been considered to be a critical window and opportunity to combat the intergenerational cycle of malnutrition [11]. Approximately, the global population is comprised of 1.2 billion adolescents and high percentages are found in developing countries [12]. In order for adolescents to grow and develop in good health, they require adequate and effective health services, safe environments and prospects to develop essential life skills.

Adolescent are susceptible to anaemia because of increased iron needs to sustain their rapid growth and mental development as well as replenishment of iron loss due to menstruation for adolescent girls [13]. In Nigeria, the prevalence of anaemia among late adolescent-girls aged 15-19 years was 60.5%; while in Kaduna State, the prevalence among women (aged 15-49 years) was 44.0% [14]. Another study conducted in Ogun State among adolescents revealed that prevalence of anaemia and iron deficiency was 24.4% and 15.0% respectively [15]. Moreover, there are few studies on the prevalence of anaemia and low awareness on IFA supplementation among adolescents in the study area. This study therefore focused on assessing the impact of weekly IFA supplements on haemoglobin levels and anaemia status among adolescents as well as challenges and barriers to compliance with IFA supplements.

MATERIALS AND METHODS

Study design

The study was a school-based longitudinal cohort design in order to assess the impact of weekly IFA on haemoglobin levels and anaemia status among in-school adolescents in Zaria. The study involved 142 adolescents from public schools in Zaria; socio-demographic characteristics of the participants were assessed. Haemoglobin level (to assess anaemia) of the participants was determined before and after intervention. Similarly, focus group discussions (FGDs) were conducted among the participants before and after intervention; the FGDs focused on challenges/barriers to compliance with IFA supplements and eating behaviour among the participants.

All the participants were dewormed using a single dose of Albendazole (400 mg) immediately after the pre-assessment to eliminate potential source of variation among participants. The IFA supplements; [ferrous fumarate 200 mg equivalent to 65 mg of elemental iron, folic acid 1000 μg and vitamin B12 100 μg (Ferrolab-12)] was purchased and given to selected health masters/teachers in each selected school who distributed to the participants. The dose used was a single tablet of Ferrolab-12 supplement administered weekly for three consecutive months. All participants were also sensitized (in a form of 1.5 hours' workshop) on "Prevention and Control of Anaemia and Iron Deficiency" during the course of the study which comprised of meaning, sign and symptoms, causes, consequences, prevention and treatment of anaemia and iron deficiency as well as tips for healthy food choices that include iron-rich foods while taking note of enhancers and inhibitors

of iron absorption.

Study area

The study area was Zaria in Northern part of Kaduna State. Zaria is a major city and a local government area (L.G.A) in Kaduna State, Nigeria. It is bordered to the North by Sabon-Gari L.G.A., to the West by Giwa L.G.A., while to the East and South–East by Soba L.G.A. of Kaduna State respectively. It is located at 11o04'N 7o42'E with an estimated population of 749,000 [15]. Zaria, a zone of the Guinea savanna has an average yearly rainfall of 1200–1600 mm and a terrain made up of parklands with patchy grasses and native woody trees that are naturally slow-growing, drought-tolerant, and tire-resistant. The economy is primarily driven by agriculture producing staples such as guinea corn, sorghum, soybeans, millet and other crops like brown sugar, onions, baobab leaves and cowpeas, as well as animal rearing.

Study participants

All apparently healthy adolescents within the age of 15-19 years attending public secondary schools in Zaria as at the time of study were eligible for inclusion into the study. Adolescents who were sick in previous two weeks and those who refused to give consent or assent were excluded.

Sample Size

The sample size was calculated using a Windows based software package Sample Size Calculator (SSC) developed by the Health Services Research Unit at Aberdeen University [17]. Based on the following: Minimum difference detectable = 5; Standard deviation of haemoglobin levels in each group estimated at 10 g/dl; Significance level at 5%; and Power at 80%. An unadjusted sample size of 126 was obtained. From the result in the software, an "intracluster correlation coefficient" ICC of 0.03 and a cluster size of 40, the number of clusters required to achieve the adequate statistical power was 8 (resulting in an increase in the number of participants required from 126 to 134). The SSC uses a design effect of 1.0. Sample size (n) = 134 which was rounded up to 140.

Sampling Technique

Multi-stage sampling was used in this study. From the Public Secondary Schools in Zaria, 2 mixed and 2 girls' only schools were randomly selected using lottery method and 4 schools were selected. Thirty-five (35) participants were recruited from each school; list of adolescents (names and classes) that meets the inclusion criteria were gotten for each school which was used for random selection. Simple random sampling (using random number generator) was used to select the participants. Male adolescents were included in the study in order to mitigate the myth by some participants whom claimed that supplements from researchers targeted towards adolescent girls are contraceptive pills. This could lead to non-compliance to intake of the supplements. The inclusion of male participants also made it possible to gather some data about occurrence of anaemia among male adolescents.

Ethical consideration

Ethical clearance for the study was obtained from the Ahmadu Bello University Committee on Use of Human Subjects for Research (Approval No.: ABUCUHSR/2021/017), Zaria as well as Health Research Ethics Committee, Kaduna State Ministry of Health (MOH/ADM/744/VOL.1/1133). Permission was also granted by the Ministry of Education, Kaduna State and the public schools that were involved. Informed written consent and assent were sought from each participant before inclusion into the study.

DATA COLLECTION

School/Field data collection

Information on socio-demographic characteristics was collected using pre-tested and validated semi-structured questionnaire, which were administered by a trained interviewer.

Qualitative data collection

Focus group discussions were conducted among the participants in each selected school using a validated FGD guide. Audio recorder was used to record the discussion which was then transcribed and translated for thematic analysis.

Blood sample collection and determination of haemoglobin concentration

Capillary blood sample was used for measurement of haemoglobin concentration using HemoCue Hb 301 system. Blood sample of approximately 10 l was drawn into the microcuvette by capillary action. To perform the test, it was ensured that the subject's hand was warm and relaxed and the middle or ring finger was used for sampling. The finger was cleaned with disinfectant and allowed to dry completely. Blood sample was taken at the side of the fingertip after applying light pressure towards the fingertip and puncturing of the finger using a lancet. The first 2 drops of blood was wiped away after which a light pressure was re-applied towards the fingertip until another drop of blood appears. When the blood drop was large enough, the microcuvette was filled in one continuous process. Excess blood from the outside of the microcuvette was wiped off with a clean, lint-free wipe. It was ensured that there was no air bubbles in the filled microcuvette. The microcuvette was then placed into the cuvette holder immediately and measurement was initiated by gently pushing the cuvette holder to its measuring position. The displayed haemoglobin value was recorded.

Data analysis

Data collected was managed and analyzed using Statistical Package for Social Sciences (SPSS) IBM software version 21. Data was represented as frequency (percentage) or mean ± standard deviation (SD) as appropriate. Descriptive statistics was performed to summarize demographic information. Wilcoxon Signed Rank test was conducted for comparison of two means. P-value ≤ 0.05 was considered statistically significant. Qualitative data was transcribed, translated and reported according to themes and sub-themes on challenges/barriers to compliance with weekly IFA supplements and nutrition behaviour among the participants.

RESULTS

Socio-demographic characteristics of in-school adolescents in Zaria

The study involved 142 participants from four different schools; they were followed-up for a period of 12 weeks and 139 participants completed the study. The socio-demographic characteristics revealed that the mean ± SD age of the adolescents was 17.5 ± 1.50 years, majority (80.3%) were female, 83.8% were Hausa and 93.7% were single as presented in Table 1. Among the adolescents, 54.9% have ≤ 10 people in their household, 37.3% of fathers have senior secondary education and 34.5% were businessmen (Table 1). Majority (42.3%) of the mothers have senior secondary education, 36.6% were full housewives while 35.9% were artisan/skilled worker as shown in Table 1

Challenges/barriers to compliance with weekly IFA supplements and nutrition behaviour before and after intervention among in-school adolescents in Zaria

A. Before Intervention

A total of 32 adolescents participated in the 4 focus group discussions held before the commencement of the intervention in each of the selected school with each of the FGD consisting of 8 participants and the results were presented in Table 2. The adolescents mentioned various types of foods as their favorites which included Jollof rice, Spaghetti and beans, Rice and beans, Rice pudding "*Tuwon shinkafa*", Pounded yam and stew. About 91% of the participants are not aware of the existence of iron-folic-acid supplements (IFAS);

"Participant 5 (Group 2): *It provides energy*. Participant 7 (Group 2): *It is all about fruits*. Participant 7 (Group1): *Eating foods that increase blood production*. Participant 1 (Group 4): *It improves health*. All participants in Group 3 *had no idea of IFAS*."

None of the participants in all groups are currently taking IFAS, however 9.4% have ever took IFAS and about 9% stated that IFAS is taken to prevent anaemia and improve blood production;

"Participant 7 (Group 4): *It is taken when an individual have anaemia*. Participant 1 and 7 (Group 2): *IFAS is taken when there is no enough blood*."

One participant out of those who had ever taken IFAS did not like taking it because it has no sweet taste, while some (6.3%) took IFAS because according them, it improved blood levels and optimum health. Only 9.4% of the participants had ever been encouraged to take IFAS either by a medical doctor, mother or relatives. One of the

participants complained that she became thirsty whenever she took IFAS, and that people were discouraged on the multiple doses to be taken. Most of the adolescents stated that the major barrier to IFAS usage was lack of awareness/enlightenment about the importance of IFAS; while other barriers include phobia for taking drugs, unwillingness, unavailability and unaffordability of the IFAS. Majority are willing to take IFAS in order to improve health and better performance, prevent anaemia and improve blood formation and would also recommend others to take IFAS especially if required;

"Participant 5 and 7 (Group 4): *I want optimum health*. Participant 3 and 4 (Group 3): *Yes, will take IFAS if found anaemic*. Participant 1 (Group 2): *Yes, I want to be healthier*. Participant 2 (Group 1): *Yes, to help prevent anaemia and increase blood*."

Majority (81%) of the adolescents got their foods from home while others bought from hawkers or restaurants. About 84% were involved in purchase of food for their household because they are sent to the market to purchase the food items. About 50% of the participants responded that they could influence the food purchased for their households and most (68%) of the participants are also involved in the preparation of foods as well. Other roles played by the participants in food preparation process include fetching of water, cooking, washing of dishes, washing and cutting of vegetables etc. However, approximately 6% played no role in household food preparation process. Majority of the participants stated that foods were kept in the stores while perishable ones were stored in cool and dry places;

"Participant 7 (Group 1): *Foods that get spoilt easily like tomato are kept in cool places*. Participant 1 and 2 (Group 3): *They keep foods mostly in the store while perishable foods are stored more appropriately*."

Most (53%) of the adolescents ate alone while 47% ate together with others in their households. Among the participants, 56% reported that household heads (fathers) decide the type of foods to be prepared and consumed in the household, 6% stated mothers whereas 38% of the respondents influenced the decision of food to be consumed. Majority stated that they eat at other places apart from home such as schools, relative's home, occasions/ceremonies and markets;

"Participant 3 and 4 (Group 4): *Yes, we eat at school, market and relative's house*. Participant 1 (Group 3): *Yes, but only in school*."

Most (53%) of the participants do not get and ate what they like while 47% stated that they got and ate the food they like when available at home. Various factors influenced food choices and consumption by the participants which include taste, food preference, availability, socio-cultural beliefs, food appearance, cravings, desire for better health and energy.

B. After Intervention

A total of 38 adolescents participated in the 4 FGDs held in each of the selected school after the intervention; each of the FGDs consisted of 8 – 10 participants and results were presented in Table 3. All the participants from each school had improved knowledge of IFAS;

"Participant 5 and 8 (Group 1): *IFAS is taken when anaemic or iron deficient*. Participant 2 (Group 2): *IFAS is consumed because of anaemia in the body and to prevent anaemia*. Participant 2 (Group 3): *IFAS enhances blood level when you lack enough blood in the body*. Participant 10 (Group 3): *IFAS increases blood level and prevents iron deficiency*. Participant 1 (Group 4): *IFAS is taken to improve blood and iron level in the body*. Participant 2 and 4 (Group 4): *IFAS prevents iron deficiency and improves overall health status*."

All the participants (100%) reported to have taken IFAS or currently taking IFAS; a high IFA supplementation compliance (97%) was observed among the adolescents in all schools. Majority of the participants responded that they took IFAS because they were anaemic or to prevent anaemia. The participants also like taking IFAS because it would improve their blood levels and overall health;

Table 1: Sociodemographic and Household Characteristics of the Participants

Socio-demographic Characteristics	Frequency (n=142)	Percentage (%)	Socio-demographic Characteristics	Frequency (n=142)	Percentage (%)
Sex					
Male	28	19.7	**Age (Years)**	17.54 ± 1.50*	
Female	114	80.3			
Tribe			**Marital Status**		
Hausa	119	83.8	Single	133	93.7
Fulani	14	9.9	Married	8	5.6
Yoruba	2	4.9	Divorced	1	0.7
Others	7	1.4			
Household Size			**Birth Order**		
≤ 10	78	54.9	1 – 3	56	39.4
11 – 20	44	30.9	4 – 6	49	34.5
21 – 30	18	12.7	7 – 9	23	16.2
31 and Above	2	1.41	10 and Above	14	9.9
Father's Level of Education			**Mother's Level of Education**		
No formal education	18	12.7	No formal education	26	18.3
Primary	7	4.9	Primary	8	5.6
Junior secondary	6	4.2	Junior secondary	10	7.0
Senior secondary	53	37.3	Senior secondary	60	42.3
Tertiary	31	21.8	Tertiary	16	11.3
Don't know	27	19.0	Don't know	22	15.5
Father's Occupation			**Mother's Occupation**		
Businessman			Full house wife		
Artisan/Skilled- worker	49	34.5	Artisan/Skilled- worker	52	36.6
Civil servant	24	16.9	Civil servant	51	35.9
Farmer			Farmer		
Private- Organisations	23	16.2	Private- Organisations	23	16.2
Others	19	13.4	Others	5	3.5
	22	15.5		5	3.5
	5	3.5		6	4.2

Table 2: Challenges/barriers to compliance with weekly IFA supplements and nutrition behaviour before intervention among in-school adolescents in Zaria

Theme/Sub-themes	Participant Responses IFA supplements	Percentage
Awareness of IFAS	***"Participant 5 (Group 2):*** *It provides energy.* ***Participant 7 (Group 2):*** *It is all about fruits.* ***Participant 7 (Group1):*** *Eating foods that increase blood production.* ***Participant 1 (Group 4):*** *It improves health.* ***All participants in Group 3*** *had no idea of IFAS."*	91% are not aware of iron-folic-acid supplements (IFAS)
Intake of IFAS	***"All participants:*** *No"*	100% are not taking IFAS currently. 9.4% ever took IFAS
Benefits of IFAS	***"Participant 7 (Group 4):*** *It is taken when an individual has anaemia.* ***Participant 1 and 7 (Group 2):*** *IFAS is taken when there is no enough blood."*	9% stated benefit of IFAS
Challenges/barriers to intake of IFAS	***"Participant 1,5 and 6 (Group 3):*** *It has no sweet taste."*	6.3% do not like the taste
	"Participant 1 and 4 (Group 1): *I am not of aware of importance of IFAS.* ***Participant 1, 3, 4 and 8 (Group 2 & 4):*** *IFAS is not available."*	84% had challenges
Willingness to take IFAS	***Participant 5 and 7 (Group 4):*** *I want optimum health.* ***Participant 3 and 4 (Group 3):*** *Yes, will take IFAS if found anaemic.* ***Participant 1 (Group 2):*** *Yes, I want to be healthier.* ***Participant 2 (Group 1):*** *Yes, to help prevent anaemia and increase blood."*	93% are willing to take IFAS
	Nutrition behaviour	
Involvement in food provision	***"Participant 3,4 and 8 (Group 1, 2 & 3):*** *I eat from food available at home. We are sent to the market and stores to buy food stuffs and groceries."*	84% involved in purchase of food
Involvement in food preparation	***"Participant 3, 4, 5 and 8 (All groups):*** *Yes, I am involved in preparation of food. Yes, we help to fetch water, cook and wash dishes. I assist in preparing vegetables."*	68% are involved in preparation of food
Storage of foods	***"Participant 7 (Group 1):*** *Foods that get spoilt easily like tomato are kept in cool places.* ***Participant 1 and 2 (Group 3):*** *They keep foods mostly in the store while perishable foods are stored more appropriately."*	85% stored foods appropriately
Eating habits	***"Participant 3 and 4 (Group 4):*** *Yes, we eat at school, market and relative's house.* ***Participant 1 (Group 3):*** *Yes, but only in school."*	78% ate outside home
	Participant 1, 2 and 5 (Group 1 & 3): *I eat alone at home.* ***Participant 3, 4 7, and 8 (Group 2 & 4):*** *We eat together with others in our households."*	53% ate alone while 47% ate together with others

Participant 1, 3 and 7 (Group 1): I take IFAS to improve blood level and be healthy.
Participant 5 and 6 (Group 1): I take IFAS to increase blood level and prevent iron deficiency.
Participant 2 (Group 2): I take IFAS because I was enlightened on its importance and health benefits.
Participant 3, 4 and 5 (Group 2): I take IFAS to prevent deficiency and enhance health.
Participant 1, 2 and 4 (Group 3): I like taking IFAS because I want to have optimum energy, be healthy and increase blood level and have enough blood in the body.
Participant 6 (Group 3): I like taking IFAS because I was educated on it and I will have enough blood in the body when taken.
Participant 8 (Group 4): I like taking IFAS because I will be healthy."

All the respondents (100%) reported that they were encouraged and asked to take IFAS after sensitization and advocacy by the research team that came to their schools. They were encouraged to take IFAS because of its various benefits and negative/adverse consequences of anaemia and iron deficiency;

Participant 4 and 5 (Group 2): Yes, the research team and health master in our school encouraged us to take IFAS.
All participants (Groups 3 and 4): The research team that came to our schools, encouraged us to take IFAS which we all took.

About 65% of the respondents stated that they observed some strange feelings which included increased hunger, nausea, black coloured faeces, increased energetic and stamina, drowsiness, increased appetite, fatigue and weakness. However, 35% of the respondents reported that they did not feel any difference;

Participant 3, 7 and 9 (Group 1): Yes, it makes me hungry and sleepy.
Participant 1 and 3 (Group 2): I felt better, energetic and strong.
Participant 4 and 5 (Group 2): Yes, I felt nausea and had black faeces.
Participant 1, 3, 4, 6 and 10 (Group 3): Yes, it makes me hungry, sleepy and weak.
Participant 2, 7 and 9 (Group 3): Yes, I felt stronger in my body.
Participant 1 and 7 (Group 4): Yes, I noticed increased appetite because I eat more.

Majority (91%) of the participants did not experience any challenges with regards to taking IFAS. About 9% mentioned some challenges such as feeling of IFAS not digesting, availability and phobia;

All participants (Group 1): No challenges.
Participant 3 (Group 2): I don't like taking drugs because I am afraid, but I like IFAS, I have no problems with it.
Participant 2 (Group 3): It does not dissolve early.
Participant 7 (Group 4): I do not get the IFAS regularly because I don't meet the health master in the office.

Most (85%) of the respondents had no barriers preventing them from taking IFAS; moreover 15% reported they forgot to take the supplements while some were discouraged to take the supplements because they perceived IFAS as contraceptive pills and were used for experimental work;

Participant 1 (Group 3): I was discouraged to take IFAS and was told it will stop me from giving birth and that I am used for experimental work.
Participant 1 and 3 (Group 4): Forgot to take IFAS.
Participant 2 (Group 4): I was hospitalized and was advised not to take any medication apart from what was prescribed by the Doctor.

Majority (95%) confirmed that they would continue to take IFAS because it improves blood levels and other health benefits; and that they have been educated on its benefits likewise the negative consequences of anaemia and iron deficiency. Similarly, most of the participants affirmed that they will recommend IFAS to others while some of the participants mentioned that they already recommended IFAS to their friends;

Participant 3 and 8 (Group 2): Yes, I will continue because it improves blood level and enhances better health.
Participant 4 (Group 3): Yes, because we were educated and IFAS increased our blood levels.
Participant 4 (Group 4): Yes, I recommended IFAS to my friends.

Furthermore, most of the participants stated that preference, interest and advice from health experts influenced their food choices. Some of the participants also confirmed that they preferred foods

they believed will improve their health and make them strong. The respondents mentioned that choice, preference, hunger, satisfaction and satiety, satisfying others interest/pressure, availability and survival needs are factors that influenced the food they consumed;

Participant 1 (Group 1): When I enjoy the food and believe it improves my health.

Participant 2 (Group 2): Sometimes I eat because there is no alternative.

Participant 3 (Group 2): I eat even if I don't want, so that I will not fall sick.

Participant 7 (Group 2): I eat even if I don't want, so as not to offend the person that offered me the food.

Participant 5 and 7 (Group 3): I eat what is available sometimes because of hunger and to survive.

Participant 1 (Group 4): Preference, interest and health informed advice influence my food choices and food I eat.

Participant 4 and 5 (Group 4): Majorly interest and preference."

Haemoglobin levels, prevalence and severity of anaemia before and after intervention among in-school adolescents in Zaria

The results showed that before intervention, the mean ± SD of haemoglobin concentration among the adolescents was 11.27 ± 1.33 g/dl which significantly ($p = 0.001$) increased to 12.60 ± 1.02 g/dl after the intervention (Table 4). Similarly, haemoglobin concentration among adolescents in School 1, 2, 3 and 4 before the intervention were significantly ($p<0.01$) lower when compared to the respective school groups after intervention.

The prevalence of anaemia among the adolescents before intervention was found to be 76.8%, which reduced to 24.5% after the intervention as shown in Figure 1. Results before intervention indicated that 64.3% of the male adolescents were anaemic while 79.8% of the female adolescents were anaemic; whereas, after the intervention the prevalence of anaemia among male and female adolescents were reported to be 37.0% and 21.4% respectively (Figure 2). Before intervention, 41.5% and 33.8% of the adolescents were mildly and moderately anaemic respectively; while 1.4% was severely anaemic; remarkably 20.9% of the adolescents were mildly anaemic and 3.6% were moderately anaemic after the intervention, meanwhile none of the adolescents was severely anaemic after the intervention (Figure 3).

Figure 1: Prevalence of anaemia before and after intervention among in-school adolescents in Zaria
Values are expressed as percentages of adolescents with anaemia and normal (n = 142 and 139: before and after intervention respectively). Male and female adolescents (15-19 years) with haemoglobin levels less than 13.0 g/dl and 12.0 g/dl respectively are termed anaemic [18].

Figure 2: Prevalence of anaemia based on gender before and after intervention among in-school adolescents in Zaria
Values are expressed as percentages of adolescents with anaemia and normal (Before Intervention; Male: n = 28, Female: n = 114, After Intervention; Male: n = 27, Female: n = 112). Male and female adolescents (15-19 years) with haemoglobin levels less than 13.0 g/dl and 12.0 g/dl respectively are termed anaemic [18].

Figure 3: Severity of anaemia before and after intervention among in-school adolescents in Zaria
Values are expressed as percentages of adolescents with anaemia or not (n = 142 and 139: Before and After intervention respectively). WHO classification of severity of anaemia among adolescents (15-19 years): Normal = (Male = 13.0 g/dl and above, Female = 12.0 g/dl and above); Mild anaemia = (Male = 11.0 – 12.9 g/dl, Female = 11.0 – 11.9 g/dl); Moderate anaemia = 8.0 – 10.9 g/dl; Severe anaemia = less than 8.0 g/dl [18].

Table 3: Challenges/barriers to compliance with weekly IFA supplements and nutrition behaviour after intervention among in-school adolescents in Zaria

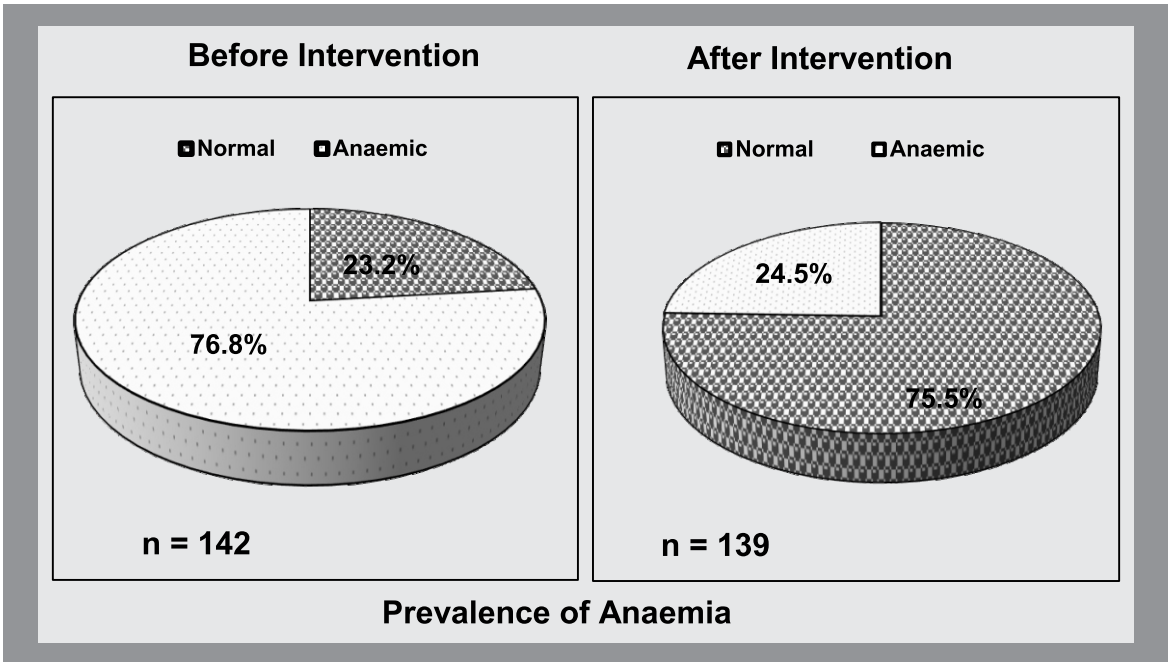
Theme/Sub-themes	Participant Responses IFA supplements	Percentage
Awareness/knowledge of IFAS	***"Participant 5 and 8 (Group 1):*** *IFAS is taken when anaemic or iron deficient.* ***Participant 2 (Group 2):*** *IFAS is consumed because of anaemia in the body and to prevent anaemia.* ***Participant 2 (Group 3):*** *IFAS enhances blood level when you lack enough blood in the body.* ***Participant 10 (Group 3):*** *IFAS increases blood level and prevents iron deficiency.* ***Participant 1 (Group 4):*** *IFAS is taken to improve blood and iron level in the body.* ***Participant 2 and 4 (Group 4):*** *IFAS prevents iron deficiency and improves overall health status."*	100% had improved awareness and knowledge of IFAS
Intake of IFAS	***"All participants:*** *Yes"*	100% took IFAS
Benefits of IFAS	***"Participant 1, 3 and 7 (Group 1):*** *I take IFAS to improve blood level and be healthy.* ***Participant 5 and 6 (Group 1):*** *I take IFAS to increase blood level and prevent iron deficiency.* ***Participant 2 (Group 2):*** *I take IFAS because I was enlightened on its importance and health benefits.* ***Participant 3, 4 and 5 (Group 2):*** *I take IFAS to prevent deficiency and enhance health.* ***Participant 1, 2 and 4 (Group 3):*** *I like taking IFAS because I want to have optimum energy, be healthy and increase blood level and have enough blood in the body.* ***Participant 6 (Group 3):*** *I like taking IFAS because I was educated on it and I will have enough blood in the body when taken.* ***Participant 8 (Group 4):*** *I like taking IFAS because I will be healthy."*	89% stated benefit of IFAS
Encourage to take IFAS	***"Participant 4 and 5 (Group 2):*** *Yes, the research team and health master in our school encouraged us to take IFAS.* ***All participants (Groups 3 and 4):*** *The research team that came to our schools, encouraged us to take IFAS which we all took."*	100% were encouraged to take IFAS

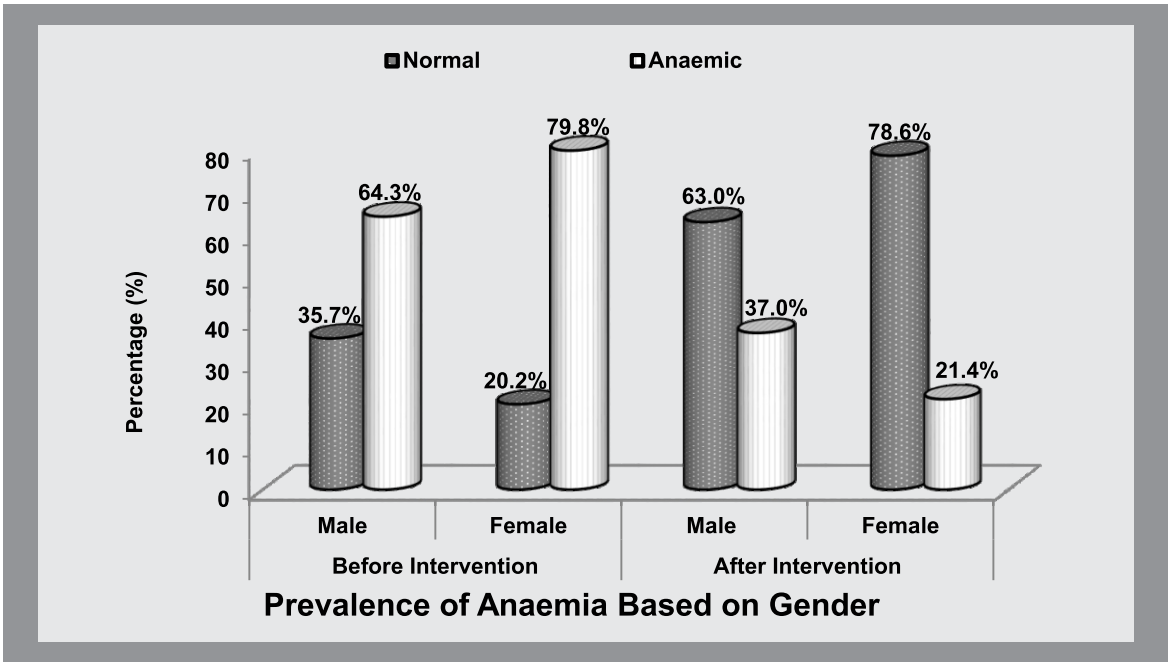
Challenges/barriers to intake of IFAS	***"Participant 3, 7 and 9 (Group 1):*** *Yes, it makes me hungry and sleepy.* ***Participant 1 and 3 (Group 2):*** *I felt better, energetic and strong.* ***Participant 4 and 5 (Group 2):*** *Yes, I felt nausea and had black faeces.* ***Participant 1, 3, 4, 6 and 10 (Group 3):*** *Yes, it makes me hungry, sleepy and weak.* ***Participant 2, 7 and 9 (Group 3):*** *Yes, I felt stronger in my body.* ***Participant 1 and 7 (Group 4):*** *Yes, I noticed increased appetite because I eat more."*	65% observed strange feelings
	"All participants (Group 1): *No challenges.* ***Participant 3 (Group 2):*** *I don't like taking drugs because I am afraid, but I like IFAS, I have no problems with it.* ***Participant 7 (Group 4):*** *I do not get the IFAS regularly because I don't meet the health master in the office."*	91% did not experience any challenge
	"Participant 1 (Group 3): *I was discouraged to take IFAS and was told it will stop me from giving birth and that I am used for experimental work.* ***Participant 1 and 3 (Group 4):*** *Forgot to take IFAS.* ***Participant 2 (Group 4):*** *I was hospitalized and was advised not to take any medication apart from what was prescribed by the Doctor."*	9% had some barriers to take IFAS
Willingness to take IFAS	***"Participant 3 and 8 (Group 2):*** *Yes, I will continue because it improves blood level and enhances better health.* ***Participant 4 (Group 3):*** *Yes, because we were educated and IFAS increased our blood levels.* ***Participant 4 (Group 4):*** *Yes, I recommended IFAS to my friends."*	95% would continue to take IFAS
	Nutrition behaviour	
Food preference and choices	***Participant 1 (Group 1):*** *When I enjoy the food and believe it improves my health.* ***Participant 2 (Group 2):*** *Sometimes I eat because there is no alternative.* ***Participant 3 (Group 2):*** *I eat even if I don't want, so that I will not fall sick.* ***Participant 7 (Group 2):*** *I eat even if I don't want, so as not to offend the person that offered me the food.* ***Participant 5 and 7 (Group 3):*** *I eat what is available sometimes because of hunger and to survive.* ***Participant 1 (Group 4):*** *Preference, interest and health informed advice influence my food choices and food I eat.* ***Participant 4 and 5 (Group 4):*** *Majorly interest and preference."*	86% stated various factors influencing their food choices

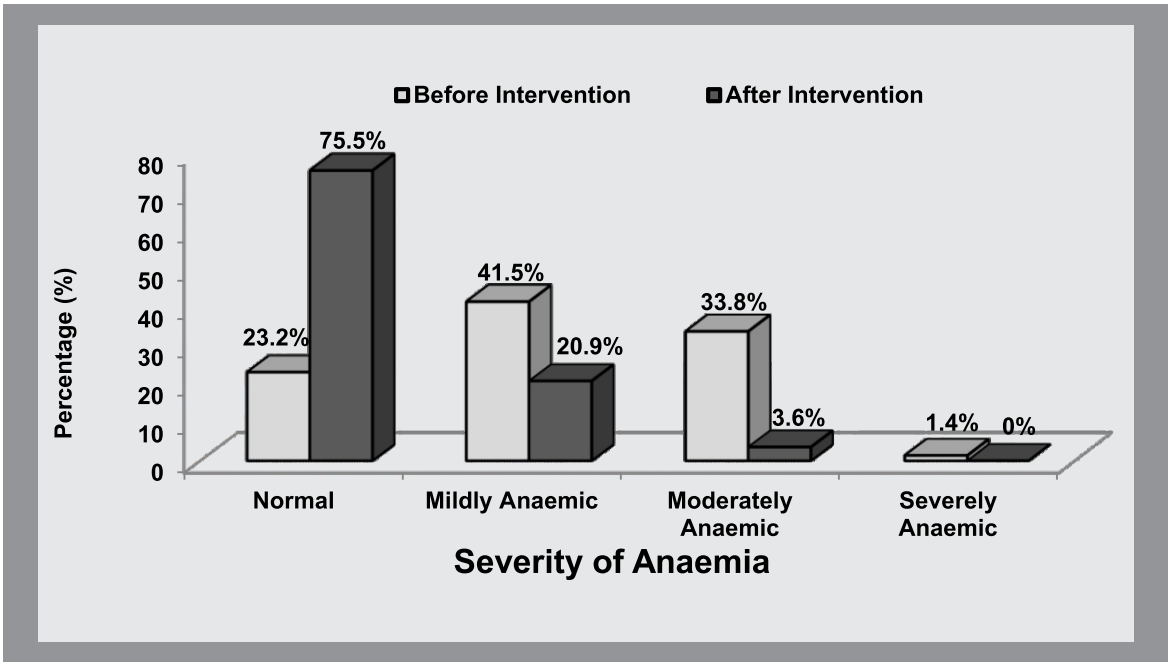
Table 4: Haemoglobin levels before and after intervention among in-school adolescents in Zaria

	Haemoglobin (g/dl)			
Groups	**Before Intervention**	**After Intervention**	**% Change**	**p-value**
Group 1	10.77 ± 1.37[a]	12.04 ± 0.92[b]	11.79	0.001
Group 2	11.13 ± 1.13[a]	13.06 ± 0.99[b]	17.34	0.001
Group 3	11.44 ± 1.20[a]	12.49 ± 1.05[b]	9.17	0.010
Group 4	11.70 ± 1.47[a]	12.66 ± 0.90[b]	8.21	0.002
All	11.27 ± 1.33[a]	12.60 ± 1.02[b]	11.80	0.001

Values are expressed as Mean ± SD of 35 participants per group; Values with different superscript alphabets across the row are significantly different, Wilcoxon Signed Rank Test.







DISCUSSION

Adolescence is a temporary period of physical and psychological development which occurs during puberty to adulthood. The adolescent years are associated with a significant morbidity and mortality rate that is preventable or treatable. Social determinants of health such as education, ethnicity, wealth, biological factors, sexism and social exclusion have been reported to be essential drivers of nutritional vulnerability among adolescents [19] which can restrict access to resources and opportunities affecting nutrition and health. The mean age of the adolescents in this study was similar to report of Onabanjo and Balogun [15] that found

mean age of 16.0 years among adolescents from secondary school in Ogun state, Nigeria. This study found that majority of the adolescents were unmarried which was similar to report of Wemakor et al., [20] with 97.8% unmarried adolescent girls in Kumbungu District, Ghana; whereas higher than the study of Chauhan et al., [21] that reported 64.4% of unmarried adolescents in Bihar and Uttar Pradesh, India. Wemakor et al., [20] found that 49.7% of adolescents in Ghana have 7-10 people in their household which was similar to results from this study. In this study, most of the adolescent's parents have attained some level of education which was higher compared to 80% (fathers) and 87% (mothers) without education in Kumbungu District, Ghana [20]. About 85% of father's occupation among adolescents in Kumbungu, Ghana was farming [20] and was higher than 13.4% reported in this study. The socio-demography of the adolescents including age, marital status, education status and occupation of parents could be responsible for (or associated with) the high prevalence and severity of anaemia recorded before intervention in this study as was previously established from other studies [20,22,23]. Lower education status, rural residence, late adolescence, wealth quintile, maternal and husband occupation were stated to be predictors and related to occurrence and prevalence of anaemia among women of reproductive age [21,24,25].

The study assessed the challenges/barriers to compliance with weekly IFA supplements and nutrition behaviour before and after the intervention among the adolescents using FGDs. The results revealed that the major challenges/barriers to taking IFA supplements by the adolescents include lack of awareness and encouragement, likewise unavailability and unaffordability of the IFA supplements. The results were similar to the study of Yidana et al. [26] that reported hunger and dizziness, perceiving the IFA tablets as contraceptive pills, lack of potable water to take tablets and heavy menstrual flow after taking tablet as challenges encountered during IFA intake among adolescent girls in Ghana. This implies that, weekly IFA supplementation could be a success story among adolescents in Zaria-Nigeria if there is an adequate awareness/advocacy and availability of the IFA supplements. These can prevent the high prevalence of anaemia reported in the study and improve school performance as well as overall health of the adolescents. With respect to nutrition behaviour, majority got their foods from home; they were involved in the processing of the food before consumption and prefer eating alone. The adolescents reported that taste, food preference, availability, socio-cultural beliefs, increased hunger, food appearance, cravings, desire for better health and energy, interest and advice from health experts were factors that influence their food choices and consumption. This indicated that adolescence is a vital stage of life that could be targeted to change or improve the dietary practices, choices and behaviours of adolescents with regards to attaining adequate nutrition through awareness/advocacy and other behavioural change strategies. This could help break the vicious cycle of malnutrition. Conversely, it has been reported that adolescents establish various patterns of behaviour related to diet and nutrition which could affect their health positively or negatively [27] at present or in the near future.

The IFA supplementation compliance among the adolescents after intervention was high as revealed during the FGDs and was comparable to reports from other studies [26,28]. This should be encouraged because anaemia is a global public health problem and adolescent girls happen to be one of the most vulnerable groups. In Nigeria, adolescent girls are more vulnerable to anaemia because majority of health and nutrition interventions are targeted towards pregnant women and under 5 children; thereby neglecting the adolescents. This study reported 76.8% prevalence of anaemia among the adolescents before the intervention which is of severe public health significance according to WHO. The prevalence of anaemia (76.8%) before intervention found in this study is higher than prevalence reported from many studies in Ghana (38.9%), Ethiopia (25.5%), Jordan (54.5%), Palestine (33.3%) and India (56.3%) among adolescents [11,26,29-31]. The high prevalence observed before the intervention could be largely associated with the lack of consumption of iron-rich foods and diversified diets, lack of knowledge/awareness about anaemia/iron

deficiency and lack of iron supplementation among the adolescents. However, the prevalence of anaemia among the adolescents after intervention of weekly IFA supplements and sensitization decreased to 24.5%. In the same manner, the severity of anaemia among the adolescents was significantly reduced after the intervention as shown in Figure 3.

The results also revealed that the concentration of haemoglobin was significantly higher after the intervention among the adolescents. This was similar to the reports from other studies (including WHO's recommendation) that supplemented oral iron and/or nutrition education increases iron status (relative to haemoglobin level) among adolescents [28,32,33].

Obviously, the impact of anaemia among adolescent girls remains a public health challenge worldwide; having major impact on individual health and national economic development particularly in low- and middle-income countries [12]. It is therefore imperative that specific actions such as encouraging consumption of iron-rich foods through dietary change (consuming diversified diet), nutritional education to inspire change, behavioural change strategies, treatment and prevention of parasitic infections should be prioritized and targeted towards adolescents. Similarly, weekly iron supplementation to improve iron status and prevent iron deficiency anaemia among adolescents should continue to be prioritized.

Conclusion

In conclusion, challenges to intake of weekly IFA supplements among in-school adolescents in Zaria were lack of awareness, misinformation, unavailability and unaffordability of supplements. The prevalence of anaemia among the in-school adolescents before and after the intervention were 76.8% and 24.5% respectively. There is need to increase the coverage of IFA tablets distribution as well as extension to hard-to-reach areas by the relevant stakeholders. The study recommends that relevant stakeholders as a matter of urgency should consider and initiate the weekly IFA supplementation among adolescents especially in Public Schools as this would go a long way in reducing the adverse consequences of anaemia and iron deficiency, health cost and lost productivity in later adult years.

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Conflict of Interest

The authors do not have any conflict of interest to declare.

Author Contributions

Conceptualization and Methodology: MAS & AS, Data curation & analysis: MAS, Investigation & original writing: MAS & SA, Writing, review & editing: MAS, SA, CCN, BA, OAO & VA, Supervision: AS, OAO & BA

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