Research Article

Anaemia among school-aged adolescent boys in the Sagnarigu District of Northern Ghana

Abstract

Background: The increased nutritional requirement in pregnancy and that associated with growth spurt in adolescence has skewed nutritional interventions towards pregnant women and girls. Among school-aged adolescents, physical and cognitive development peaks. This affects both males and females but overall nutritional deficiency in males has not been fully described. We assessed prevalence of anaemia and its predictors among school-aged adolescent boys in the Sagnarigu district, Northern Region.

Method: We used cross-sectional design with multi-stage sampling involving 349 adolescents in eleven (11) public JHSs. We included adolescent girls for comparison on the prevalence of anaemia and to answer the question whether anaemia in the boys was any different from their female colleagues. We estimated household wealth using Principal Component Analysis (PCA). We assessed Dietary Diversity and food security using 24-hour recall and FANTA-USAID Household Hunger Scale (HHS) module respectively. We analysed capillary blood samples using HaemoCue (Hb-301) to determine anaemia. We measured weight and height and determined nutritional status using the WHO 2007 growth reference. We conducted data analysis using STATA Version 15 and used Two-sample t-test to determine mean differences and Chi-square ($\chi 2$) or fisher's exact tests for associations. We fitted logistic regression models to the data to determine factors associated with anaemia among boys.

Findings: We found overall mean haemoglobin concentration of 13.3±1.7g/dl and anaemia prevalence of 25.2%. We found no statistical difference between anaemia in boys and girls (24.2% for boys vs. 26.8% for girls, p=0.59). Low dietary diversity was 29.5%, medium dietary diversity was 33.5%, high dietary diversity was 37.5% and food insecurity was (21.2%). In total, 14.3% of children had nutritional challenges, with 8.5% underweight, 5.8% Overweight/obese and 9.9% stunted.

Among boys, anaemia was predicted by wealth (OR=0.5, 95% CI=0.2 -1.0, P=0.049) and stunting (OR=2.7, 95%CI=1.1 - 6.8, p=0.034). Living in upper 60% household wealth was a protective factor with 50% less odds of anaemia as compared to their counterparts living in the lower 40%. Similarly, stunted boys had 2.7times odds of anaemia as compared to those not stunted.

Conclusion: We concluded that anaemia equally affects boys and girls in the Sagnarigu district. Family/household circumstances may determine anaemia among these adolescents rather than biology (menstruation in girls). Indeed, irrespective of the age, educational level of parents and household food security, anaemia among boys in the district was predicted by household wealth and stunting.

Keywords: anaemia, adolescents, chronic illness, pregnancy

Volume 13 Issue 1 - 2022

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Received: February 22, 2022 | **Published:** February 28, 2022

Background

Anaemia affects about 2.4 billion individuals and account for the highest Years Lived with Disabilities (YLDs), 77.9 million globally (Vos et al., 2016). The burden of anaemia is highest in developing countries, accounting for more than 89% of the global burden (Kassebaum, 2016). In eleven (11) western sub-Saharan Africa countries, Iron-deficiency anaemia is ranked the leading cause of YLDs (Vos et al., 2016). According to Yasemin, et al, (2012), 27% of adolescents in developing countries and 6% in developed countries suffer from anaemia. Anaemia was projected to be the greatest nutritional problem (WHO, 2005), with adolescent girls particularly more prone to it due to menstruation. However, Anaemia in adolescent boys (when no chronic conditions might be affecting their haemoglobin levels) may be a proxy indicator of overall anaemia levels and general health status. In Ghana anaemia affects 23.5% school-going adolescent girls and 13.1% among boys (Gosdin et al., 2020).

Nutritional deficiencies (iron, folate, vitamin A and vitamin B12) are identified causes of anaemia in developing countries, with iron deficiency identified as the main cause in most populations (Kassebaum, 2016), infections (e.g. malaria and intestinal parasitic infections), chronic illness and genetic haemoglobin disorders (Balarajan, Ramakrishnan, Özaltin, Shankar, & Subramanian, 2011; WHO, 2017).

Health status, socio-economic development, and overall quality of life of an individual could be negatively affected by anaemia. Anaemia decreased resistance to infection in adolescents, impaired physical growth and mental development, decreased physical activity, efficiency of work, regular task focus, academic performance and increased drop-out in schools (WHO, 2005).

Adolescence is a window of opportunity to address some nutritional deficiencies including anaemia and promote good health and nutrition. Effective anaemia prevention strategies are well known.

These includes iron supplementation (iron and folic acid or multiple micronutrients), fortification of staple foods or condiments, and disease control, particularly malaria and deworming (WHO, 2012). Despite the detrimental impact that anaemia could have on adolescent boys and girls, interventions addressing it in Ghana mostly target only girls. This study therefore seeks to;

a. Determine the prevalence of anaemia among adolescent boys in the public JHSs in the Sagnarigu district by measuring haemoglobin in a whole blood using HaemoCue (Hb-301) and compare with their female counterparts.

b. Assess socio-demographic characteristics associated with anaemia among adolescent boys in the district

c. Assess dietary factors (diversity and household food security) among adolescent boys in the district and determine their association with anaemia.

d. Evaluate association between anaemia and anthropometric indices among the JHS boys.

e. Our findings have contributed in providing guidance to policymakers and health care providers in Ghana with reference to the WHO guidelines on intermittent iron and folic acid supplementation and has provided an epidemiological data for the review of the GIFTS programme in Ghana.

Methods

Study design, setting & target population

We used cross-sectional design and interviewed 349 adolescents (211 boys and 138 girls) using structured questionnaire from March to August 2020. We conducted the study in 11 Public Junior High Schools across the 6 sub-districts of the Sagnarigu. We included all students in the 11 selected public Junior High Schools and excluded students with known haemoglobinopathies (e.g. sickle cell disease) or physical disability such as spinal deformities (e.g scoliosis or kyphosis).

Sample size determination and sampling

We estimated sample size using modified Cochrane and Snedecor formula. We used multi-stage sampling technique involving two (2) stages, random sampling of schools and systematic sampling of study participants. We obtained list of public schools from the district directorate of health services 2019 Girls Iron-Folate Tablets Supplementation (GIFTS) reports and all academic class registers from the sampled schools. In each sampled school, we obtained serial numbers of all students from the academic class registers and segregated into boys and girls. We systematically sampled required number of boys (20) and girls (13) and extracted corresponding names of the sampled serial numbers onto a tracking sheet for consent and assent.

Study variables and data collection procedures

We obtained anaemia as the main outcome variable by measuring haemoglobin concentration of capillary whole blood sample from a finger-prick and analysed using haemocue (Hb-301) device. We defined anaemia for girls<12 years with Hb<11.5 g/dl and Hb< 12 g/dl for girls>=12 years. Also, Hb <11.5 g/dl for adolescent boys <12yrs, Hb <12 g/dl for boys 12-14 years and Hb<13d/dl for >=15 years. Study participants with Hb less than 7g/dl for girls and 8g/dl for boys were classified as severely anaemic (WHO, 2011).

We measured Dietary diversity of adolescents using 24-hour dietary recall of 15 food groups (FAO, 2010), and classified it as Low Dietary Diversity Score (DDS ≤3), Medium Dietary Diversity (DDS=4/5) and High Dietary Diversity (DDS≥6). Food Security level of adolescents' households were grouped into; Little to No Hunger (HHS≤1), Moderate Hunger (HHS=2/3) and Severe Hunger (HHS 4-6).

We measured height and weight to the nearest 0.1cm and 0.1Kg using Shorr board and SECA scale (Module 874) respectively. For adolescents aged 10-19 years, BMI-for-age *Z*-scores (BMIZ) and height-for-age Z-score (HFAZ) were determined using the WHO 2007 growth reference. We classified BMIZ as underweight (BMIZ < -2 *SD*), normal weight (BMIZ ≥ -2 *SD* and ≤ 1 *SD*) and overweight (BMIZ >1 *SD*). and height-for-age scores as either stunted (HFAZ<-2SD) or Normal (HFAZ ≥ -2) (WHO., 2007).

Data processing and analysis

We obtained electronic data in Microsoft Excel and transferred onto Stata version 15 (Stata Corp, Texas, USA) for analysis. We dichotomized wealth quintiles from the PCA analysis into lower 40% and upper 60% and fitted it into bivariable and multivariable logistic regression models. Mean and standard deviation (SD) were determined for Continuous variables, while for categorical variables, percentages were determined. Differences in means of continues variables was established using Two-sample t-test with equal variances. Chi-square (χ^2) were used to determine associations. Bivariable logistic regression was used to test for the association between anaemia and each explanatory variable among adolescent boys. Factors with p-values of at least 0.2 from the bivariate model were fitted in to a multivariable model to determine factors associated with anaemia. Statistical significance for the multivariable models were assessed at 5% level.

Data quality assurance

We pre-tested the data collection tools among 11 adolescents. We calibrated the weighing scales with a known weight prior to start of data collection and repeated periodically during data collection in each school. The first two drops of blood after a prick were wiped off and the third drop was used to measure Hb concentration.

Ethical considerations

We obtained Ethical approval (**GHS-ERC 019/11/19**) from the Ghana Health Service Ethics Review Committee (GHSERC) of the Research and Development Division, Accra.

Results

The mean age of the study participants was 15.5years (SD =1.7) and ranges from 11-21years. Overall, 70.2% were aged 15 years and above and 29.8% were aged 10-14 years. Boys had a significantly higher age compared to girls (p=0.0394). The mean age of boys was 15.6years (SD=1.8) and ranged (11, 21), and that of girls 15.3years (SD=1.6), ranged (12, 20) (Table 1).

Close to three-quarters of mothers (72.8%) and more than half of fathers (57.3%) had no education. Among parents with education, 14.3% of fathers had basic education (primary and junior high school) and 15.5% had at least secondary education. In mothers, 10.3% had basic education and only 4.9% had at least secondary education.

Average household size in this study was 9 and range (2, 20). More than half, (57.3%) of fathers were into agriculture and 3.5%

Citation: Abdulai M, Manu AA, Taufique M, et al. Anaemia among school-aged adolescent boys in the Sagnarigu District of Northern Ghana. *Obstet Gynecol Int J.* 2022;13(1):82‒90. DOI: 10.15406/ogij.2022.13.00630

unemployed. Among mothers, sales and services or petty trading was 65.5%, 6.6% was unemployed and 16.4% were into agriculture. Most of the households of the adolescents were headed by a male (88.0%) and 73.1% were headed by father. Female headed household were 12.0% and only 6.3% were headed by mother.

Nearly 9 out of 10 adolescents (88.3%) had improved drinking water source, and less than half (35.8%) of households had improved sanitation. Approximately half (49.6%) practiced open defecation. Only 4.6% of households used clean sources of cooking fuel with 55.0% using wood and 40.4% charcoal (Table 2).

Table 1 Demographic characteristics of respondents

Variable	Total (%) N=349	Sex		P-value
		Male (%)	Female (%)	
		n =211	n =138	
Age (years)				
Less than 15	104(29.8)	58(27.5)	46(33.3)	0.243
15 or more	245(70.2)	153(72.5)	92(66.7)	
Father's Education				
No education	200(57.3)	125(59.2)	75(54.4)	0.668
Basic Education	50(14.3)	29(13.7)	21(15.2)	
Secondary+	54(15.5)	29(13.7)	25(18.1)	
Don't Know	45(12.9)	28(13.3)	17(12.3)	
Mother's Education				
No education	254(72.8)	150(71.1)	104(75.4)	0.307
Basic Education	36(10.3)	27(12.8)	9(6.5)	
Secondary+	17(4.9)	10(4.7)	7(5.1)	
Don't Know	42(12.0)	24(11.3)	18(13.0)	
Occupation of father(N=349)				
Agriculture/Farming	185(54.6)	110(53.4)	75(56.4)	0.235
Sales and Service	33(9.7)	17(8.3)	16(12.0)	
Manual (Skilled & Unskilled)	69(20.4)	46(22.3)	23(17.3)	
Professional	40(11.8)	28(13.6)	12(9.0)	
Unemployed	12(3.5)	5(2.4)	7(5.3)	
Occupation of mother (N=348)				
Agriculture/Farming	57(16.4)	28(13.3)	29(21.2)	0.016
Sales and Service	228(65.5)	149(70.6)	79(57.7)	
Manual (Skilled & Unskilled)	27(7.8)	17(8.1)	10(7.3)	
Professional	13(3.7)	9(4.3)	4(2.9)	
Unemployed	23(6.6)	8(3.8)	15(11.0)	

Table 2 Household characteristics of study respondents

Variable	Total N=349	Sex: n (%)		p-value
		Male	Female	
		n=211(60.5)	n=138(39.5)	
Household size				
≤ 5	70(20.1)	38(18.0)	32(23.2)	0.491
6-9	157(45.0)	98(46.5)	59(42.8)	
≥10	122(35.0)	75(35.6)	47(34.1)	

Table Continued...

Variable	Total N=349	Sex: n (%)		p-value
		Male	Female	
		n=211(60.5)	n=138(39.5)	
Household headship				
Father	255(73.1)	161(76.3)	94(68.1)	0.012
Mother	20(5.7)	12(5.7)	8(5.8)	
Other male relative	52(14.9)	32(15.2)	20(14.5)	
Other female relative	22(6.3)	6(2.8)	16(11.6)	
Household WASH Facilities & Electricity				
No facility (Bush, field, etc)	173(49.6)	103(48.8)	70(50.7)	0.705
Flush/pour flush	64(18.3)	37(17.5)	27(19.6)	
Public toilet (WC, Pit)	82(23.5)	50(23.7)	32(23.2)	
Pit Latrine	30(8.6)	21(10.0)	9(6.5)	
Households with Adequate Water & Sanitation (WASH)	63(35.8)	72(66.7)	41(60.3)	0.391
Improved source of drinking water	308(88.3)	190(90.1)	118(85.5)	0.198
Households with Electricity	322(92.3)	196(92.9)	126(91.3)	0.588
Wealth Quintile				
Quintile 1	70(20.0)	38(18.0)	32(23.2)	0.257
Quintile 2	70(20.0)	39(18.5)	31(22.5)	
Quintile 3	70(20.0)	41(19.9)	28(20.3)	
Quintile 4	70(20.0)	50(23.7)	20(14.5)	
Quintile 5	69(20.0)	42(19.9)	27(19.6)	

Improved source of drinking water: water from piped system, tube well or borehole, protected well, protected spring, rainwater collection, bottled water or sachet water

Unimproved source: water from unprotected well, unprotected spring, tanker truck or cart, surface water or other

Inadequate sanitation: Shared (public + sharing of household pit latrine & flush/pour)

Adequate sanitation: Not shared (Not sharing household flush/pour & pit latrine

On wealth quintile, 20% of adolescent households were found in each of quintile. Household wealth quintile ranges from 18.0% first quintile to 23.7% in the fourth quintile. In girls, the wealth quintile ranges from 14.5% in the fourth quintile to 23.2% in the first quintile (Table 2).

Table 3 showed 121(34.7%) had recent infections (i.e. diarrhoea/ cough or both) with 26 (7.5%) having both diarrhoea and cough. Diarrhoea incidence was 12.0% and cough was 30.1%. Over the two weeks prior to the survey. Girls who attained menarche was 73.9% and all surveyed schools were implementing the Girls Iron-Folate Tablet Supplementation (GIFTS) programme. Girls who took at least one (1) Iron and Folic Acid (IFA) tablet through the GIFTS programme in the school term was 83.3%. Mean dietary diversity score was 4.8±2.0 SD with 4.8± 1.8 SD and 4.9±2.1 SD among boys and girls respectively (Table 3). There was no statistical difference between mean dietary diversity score of males and that of females (p=0.9806). Low dietary diversity score was 29.5%, 70.5% had medium- to-high dietary diversity score with medium dietary diversity score of 33.5% and high dietary diversity score of 37.0%. Pica was 32.1% and did not differ by sex (p=0.384). Severe hunger was non-existent, with moderate hunger of 21.2% and that of little-to-no hunger was 78.8%. Consumption of cereals (97.8%), meat or fish or its products (81.2%) were more common than any other food groups. However, consumption of organ meat (10.1%), egg (27.5%) and milk and milk product (27.5%) were relatively low.

Mean weight was 50.0Kg (SD=9.7) and range (28.2, 86.3) Kg. Mean weight of girls (51.3±8.4SD) was significantly higher than that of boys (49.2±10.3SD) (p=0.0469). Mean height was 161.3cm (SD=9.4) and ranged (133.8, 193.3) cm. Boys were significantly taller than girls (p=0.0004). The mean height of boys was 162.7cm (SD=10.73) and that of girls was 159.09cm (SD=6.4). Underweight was 8.5% whiles overweight or obesity was 5.8% and stunting was 9.9% (Table 3). Underweight in boys (12.6%) was significantly higher compared to girls (2.2%) (p=0.001). Similarly, stunting in boys (14.6%) was significantly higher than that of girls (2.9%) (p<0.001). However, overweight/obesity in girls (10.9%) was significantly higher than in boys (2.4%) (p<0.001) (Table 3).

Mean haemoglobin concentration of adolescents was 13.3g/ dl (SD=1.7) and ranged (7.5, 18.2). Boys had a significantly higher mean haemoglobin concentration, 13.7±1.7g/dl compared to girls, 12.7±1.5g/dl (p<0.0001). The prevalence of anaemia was 25.2% with 24.2% in boys and 26.8% in girls. There was no statistically significant difference in the prevalence of anaemia among boys and girls (p=0.579) (Table 3) Sixty-nine (19.8%) was mildly anaemic and 5.4% had moderate-to-severe anaemia.

Table 3 Dietary practices, food security and anthropometry among adolescents

Variable	Total n (%)	Sex		p-value
		Male n (%)	Female n (%)	
Occurrence of Infections				
Reported Recent infections in the past 2 weeks	121(34.7)	73(34.6)	48(34.8)	0.972
Diarrhoea in the past 2 weeks	42(12.0)	24(11.4)	18(13.0)	0.639
Coughing in the past 2 weeks	105(30.1)	62(29.4)	43((31.2)	0.724
Dietary Practices				
Low dietary diversity Score	103(29.5)	64(30.3)	39(28.3)	0.687
Medium dietary diversity Score	117(33.5)	67(31.8)	50(36.2)	
High dietary diversity Score	129(37.0)	80(37.9)	49(35.5)	
Practice of pica(geophagy)	112(32.1)	64(30.3)	48(34.8)	0.384
Taking Supplements containing Iron in past 7 days	148(42.4)	78(37.0)	70(50.7)	0.011
Household Hunger Score (HHS)				
Little to no hunger (HHS≤1)	275(78.8)	111(80.4)	164(77.7)	0.545
Moderate hunger (HHS=2/3)	74(21.2)	27(19.6)	47(22.3)	
Severe hunger (HHS≥4)	0(0.0)	0(0.0)	0(0.0)	
Anthropometric				
Stunting	34(9.9)	30(14.6)	4(2.9)	< 0.001
Underweight	29(8.5)	26(12.6)	3(2.2)	0.001
Overweight/Obesity	20(5.8)	5(2.4)	15(10.9)	< 0.001
Anaemia (Mild & Moderate)	88(25.2)	51(24.2)	37(26.8)	0.579

Recent infection: includes reported possible diarrhoea/cough/both in the two weeks prior to the survey

Bivariate analysis of factors associated with anaemia among adolescent boys

At household level, sharing of toilet facilities, type of water and sanitation facilities, availability of electricity, BMI-for-age, and height-for-age were independently associated with anaemia. There were 70% reduced odds of anaemia among boys in households with improved water and sanitation compared to those with unimproved ones (OR=0.3, 95% CI= 0.1, 1.0, p=0.0268). Similarly, there was 90% reduced odds of anaemia among those in households with electricity compared to those without (OR=0.1, 95% CI= 0.1, 0.4, p=0.0003). Also, adolescents who had Low BMI-for-age (thinness/underweight) were 2.6 times more likely to be anaemic compared to those with normal (OR=2.6.5, 95% CI= 1.1, 6.0, p=0.0348). Normal/overweight among boys was associated with 60% decreased odds of anaemia. Low height-for-age (stunting) was associated with 2.3 times odds of anaemia among stunted boys (p=0.0450).

Multiple variables analysis of factors associated with anaemia in adolescent boys

Household wealth and stunting were significant factors associated with anaemia. In addition, household hunger was borderline significant associated factor of anaemia. There were 50% reduced odds of anaemia among adolescents in upper 60% wealth quintile households compared to those in the lower 40% after adjusting for age, father's education, mother's education and household hunger (OR=0.5, 95%CI= 0.2, 1.0, p=0.049). The odds of anaemia were 2.7 times higher in stunted boys as compared to those who were normal (OR=2.7, 95%CI= 1.1, 6.8, p=0.034) and 2.2 times among those who lived in households with moderate-to-severe level of hunger as compared to those in households with little-to-no-hunger (OR=2.2, 95%CI= 0.9, 5.2, p=0.082) (Tables 4–6).

Table 4 Bivariable associations between anaemia and socio-demographic characteristics of adolescent boys

Variable	N=211	Anaemia (%)	OR (95%CI)	p-value
Age group (years)				
Less than 15	58	11(19.0)	-	0.2685
15 & above	153	40(26.1)	1.5(0.7, 3.2)	

Table Continued...

Variable	N=211	Anaemia (%)	OR (95%CI)	p-value
Religion				
Christianity	17	2(11.8)	-	0.181
Islamic	194	49(25.3)	2.5(0.6, 11.5)	
Household size				
≤5	38	6(15.8)	-	0.1665
6+	173	45(26.0)	1.9(0.7, 4.8)	
Household headship				
Female	18	4(22.2)	-	0.8386
Male	193	47(24.4)	1.1(0.4, 3.6)	
Main Source of Water for Drinking.				
Unimproved source	21	5(23.8)	-	
Improved source	190	46(24.2)	1.0(0.4, 2.9)	0.9675
Type of toilet facility used at household level				
No facility (Bush, field, etc)	103	24(23.3)	-	0.6758
Flush/pour flush	37	7(18.9)	0.8(0.3, 2.0)	
Public toilet (WC, Pit)	50	15(30.0)	1.4(0.7, 3.0)	
Pit Latrine	21	5(23.8)	1.0(0.3, 3.1)	
Sharing of household toilet				
Not shared (Not sharing of pit latrine & flush)	36	5(13.9)	-	0.0506
Shared (Sharing pit latrine, flush & public)	72	22(30.6)	2.7(0.9, 8.0)	
Type Water and Sanitation (WASH) facilities				
Unimproved	180	48(26.7)	-	0.0268
Improved	31	3(9.7)	0.3(0.1, 1.0)	
Availability of electricity at household				
Not Connected/Not available	15	10(66.7)	-	0.0003
Connected /Available	196	41(20.9)	0.1(0.0, 0.4)	
Wealth Quintile				
Lowest 40% (1st & 2nd Quintile)	77	23(29.9)	-	0.1463
Highest 60% (3rd, 4th & 5th Quintile)	134	28(20.9)	0.6(0.3, 1.2)	
Father's education				
No education	125	35(28.0)	-	0.1821
At least basic (Primary & above)	58	11(19.0)	0.6(0.3, 1.3)	
Mather's Education				
No education	150	42(28.0)	-	0.1269
At least basic (primary & above)	37	6(16.2)	0.5(0.2, 1.3)	
Occupation of the Father				
Unemployed	11	2(18.2)	-	0.7039
Other Employment	90	20(22.2)	1.3(0.3, 6.4)	
Agriculture	110	29(26.4)	1.6(0.3, 7.9)	

Table 5 Bivariable associations between anaemia among adolescent boys and demographic variables in public Junior High Schools, Sagnarigu District, 2020

Variable	N	Anaemia (%)	OR (95%CI)	p-value
Occupation of the mother				
Unemployed	8	1(12.5)	-	0.3243
Other Employment	54	10(18.5)	1.6(0.2, 14.4)	
Sales & Services	149	40(26.9)	2.6(0.3, 21.5)	
History of possible infections (Cough/Diarrhoea/Both)				
No history of infections	138	33(23.9)	-	0.9045
History of infections	73	18(24.7)	1.04(0.5, 2.0)	
bmi-for-Age				
Normal and Overweight	180	40(24.3)	-	0.0348
Underweight	26	11(42.3)	2.6(1.1, 6.0)	
height-for-age				
Normal	176	36(22.2)	-	0.045
Stunted	30	12(40.0)	2.3(1.0, 5.3)	
Dietary Diversity Score				
Low dietary diversity Score (DDS≤3)	53	13(24.5)	-	0.7122
Medium dietary diversity Score (DDS=4/5)	74	20(27.0)	1.1(0.5, 2.6)	
High dietary diversity Score (DDS≥6)	84	18(21.4)	0.8(0.4, 1.9)	
Household hunger Score				
Little-to-no hunger (HHS≤1)	164	37(22.6)	-	0.3157
Moderate-to-Severe hunger (HHS=2/3)	47	14(29.8)	1.5(0.7, 3.0)	

Table 6 Multiple variable analysis of factors associated with anaemia among adolescent boys in Sagnarigu District, 2020

Variable	Odds ratio	(95%CI)	p-value
Age (years)			
14-Oct	1	-	
15-19	1.2	(0.5, 2.9)	0.703
Wealth quintile			
Lowest 40%	1	-	
Highest 60%	0.5	(0.222, 0.996)	0.049
Father's education			
No Education	1	-	
Primary & above	0.9	(0.4, 2.1)	0.814
Mother's education			
No Education	1	-	
Primary & above	0.4	(0.2, 1.3)	0.128
Stunting			
Normal	1	-	
Stunted	2.7	(1.1, 6.8)	0.034
Household hunger			
Little-to-no Hunger	1	-	
Moderate-to-Higher Hunger	2.2	(0.9, 5.2)	0.082

Discussion

Our study aimed to estimate the prevalence of anemia among adolescents, whether it differs by sex and the factors causing it among boys in the Sagnarigu district of Northern Region. We found 1 in every 4 adolescents (25.2%) in public JHSs in the district anaemic. There was no statistically significant difference in prevalence between girls (26.8%) and boys (24.2%) (P=0.579). We therefore failed to reject the null hypothesis of equal prevalence of anaemia in both sexes. We also found that only household wealth and stunting were predictors of anaemia.

The similarity in the burden of anaemia among male and female JHS students coupled with the finding that household wealth was a determinant of anaemia among the boys may suggest that household circumstances are more predictive of anaemia among adolescents than biological mechanisms such as menstruation. Indeed, the marginally higher prevalence of anaemia among girls compared to boys could be attributed to nutrition interventions such has the GIFTS programme targeted at only adolescent girls. This might have resulted in improved knowledge on anaemia and its preventive measures among girls and have reduced the gap between both sexes.

The prevalence in this study was consistent with report among North-Western Ugandan children 1-14 years (p= 0.224) (Legason, et al., 2017). However, it contrasts with that of Christian & Smith, (2018) where the prevalence of iron deficiency and iron deficiency anaemia was reported to be higher among adolescent females than males globally.

The present estimated burden in girls is comparable to the 24.9% reported among Ethiopian girls 15-19 years and lower than the 40%

prevalence for girls 15-19years reported for the ECOWAS region (Worku, Tesema, & Teshale, 2020; ECOWAS, 2016). Similarity, prevalence could be due to the similar biological traits and dietary practices exhibited by adolescents living in Sub-Saharan Africa. Our findings could also be due to impact of public health interventions put in place across the Sub-region since 2016.

The 26.8% prevalence of anaemia in girls is consistent with 26.4% reported in the 2017 Ghana micronutrients survey for girls 15-19 years and similar to the 23.5% prevalence reported in the GIFTS based-line survey among school-going girls in the five (5) regions of Ghana (Gosdin et al., 2020; Wegmüller et al., 2020). This could be due to the similarity in the characteristics of study participants, (i.e. school-going adolescents). The current prevalence in girls is however lower compared to the 48% prevalence reported in the 2014 GDHS for 15-19years girls. The lower prevalence reported in this survey could also be attributed to the public health interventions ongoing in schools, which may result in increased knowledge and change in behaviours towards anaemia prevention. The current prevalence of 24.2% in boys is however high relative to the 13·1% among school-going boys in Western, Western North and Upper West regions of Ghana and 10.9% prevalence reported among adolescent boys in the Upper West region (Gosdin et al., 2020).

The only demographic factor predicting anaemia among boys in this study was wealth after adjusting for adolescent age, level of education of father, level of education of mother, stunting and food security. This is consistent with the findings of Gosdin et al., (2020) on school-going adolescents in five (5) regions of Ghana. The present study revealed 50% less likelihood of developing anaemia among the upper 60% wealth quintile as compared to the lower 40%. This indicates that anaemia is not just a health issue but an economic issue. Hence, interventions addressing anaemia should not lose sight of the livelihood programmes that seeks to improve the economic status of households. However, contrary to findings of Gosdin et al., (2020), this study did not find any association between anaemia and geophagy.

The prevalence of stunting reflects chronic nutritional inadequacies as well as chronic/recurrent infections. About 1 in every 10 adolescents was stunted and was more common in boys (14.6%) as compared to girls (2.9%). The prevalence in this study was lower and differences in sex was consistent with the report among Nigerian school children (Ayogu, et al., 2016). Further research is needed to unravel what might be accounting for this in adolescents.

Stunting was the only anthropometry predictor of anaemia among boys after adjusting for age, wealth, father's education, mother's education and food security (P=0.034; 95% CI=1.1, 6.8). This was consistent with the report among Indonesia Junior High School Children 12-14years (Puristasari & Fatimah, 2016), but inconsistent with report among Nigeria adolescents 12-18years (Ayogu et al., 2016). Stunting could be because of prolong or chronic infections among adolescents. The higher burden of anaemia among stunted adolescents could be confounded by infections as established in literature to be a predictor of anaemia in all ages (Stephenson, etel, 1993; WHO, 2011 Zaas, etel, 2015). However, this study did not biologically measure the presence of infections among adolescents and therefore could not biologically ascertain the association of infections and anaemia.

Though the intake of diversified foods is supposed to protect against anaemia, a lack of correlation between dietary diversity and anaemia has been documented in some studies, especially in environments where factors other than dietary exposure may increase the risk of anaemia. In many studies, neither minimum dietary diversity as a composite index nor consumption of particular food groups (e.g. grains, vegetables, flesh foods and eggs) have been reported to be associated with anaemia (Mikki, et al.,2011). This is consistent with the findings in this study. We found no association between dietary diversity and anaemia among adolescent boys consistent with Saaka & Galaa, (2017) on Ghanaian children under age 5years and inconsistent with report on pregnant women attending public health facilities in Ethiopia (Delil, Tamiru, & Zinab, 2018). Other studies in Southwestern Nigeria and Dembia district in Northwest Ethiopia among adolescent girls also found an association between anaemia and dietary diversity contrary to the present findings (Gonete, et al., 2018:Olumakaiye, 2013).

The odds of having anaemia were 2.2 times higher among adolescents from moderate food-insecure households compared to their counterparts. Our findings was lower compared to 4.1 odds reported among adolescents girls in senior high schools in Southwest Ethiopia (Gonete et al., 2018). In fact, household food insecurity impairs micronutrient intake of household members which in turn increases the likelihood of developing anaemia (Moradi, et al., 2018; Scholl, 2005). However, in this study there was no significant association between food insecurity and anaemia.

Conclusion

In conclusion, in the Sagnarigu district, anaemia among adolescents equally affects boys and girls, suggesting that family and household circumstances may be more answerable for the anaemia rather than biology. Dietary quality was sub-optimal among adolescents in the district and one in five households were moderately food insecure. Indeed, irrespective of the adolescent's age, educational level of parents and food security in the household, anaemia among boys was predicted by household wealth and stunting.

Recommendations

i. Ghana Health Service should extend the Girls Iron-Folate Tablets Supplementation (GIFTS) programme to include adolescent boys based on the current prevalence established in this survey. Before this is done, there may be the need to have a larger and better powered study to confirm these results.

ii. Anaemia prevention strategies implemented by the government of Ghana should target boys, as well as supporting poorer households with pro-poor interventions.

iii. Strategies by the Ghana Health Service and other agencies in the Ministry of Health and Education must, in the short to medium term (next 2-5 years) use stunting among adolescents (which is more reliably measured in larger and better powered surveys) as an indicator of nutritional challenge and for targeting interventions to address anaemia.

iv. Ghana Health Service in collaboration with Ghana Education Service through the School Health Education Programme (SHEP) should intensify health and nutrition education in the schools to contribute in addressing all forms of malnutrition especially anaemia. Since children cannot implement the promoted practices, parent-teacher association (PTA) meetings could be used as a medium to promote messages about adolescent nutrition.

Limitation

No measurement of biological predictors of anaemia was done.

Acknowledgments

None.

Funding

None.

Conflicts of interest

I declare no competing interest in this study.

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