Original Article

Child Nutrition and Health Indicators as Predictors of Academic Performance among Primary School Children in Binduri District, Ghana

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Abstract: Child nutrition and health indicators are crucial for monitoring child growth and predicting health outcomes. Poor health in early childhood can negatively affect cognitive abilities and academic achievement, while poor nutritional indicators have been linked to lower academic performance in children. This study was aimed at assessing child nutrition and health indicators as predictors of academic performance among primary school children in Binduri District, Ghana. Overall, 460 children from 63 schools were studied to assess the relationship between child nutrition, health indicators, socioeconomic status and academic performance. Data was collected through questionnaires, height/weight measurements, and academic records. Statistical methods such as Chi-squared tests and binary regression were used to determine associations with a 95% confidence level and 5% precision. Overall, stunting (cOR =2.44, 95% CI: 1.17-5.11, p=0.018) and thinness (a OR=11.75, 95% CI: 3.99-34.60, p<0.0001) were significantly associated with poor academic performance, while wasting and overweight were not. Second intermittent preventive treatment in infants is strongly associated with poor academic performance (a OR=6.50, 95% CI: 2.02-20.89, p=0.002), while yellow fever vaccination at 9 months is negatively associated with poor academic performance (c OR=0.21, 95% CI: 0.05-0.88, p=0.032). Children aged 11-14 years (OR=0.40, 95% CI: 0.22-0.71, p=0.002), Muslim children (a OR=2.14, 95% CI: 1.04-4.41, p=0.039), public school attendees (a OR=6.58, 95% CI: 2.13-20.32, p=0.001) children with separated or divorced parents (a OR=7.22, 95% CI: 2.85-18.31, p<0.0001) all had significant associations with poor academic performance. This study highlights the association between child nutrition, health indicators and academic performance in primary school children in Ghana's Binduri District. Interventions to reduce stunting and thinness and increase access to yellow fever vaccination should be prioritized. School policies should also consider demographic factors affecting academic performance to provide targeted support to at-risk students.

Keywords: child nutrition, health indicators, academic performance

1. INTRODUCTION

Child nutrition and health indicators are essential for monitoring child growth and development and predicting future health outcomes. Anthropometry refers to the measurement of human body size and composition. Nutritional indicators, including height, weight, and body mass index (BMI), can provide information on the nutritional status of children. Malnutrition in childhood can lead to stunted growth and impaired cognitive development, which can negatively impact academic performance [1].

Academic performance is a critical outcome measure of education. Several studies have examined the relationship between child nutrition, health indicators and academic performance, and have found that poor health in early childhood can negatively impact academic achievement [2]. Research studies have suggested that child nutrition and health indicators are strong predictors of academic performance in children worldwide. A study conducted in Pakistan found that children with a healthy birth weight had higher academic scores than children with a low birth weight. The study also revealed that children with a history of malnutrition had lower academic performance than children without a history of malnutrition [3]. Another study in Brazil found a significant association between height-for-age and academic performance in children aged 8-11 years. The study concluded that taller children performed better academically than shorter children [4]. Several studies have found a significant association between child nutrition, health indicators and academic performance in Africa. For example, a study conducted in Nigeria [5] found that children with a history of malnutrition had lower academic performance compared to their well-nourished peers. Similarly, a study conducted in Ghana [6] found that children who had received all the recommended childhood vaccinations had higher academic achievement scores compared to those who had not received all the vaccinations. Similarly, a study conducted in Ghana [7] found that children who were both stunted and underweight had lower academic achievement scores compared to those who were either stunted or underweight. The authors suggested that the combined effects of stunting and underweight could lead to a greater risk of cognitive impairment, which could affect academic performance. Child nutrition and health records, including vaccination status, history of illness, and nutritional status, are significant predictors of academic performance in Sub-Saharan Africa (SSA). Children with a history of illness and poor nutritional status were more likely to have lower academic performance than their healthy peers. Nutritional indicators, including height-for-age, weight-for-age, and body mass index (BMI), was also found to be a significant predictor of academic performance. Children with nutritional indicators were more likely to have lower academic performance than their well-nourished peers. The Upper East Region, where Binduri district is located, has 28% of households that are severely or moderately food insecure, which is among the highest in Ghana [8]. Stunting and wasting are common among school children in underdeveloped nations, including Ghana and the Upper East region [9]. High levels of stunting among children suggest that there will also be a long-term deficit in mental and physical development that leaves children unable to take maximum advantage of learning opportunities in schools [10]. In the Binduri District of Ghana, where poverty and malnutrition are prevalent, many children are at risk of poor academic performance due to inadequate healthcare and nutrition [11]. To address this issue, this study investigated the relationship between child nutrition and health indicators Nd academic performance among primary school children in Binduri District. The aim of this study is to establish the relationship between child nutrition and health indicators and academic performance of school children in Binduri district, to assess the academic performance of school children in the Binduri District, to assess health status of school children in the Binduri district, to assess the nutritional status of school children in the Binduri District, to determine the relationship between child health and nutritional status and academic performance of school children.

2. MATERIALS & METHOD

This study was conducted using the cross-sectional survey design. This method ensures the selection of participants at a specific point in time and within a catchment area who represent the population of interest [12]. This study was conducted within the Binduri District in the Upper East Region of Ghana. The district recorded a pass rate of 49.1% in the 2021 Basic Education Certificate Examination. A study conducted in the Binduri district indicates that two out of every three Women of Reproductive Age (WRA) were anemic, with more than three quarters of the study participants having normal Body Mass Index (BMI) [13]. The district has a total of 43 Public Primary Schools and 20 private primary schools.

There are 38 Junior High Schools of which 29 are Public and 8 are private. It also has one Senior High School and three vocational training schools. The Ghana Education Service in the district has five circuits and a total student population of 22,325 with 4,823 in kindergarten, 13,155 in Primary school, 3,315 in Junior High School and 1,032 in Senior High and Vocational training institutions. All school children aged between 7 and 14 years within the Binduri District who met the inclusion criteria were part of the study population. The rationale for choosing this age group is that generally, this age group covers the age range of upper primary school students in Ghana. The sample size that was used for this study was determined using the finite population formula for sample size. The sample size was calculated based on the pass rate for the 2021 BECE performance in the district, which is 49.1%, with a Population of 16,334 children aged 7-14 years, at the 95% confidence level, with a design effect of 1 and a precision of 5%.

$$= \frac{Deff * N * p * (1-p)}{d^2/_{z^2} * (N-1) + p * (1-p)}$$

Where;

Deff is the design effect

N: is the finite population (16,334); from the 2021 population census

P: Hypothesized % frequency of academic performance in the population (49.1%)

D: Confidence limits as % of 100(absolute +/- % (5%)

Z: is the z-value at the 95% confidence level

Hence N = 376

Aadding a non-response rate of 10% =376+26= N≈ 414

Therefore, a sample size of 414 participants was required for this study. The study employed a multistage sampling technique to ensure a representative sample. In the first stage, all five circuits within the district were included, and schools were selected using a list obtained from the Binduri District office of the Ghana Education Service. In the second stage, participant selection was based on the proportionate-to-size procedure. The sample size required for each selected school was calculated, taking into account the allotted sample size. The proportion of eligible students was determined using simple random sampling. Pieces of paper with "YES" or "NO" were placed in a bag, and only eligible students meeting the predefined criteria were asked to pick a paper. Overall, a total of 460 eligible participants (students) were identified and recruited for the study through this rigorous multistage sampling process. An interviewer administered semi- structured questionnaire was used to collect data. The questionnaire was organized into three sections. Each of the sections was designed to assess various variables. The first section elicited responses on participants' socio-demographic characteristics. The second section was a data extraction sheet that collected data on participants' academic information (Mathematics and English results for the three most recent end of term examination) from their cumulative record book that was obtained from the school. The third and last section had a data extraction sheet that was used to gather information on the child's vitamin A supplementation, immunization history, birth weight and weight over the first 24 months. These details were extracted from the child health record book which they were asked to bring to school. The anthropometry was taken during their breaks and after close of school. Weight in kilograms was taken using digital SECA® weighing scale. The weight was recorded to the nearest 100 g (0.1 kg). Each pupil was measured thrice and an average of the two closest readings taken to minimize measurement

errors. A reading range of plus or minus two was acceptable. Measurements was taken with the pupils in light clothing to minimize error due to different texture and weight of clothing. Before commencing each day, the weighing scale was inspected and checked for accuracy and consistency by using a known 2 kg weight. Height in meters was measured using SECA stadiometer, model 213 Hamburg August 2014 without footwear, with the occiput, back of chest, buttocks and heel touching the vertical plane and head in the horizontal Frank-fort plane. The height was recorded to the nearest one millimeter. With a horizontal line of sight to the participant, the head piece of the stadiometer was used to ensure that the top of the head is measured at right angle to the wall. Weight and height of each child was entered accordingly into their checklists, which was checked for completeness at the end of each day. The body mass index was calculated using the formula;

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

Weight was measured in kilograms (Kg) and height in meters (M). Data was downloaded from Kobo Collect, cleaned and then exported to Stata version 17.0 for analysis. Statistical significance of association was considered at 95% confidence interval of p-value of <0.05. Undernutrition was derived from either underweight, thinness, stunting or combination of these. The anthropometric parameters, height-for-age Z score and Body Mass Index-for-age Z score was calculated using WHO Anthro Plus software. Values were compared to the recommended 2011 WHO growth charts. Nutritional status (e.g., underweight, overweight, obesity, stunting, thinness and wasting) were defined using the appropriate cut-off Z-scores as recommended by World Health Organization. Obesity was defined as >2+ Z score, overweight was defined as >+1Z score and <-2Z score was defined for thinness using BMI-for-age indicator. The WHO 2011 criteria for measuring malnutrition in school-age children and adolescent was used. Vaccination schedule was calculated at birth, 4 months, 6 weeks, 10 weeks, 14weeks, 9 months and 18 months. Logistic regression was used to analyze vaccine uptake in relation to academic performance.

Table 01: Ghana Education Service Grading System

Grade	Score	Description
A+	90-100	Highest
A	80-89	Higher
B+	70-79	High
B	60-69	High average
C+	55-60	Average
C	50-54	Low average
D+	40-49	Low
E	35-39	Lower
F	0-34	Lowest

3. RESULTS & DISCUSSION

From table 02, Out of the 460 students, 172 (37.4%) were males and 288 (62.6%) were females. The mean age of all students was 9.96 years with a standard deviation of 1.68. Male students had a lower mean age of 9.67 years, while female students had a higher mean age of 10.14 years, and this difference was statistically significant (p=0.004). Regarding religion, 60.9% of the students identified as Christian, and 39.1% identified as Muslim. When it comes to the type of school, 59.1% of students attended public schools while 40.9% attended private schools. There was a significant difference between male and

female students in terms of the type of school they attended (p=0.001), with more males attending private schools. In terms of the class, 57.4% of the students were in lower primary, and 42.6% were in upper primary. There was no significant difference in the distribution of classes between male and female students (p=0.070). Also, 15.6% of the students had repeated a class, and 5.2% had skipped a class. There was no significant difference in the distribution of repeating any class and private extra tuition between male and female students. However, there was a significant difference in the distribution of skipping any class between male and female students (p=0.002). The majority of the students (73%) lived in rural areas, while 27% lived in urban areas. There was no significant difference in the distribution of place of residence between male and female students (p=0.221).

Table 02: Demographic and Educational characteristics of the School Children

Demographic characteristics and features of blood donors

Variables	Total [N=460] n (%)	Male students [N=172] n (%)	Female students [N=288] n (%)	χ2 (p-value)
Mean (SD)	9.96 (1.68)	9.67 (1.73)	10.14 (1.63)	8.36 (0.004)
Age (In years)				0.23 (0.635)
7 – 10	304 (66.1)	116 (67.4)	188 (65.3)	
11 – 14	156 (33.9)	56 (32.6)	100 (34.7)	
Religion				2.95 (0.086)
Christian	280 (60.9)	96 (55.8)	184 (63.9)	
Muslim	180 (39.1)	76 (44.2)	104 (36.1)	
Type of School				12.04 (0.001)
Private	188 (40.9)	88 (51.2)	100 (34.7)	
Public	272 (59.1)	84 (48.8)	188 (65.3)	
Class				3.27 (0.070)
Lower Primary	264 (57.4)	108 (62.8)	156 (54.2)	
Upper Primary	196 (42.6)	64 (37.2)	132 (45.8)	
Repeat any class (yes)	72 (15.6)	28 (16.3)	44 (15.3)	0.08 (0.775)
Skip any class (yes)	24 (5.2)	16 (9.3)	8 (2.8)	9.27 (0.002)
Private extra tuition (yes)	128 (27.8)	48 (27.9)	80 (27.8)	0.00 (0.976)
Place of residence				1.50 (0.221)
Urban	124 (27.0)	52 (30.2)	72 (25.0)	
Rural	336 (73.0)	120 (69.8)	216 (75.0)	

Table 03: Demographic and Socioeconomic characteristics of parents of the school children

Variables	Total [N=460] n (%)	Male students [N=172] n (%)	Female students [N=288] n (%)	χ2 (p-value)
Marital status				1.98 (0.371)
Married	360 (78.3)	140 (81.4)	220 (76.4)	
Separated/Divorce	84 (18.3)	28 (16.3)	56 (19.4)	
Widowed	16 (3.4)	4 (2.3)	12 (4.2)	

Educational level of mother				14.94 (0.001)
No education	148 (32.2)	40 (23.2)	108 (37.5)	
Basic (Primary/JHS)	192 (41.7)	72 (41.9)	120 (41.7)	
SHS/ Tertiary	120 (26.1)	60 (34.9)	60 (20.8)	
Educational level of father (n=448)*				6.09 (0.107)
No education	100 (22.3)	48 (28.6)	52 (18.6)	
Basic (Primary/JHS)	172 (38.4)	60 (35.7)	112 (40.0)	
SHS	48 (10.7)	16 (9.5)	32 (11.4)	
Tertiary	128 (28.6)	44 (26.2)	84 (30.0)	
Mother's occupation				2.71 (0.259)
No employment (House wife/ student)	20 (4.3)	4 (2.3)	16 (5.5)	
Self-employed (Artisan/ farming/ trading)	356 (77.4)	136 (79.1)	220 (76.4)	
Civil servant (Health professions/ teaching)	84 (18.3)	32 (18.6)	52 (18.1)	
Father's occupation (n=448)*				0.10 (0.748)
Self-employed (Artisan/ farming/ trading)	316 (70.5)	120 (71.4)	196 (70.0)	
Civil servant (Health professions/ teaching)	132 (29.5)	48 (28.6)	84 (30.0)	
Household size				2.74 (0.098)
2 – 5	160 (34.8)	68 (39.5)	92 (31.9)	
6+	300 (65.2)	104 (60.5)	196 (68.1)	
Note: * (Deceased), JHS (Junior High School), SHS (Senior High School).				

From table 03, the Chi-square test statistic is 16.40, with a p-value of 0.037, which suggests that there is a statistically significant association between gender and academic performance. Grade A+ was the highest grade, and only 3.5% of students received this grade. Among male students, 2.3% received an A+, while among female students, 4.2% received an A+. Also, 13% of students received an A, with male students (18.6%) receiving this grade slightly more frequently than female students (9.7%). Additionally, 13% of students received a B+, with male and female students receiving this grade at a similar rate. Also, 24.4% of students received a B, with male students (27.9%) receiving this grade slightly more frequently than female students (22.2%). Also, 7% of students received a C+, with male students (4.7%) receiving this grade slightly less frequently than female students (8.3%). For grade C, 7.9% of students received it with male students (4.7%) receiving this grade slightly less frequently than female students (9.7%). For grade D+, 13% of students received it with male and female students receiving this grade at a similar rate. For grade E, only 3.5% of students received it, with male and female students receiving this grade at a similar rate. Grade F is the lowest grade, and 14.8% of students received this grade. Male and female students received this grade at a similar rate.

Table 04: Academic Performance of the school children

Variables	Total [N=460] n (%)	Male students [N=172] n (%)	Female students [N=288] n (%)	χ2 (p-value)

Grade	Score			Description		
A+	90-100	Highest	16(3.5)	4(2.3)	12(4.2)	16.40**(0.037)**
A	80-89	Higher	60(13.0)	32(18.6)	28(9.7)	
B+	70-79	High	60(13.0)	24(14.0)	36(12.5)	
B	60-69	High average	112(24.4)	48(27.9)	64(22.2)	
C+	55-60	Average	32(7.0)	8(4.7)	24(8.3)	
C	50-54	Low average	36(7.9)	8(4.7)	28(9.7)	
D+	40-49	Low	60(13.0)	20(11.6)	40(13.9)	
E	35-39	Lower	16(3.5)	4(2.3)	12(4.2)	
F	0-34	Lowest	68(14.8)	24(14.0)	44(15.3)	

Table 05: Childhood Immunization coverage of the school children

Variables	Gender [n (%)]			χ2 (p-value)
	Total [N=460] n (%)	Male students [N=172] n (%)	Female students [N=288] n (%)	
Vaccinations at birth				
BCG	460 (100.0)	172(100.0)	288(100.0)	
Polio 0	136 (29.6)	76(44.2)	60(20.8)	28.20(<0.0001)
Hepatitis B	20 (4.3)	8(4.7)	12(4.2)	0.06(0.805)
Vaccination at 6 weeks				
Polio 1	456 (99.1)	168(97.7)	288(100.0)	(0.019) *
DPTH Hep B 2	456 (99.1)	168(97.7)	288(100.0)	(0.019) *
Pneumococcal 1	148 (32.2)	84(48.8)	64(22.2)	34.96(<0.0001)
Rotavirus 1	144 (31.3)	80(46.5)	64(22.2)	29.54(<0.0001)
Vaccination at 10 weeks				
Polio 2	460 (100.0)	172(100.0)	288(100.0)	
DPTH Hep B 2	452 (98.3)	172(100.0)	280(97.2)	(0.028) *
Pneumococcal 2	144 (31.3)	84(48.8)	60(20.8)	39.27(<0.0001)
Rotavirus 2	144 (31.3)	84(48.8)	60(20.8)	39.27(<0.0001)
Vaccination at 14 weeks				
Polio 3	452 (98.3)	172(100.0)	280(97.2)	(0.028) *
DPTH Hep B 3	448 (97.4)	172(100.0)	276(95.8)	(0.005) *
Pneumococcal 3	148 (32.2)	84(48.8)	64(22.2)	34.96(<0.0001)
Supplementation at 6 months				
Vitamin A 100000IU	368 (80.0)	136(79.1)	232(80.6)	0.15(0.700)
Vaccination at 9 months				
Measles 1	448 (97.4)	172(100.0)	276(95.8)	7.36(0.007)
Yellow Fever	452 (98.3)	172(100.0)	280(97.2)	(0.028) *
Supplementation at 12 months				
Vitamin A 200000IU	412 (89.6)	160(93.0)	252(87.5)	3.52(0.061)
Vaccination/ Supplementation at 18 months				

	Vitamin A 200000IU	388 (84.3)	160(93.0)	228(79.2)	15.67(<0.0001)
	Measles 2	144 (31.3)	84(48.8)	60(20.8)	39.27(<0.0001)
	Meningitis A	136 (29.6)	80(46.5)	56(19.4)	37.89(<0.0001)
	Other interventions				
LLIN		316 (68.7)	116(67.4)	200(69.4)	0.20(0.654)
First IPT i		180 (39.1)	52(30.2)	128(44.4)	9.13(0.003)
Second IPT i		160 (34.8)	60(34.8)	100(34.7)	0.0012(0.972)
Third IPT i		132 (29.7)	36(21.4)	96(34.8)	8.91(0.003)
Note: BCG (Bacille Calmette-Guérin), DPTH-Hep B (Diphtheria, Pertussis, Tetanus, and Hepatitis B), LLIN (Long-Lasting Insecticidal Net), IPT i (Intermittent Preventive Treatment in Infants), *(Fisher exact p-values).					

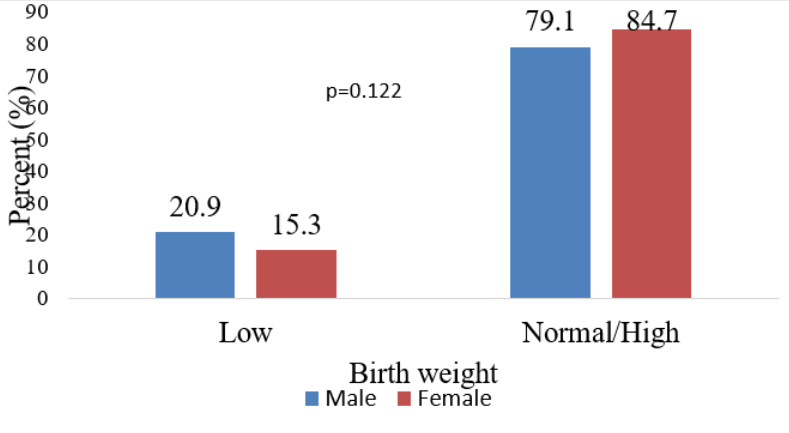

Figure 01: Birthweight and sex of the school children

Table 06: Nutritional status of the school children from measuring participants

Variables	Total [N=460] n (%)	Male students [N=172] n (%)	Female students [N=288] n (%)	χ2; p-value
Mean height (cm)	134.5 (10.2)	132.0 (9.7)	135.9 (10.2)	**16.44; 0.001**
Mean weight (kg)	28.2 (7.0)	26.7 (6.3)	29.0 (7.3)	**11.72; 0.001**
Weight for height (SD)	-0.8 (1.0)	-0.9 (1.1)	-0.7 (0.9)	1.83; 0.177
Wasting (WHZ)				**8.97; 0.003**
Normal	280 (92.1)	100 (86.2)	180 (95.7)	
Wasted	24 (7.9)	16 (13.8)	8 (4.3)	
Height for age (SD)	-0.6 (1.0)	-0.7 (1.0)	-0.5 (1.0)	1.77; 0.185
Stunting (HAZ)				0.83; 0.362
Normal	424 (92.2)	156 (90.7)	268 (93.1)	
Stunted	36 (7.8)	16 (9.3)	20 (6.9)	
BMI for age (SD)	-0.9 (1.1)	-1.0 (1.0)	-0.9 (1.1)	1.98; 0.160

BMI (BAZ)				(0.510) *
Thinness	68 (14.8)	28 (16.3)	40 (13.9)	
Normal	376 (81.7)	140 (81.4)	236 (81.9)	
Overweight/ Obese	16 (3.5)	4 (2.3)	12 (4.2)	
Note: *(Fisher exact p-values).				

Table 07: Association between Childhood Immunization and Academic Performance

Variables	Academic performance [n (%)]			χ2 (p-value)
	Total [N=460] n (%)	Above average [N=376] n (%)	Below average [N=84] n (%)	
Vaccinations at birth				
BCG	460 (100.0)	376 (100.0)	84 (100.0)	
Polio 0	136 (29.6)	108 (28.7)	28 (33.3)	0.70 (0.403)
Hepatitis B	20 (4.3)	16 (4.3)	4 (4.8)	(0.771) *
Vaccination at 6 weeks				
Polio 1	456 (99.1)	372 (98.9)	84 (100.0)	(1.00) *
DPTH Hep B 2	456 (99.1)	372 (98.9)	84 (100.0)	(1.00) *
Pneumococcal 1	148 (32.2)	116 (30.8)	32 (38.1)	1.65 (0.199)
Rotavirus 1	144 (31.3)	112 (29.8)	32 (38.1)	2.20 (0.138)
Vaccination at 10 weeks				
Polio 2	460 (100.0)	376 (100.0)	84 (100.0)	
DPTH Hep B 2	452 (98.3)	368 (97.9)	84 (100.0)	(0.361) *
Pneumococcal 2	144 (31.3)	112 (29.8)	32 (38.1)	2.20 (0.138)
Rotavirus 2	144 (31.3)	112 (29.8)	32 (38.1)	2.20 (0.138)
Vaccination at 14 weeks				
Polio 3	452 (98.3)	368 (97.9)	84 (100.0)	(0.361) *
DPTH Hep B 3	448 (97.4)	364 (96.8)	84 (100.0)	(0.135) *
Pneumococcal 3	148 (32.2)	116 (30.8)	32 (38.1)	1.65 (0.199)
Supplementation at 6 months				
Vitamin A 100000IU	368 (80.0)	296 (78.7)	72 (85.7)	2.10 (0.148)
Vaccination at 9 months				
Measles 1	448 (97.4)	368 (97.9)	80 (95.2)	(0.245) *
Yellow Fever	452 (98.3)	372 (98.9)	80 (95.2)	**(0.040) ***
Supplementation at 12 months				
Vitamin A 200000IU	412 (89.6)	336 (89.4)	76 (90.5)	0.09 (0.763)
Vaccination/ Supplementation at 18 months				
Vitamin A 200000IU	388 (84.3)	316 (84.0)	72 (85.7)	(0.868) *
Measles 2	144 (31.3)	116 (30.8)	28 (33.3)	0.20 (0.657)
Meningitis A	136 (29.6)	108 (28.7)	28 (33.3)	0.70 (0.403)
LLIN	316 (68.7)	260 (69.1)	56 (66.7)	0.20 (0.657)
First IPTi	180 (39.1)	14 (38.3)	36 (42.9)	0.60 (0.439)
Second IPTi	160 (34.8)	120 (31.9)	40 (47.6)	**7.46 (0.006)**

Third IPTi	132 (29.7)	100 (27.8)	32 (38.1)	3.47 (0.062)
Note: BCG (Bacille Calmette-Guérin), DPTH-Hep B (Diphtheria, Pertussis, Tetanus, and Hepatitis B), LLIN (Long-Lasting Insecticidal Net), IPTi stands for Intermittent Preventive Treatment in Infants, *(Fisher exact p-values).				

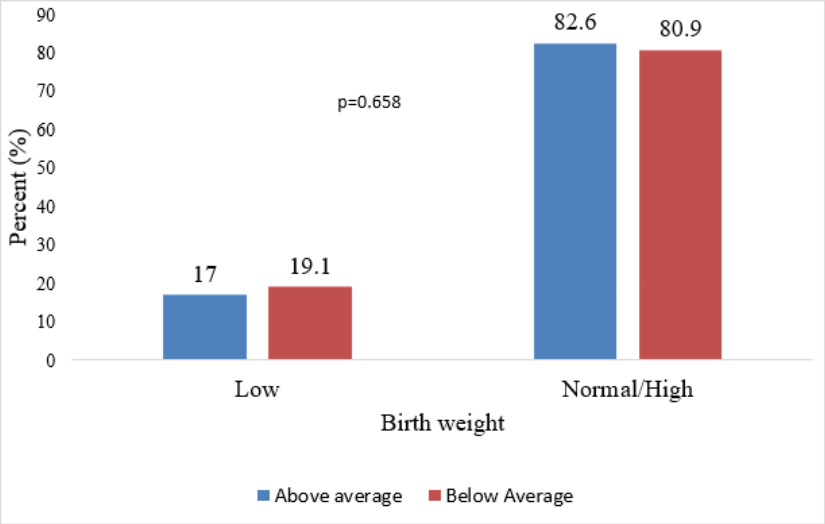

Figure 02*:* Birth weight and academic performance of school children

Table 08: Correlation between infant weight and Academic Performance

Variable	Academic performance (r)	p-value
Birth weight	0.0830	0.0752
Routine weight measurement of infants		
Weight at age 1 month	0.2782	0.0000
Weight at age 2 months	0.0674	0.2208
Weight at age 3 months	0.0296	0.6004
Weight at age 4 months	-0.0099	0.8584
Weight at age 5 months	0.0324	0.5593
Weight at age 6 months	-0.0094	0.8622
Weight at age 7 months	0.1422	0.0150
Weight at age 8 months	0.0293	0.6205
Weight at age 9 months	-0.0858	0.1305
Weight at age 10 months	0.0921	0.1267
Weight at age 11 months	0.1010	0.1126
Weight at age 12 months	0.1133	0.0681
Weight at age 13 months	0.0814	0.1908
Weight at age 14 months	-0.0329	0.5980
Weight at age 15 months	0.2396	0.0003
Weight at age 16 months	0.0349	0.5908
Weight at age 17 months	0.0598	0.3689
Weight at age 18 months	0.0330	0.6295

Weight at age 19 months	-0.0095	0.8946
Weight at age 20 months	0.1379	0.0649
Weight at age 21 months	-0.0239	0.7583
Weight at age 22 months	-0.0526	0.5311
Weight at age 23 months	0.2169	0.0101
Weight at age 24 months	-0.1331	0.1117
current anthropometric measurements		
Age (in months)	0.1236	0.0080
Height (in centimeters)	0.1574	0.0007
Weight (in kilograms)	0.0960	0.0395
WHZ	0.0640	0.2663
HAZ	0.0689	0.1403
BAZ	-0.0765	0.1015
Note: WHZ (Weight-for-Height Z-score), HAZ (Height-for-Age Z-score), BAZ (Body Mass Index-for-Age Z-score)		

Table 09: Association between Nutritional Indicators from student measurements and Academic Performance

Variables		Academic performance			F; p-value
		Total [N=460] n (%)	Above average [N=376] n (%)	Below average [N=84] n (%)	χ2 (p-value)/ Fisher's exact
Weight for height (SD)		-0.80 (1.03)	-0.72 (1.02)	-1.06 (1.03)	5.89; 0.016
Wasting (WHZ)					(0.615)
	Normal	280 (92.1)	216 (91.5)	64 (94.1)	
	Wasted	24 (7.9)	20 (8.5)	4 (5.9)	
Height for age (SD)		-0.59 (0.99)	-0.53 (0.98)	-0.87 (1.02)	8.30; 0.004
Stunting (HAZ)					5.94 (0.015)
	Normal	424 (92.2)	352 (93.6)	72 (85.7)	
	Stunted	36 (7.8)	24 (6.4)	12 (14.3)	
BMI for age (SD)		-0.92 (1.06)	-0.92 (1.05)	-0.94 (1.12)	0.03; 0.860
BMI					(0.022) *
	Thinness	68 (14.8)	48 (12.8)	20 (23.8)	
	Normal	376 (81.7)	316 (84.0)	60 (71.4)	
	Overweight/ Obese	16 (3.5)	12 (3.2)	4 (4.8)	
Note: *(Fisher exact p-values).					

In terms of class, more students are in the lower primary class (57.4%) than in the upper primary class (42.6%). There is a significant association between class and academic performance ($p = 0.004$), with more students in the lower primary class performing well academically. The proportion of students who repeated any class is 15.6%, with more students who repeated any class performing poorly academically ($p < 0.0001$). On the other hand, only 5.2% of students skipped any class, and this is not

significantly associated with academic performance (p = 0.012). Regarding private extra tuition, 27.8% of students receive private extra tuition, with no significant association with academic performance (p = 0.364). Finally, the majority of students live in rural areas (73.0%), with the remaining living in urban areas (27.0%). There is a significant association between place of residence and academic performance (p = 0.004), with more students in urban areas performing well academically.

Table 10: Association between demographic and educational characteristics of school children and academic performance

Variables	Academic performance [n (%)]			F; p-value χ2 (p-value)/ Fisher's exact
	Total [N=460] n (%)	Above average [N=376] n (%)	Below average [N=84] n (%)	
Mean age (SD)	9.96 (1.68)	10.07 (1.72)	9.47 (1.37)	8.86; 0.003
Age (In years)				10.13 (0.001)
7 – 10	304 (66.1)	236 (62.8)	68 (80.9)	
11 – 14	156 (33.9)	140 (37.2)	16 (19.1)	
Gender				0.72 (0.395)
Male	172 (37.4)	144 (38.3)	28 (33.3)	
Female	288 (62.6)	232 (61.7)	56 (66.7)	
Religion				22.37 (<0.0001)
Christian	280 (60.9)	248 (66.0)	32 (38.1)	
Muslim	180 (39.1)	128 (34.0)	52 (61.9)	
Type of School				20.25 (<0.001)
Private	188 (40.9)	172 (45.7)	16 (19.0)	
Public	272 (59.1)	204 (54.3)	68 (810)	
Class				8.28 (0.004)
Lower Primary	264 (57.4)	204 (54.3)	60 (71.4)	
Upper Primary	196 (42.6)	172 (45.7)	24 (28.6)	
Repeat any class (yes)	72 (15.6)	48 (12.8)	24 (28.6)	12.99 (<0.0001)
Skip any class (yes)	24 (5.2)	24 (6.4)	0 (0.0)	(0.012) *
Private extra tuition (yes)	128 (27.8)	108 (28.7)	20 (23.8)	0.82 (0.364)
Place of residence				8.38 (0.004)
Urban	124 (27.0)	112 (29.8)	12 (14.3)	
Rural	336 (73.0)	264 (70.2)	72 (85.7)	
Note: *(Fisher exact p-values).				

Table 11: Association between socio-demographic characteristics of parents and academic performance

Variables	Academic performance			χ2 (p-value)
	Total [N=460] n (%)	Above average [N=376] n (%)	Below average [N=84] n (%)	

Marital status of parents					(<0.0001) *
	Married	360 (78.3)	308 (81.9)	52 (61.9)	
	Separated/Divorce	84 (18.3)	56 (14.9)	28 (33.3)	
	Widowed	16 (3.4)	12 (3.2)	4 (4.8)	
Educational level of mother					(<0.0001) *
	No education	148 (32.2)	120 (31.9)	28 (33.3)	
	Basic (Primary/JHS)	192 (41.7)	140 (37.2)	52 (61.9)	
	SHS/ Tertiary	120 (26.1)	116 (30.9)	4 (4.8)	
Educational level of father (n=448) *					(<0.0001) *
	No education	100 (22.3)	96 (26.3)	4 (4.8)	
	Basic (Primary/JHS)	172 (38.4)	108 (29.7)	64 (76.2)	
	SHS	48 (10.7)	40 (11.0)	8 (9.5)	
	Tertiary	128 (28.6)	120 (33.0)	8 (9.5)	
Mother's occupation					(<0.0001) *
	No employment (House wife)	20 (4.3)	20 (5.3)	0 (0.0)	
	Self-employed (Artisan/ farming/ trading)	356 (77.4)	272 (72.3)	84 (100.0)	
	Civil servant (Health professions/ teaching)	84 (18.3)	84 (22.4)	0 (0.0)	
Father's occupation (n=448) *					19.78(<0.0001)
	Self-employed (Artisan/ farming/ trading)	316 (70.5)	240 (65.9)	76 (90.5)	
	Civil servant (Health professions/ teaching)	132 (29.5)	124 (34.1)	8 (9.5)	
Household size					0.49 (0.481)
	2 – 5	160 (34.8)	128 (34.0)	32 (38.1)	
	6+	300 (65.2)	248 (66.0)	52 (61.9)	
Note: * (Deceased), JHS (Junior High School), SHS (Senior High School). *(Fisher exact p-values).					

Table 12: Multivariate logistic showing the demographic and educational factors associated with poor academic performance in 460 school children

Variables	cOR [95% CI], p-value	A OR [95% CI], p-value
Age (In years)		
7 – 10	Ref.	Ref.
11 – 14	**0.40 (0.22-0.71), 0.002**	0.55 (0.14-2.19), 0.398
Sex		
Male	Ref.	
Female	1.24 (0.75-2.04), 0.396	
Religion		

	Christian	Ref.	Ref.
	Muslim	**3.14 (1.93-5.15), <0.0001**	2.14 (1.04-4.41), 0.039
Type of School			
	Private	Ref.	Ref.
	Public	**3.58 (2.00-6.41), <0.0001**	6.58 (2.13-20.32), 0.001
Class			
	Lower primary	Ref.	Ref.
	Upper primary	0.47 (0.28-0.79), 0.005	0.97 (0.22-4.20), 0.971
Repeat any class (yes)		2.73 (1.56-4.79), <0.0001	3.50 (1.24-9.92), 0.018
Private extra tuition (yes)		0.77 (0.45-1.34), 0.364	
Place of residence			
	Urban	Ref.	Ref.
	Rural	2.54 (1.33-4.87), 0.005	1.11 (0.28-4.29), 0.885
Marital status of Parents			
	Married	Ref.	Ref.
	Separated/Divorce	2.96 (1.72-5.08), <0.0001	7.22 (2.85-18.31), <0.0001
	Widowed	1.97 (0.61-6.35), 0.254	-
Educational level of mother			
	No education	Ref.	Ref.
	Basic (Primary/JHS)	1.59 (0.95-2.68), 0.080	0.74 (0.29-1.87), 0.524
	SHS/ Tertiary	0.15 (0.05-0.43), 0.001	0.05 (0.01-0.23), <0.0001
Educational level of father (n=448) *			
	No education	Ref.	Ref.
	Basic (Primary/JHS)	14.22 (4.99-40.51), <0.0001	14.62 (4.16-51.34), <0.0001
	SHS	4.80 (1.37-16.85), 0.014	2.23 (0.48-10.33), 0.307
	Tertiary	1.60 (0.47-5.47), 0.454	28.46 (3.26-248.08), 0.002
Father's occupation (n=448) *			
	Self-employed (Artisan/ farming/ trading)	Ref.	Ref.
	Civil servant (Health professions/ teaching)	0.20 (0.09-0.43), <0.0001	0.09 (0.02-0.53), 0.008
Household size			
	2 – 5	Ref.	
	6+	0.84 (0.51-1.37), 0.481	
Note: * (Deceased), JHS (Junior High School), SHS (Senior High School).			

Compared to individuals with normal HAZ, individuals with Stunted HAZ had an OR of 2.44 (95% CI: 1.17-5.11) for poor academic performance, and the p-value of 0.018 indicates that this association is statistically significant. When adjusting for other variables, the adjusted odds ratio (a OR) for Stunting and poor academic performance was 0.32 (95% CI: 0.07-1.45), but this association was not statistically significant (p-value = 0.139).

Compared to individuals with normal BMI, individuals who were thin had 2.19 odds (95% CI: 1.22-3.96) of poor academic performance. The a OR for thinness was 11.75 (95% CI: 3.99-34.60), and this association was highly statistically significant (p-value < 0.0001). Overall, the table shows that stunting and thinness are significantly associated with the poor academic performance, while wasting and overweight/obese are not.

Table 13: Forward elimination binary logistic regression showing factors associated with poor academic performance

Variables	cOR [95% CI], p-value	A OR [95% CI], p-value
Birth weight (kg)		
Low	1.15 (0.62-2.10), 0.658	
Normal/ High	Ref.	
Polio 0	1.24 (0.75-2.06), 0.403	
Hepatitis	1.13 (0.37-3.45), 0.837	
Vaccination at 6 weeks		
Pneumococcal 1	1.38 (0.84-2.25), 0.200	
Rotavirus 1	1.45 (0.89-2.37), 0.139	
Vaccination at 10 weeks		
Pneumococcal 2	1.45 (0.89-2.37), 0.139	
Rotavirus 2	1.45 (0.89-2.37), 0.139	
Vaccination at 14 weeks		
Pneumococcal 3	1.38 (0.84-2.25), 0.200	
Vaccination at 6 months		
Vitamin A 100000IU	1.62 (0.84-3.13), 0.151	1.70 (0.47-6.17), 0.421
Vaccination at 9 months		
Measles 1	0.43 (0.13-1.48), 0.182	0.24 (0.02-2.89), 0.264
Yellow Fever	0.21 (0.05-0.88), 0.032	-
Vaccination at 12 months		
Vitamin A 200000IU	1.13 (0.51-2.51), 0.763	
Vaccination at 18 months		
Vitamin A 200000IU	1.14 (0.58-2.23), 0.703	
Measles 2	1.12 (0.68-1.85), 0.657	
Meningitis A	1.24 (0.75-2.06), 0.403	
LLIN	0.89 (0.54-1.48), 0.657	
First IPTi	1.21 (0.75-1.95), 0.439	
Second IPTi	1.94 (1.20-3.13), 0.007	6.50 (2.02-20.89), 0.002
Third IPTi	1.60 (0.97-2.63), 0.064	0.56 (0.17-1.84), 0.344
Nutritional factors		
Wasting (WHZ)		
Normal	Ref.	
Wasted	0.67 (0.22-2.05), 0.487	
Stunting (HAZ)		
Normal	Ref.	Ref.

	Stunted	2.44 (1.17-5.11), 0.018	0.32 (0.07-1.45), 0.139
BMI			
	Normal	Ref.	Ref.
	Thinness	2.19 (1.22-3.96), 0.009	11.75 (3.99-34.60), <0.0001
	Overweight/ Obese	1.75 (0.55-5.63), 0.344	3.49 (0.61-19.91), 0.159
Note: Ref. group (Not vaccinated), BCG (Bacille Calmette-Guérin), DPTH-Hep B (Diphtheria, Pertussis, Tetanus, and Hepatitis B), LLIN (Long-Lasting Insecticidal Net), IPT i stands for Intermittent Preventive Treatment in Infants, Covariates adjusted for (age, sex, religion, type of school, class).			

DISCUSSION

The study found a significant association between Yellow Fever vaccination and academic performance, with 98.9% of those vaccinated and having above average performance. A similar relationship was observed for Second IPT i, with those receiving the treatment having a higher likelihood of above average performance. This is consistent with a study conducted in Ethiopia which found that children who received routine vaccinations had better cognitive performance than those who did not receive routine vaccinations [14]. Similarly, a study conducted in Kenya found that children who received the measles vaccine had better academic performance than those who did not receive the vaccine [15]. Findings from this study revealed that, there was a statistically significant difference between birth weight and academic performance. Infants with a higher birth weight were inclined to have better academic performance. This finding is consistent with previous research that has shown a positive correlation between birth weight and cognitive development [16]. Research has also suggested that there may be a relationship between birth weight and academic performance later in life [17]. The results indicated that stunted students performed worse academically compared to non-stunted students. This is consistent with previous research that has shown a link between stunting and poor cognitive development, which may lead to lower academic achievement [18,19]. The higher percentage of thinness in the poor academic performance group is consistent with some previous studies that found a negative correlation between academic achievement and thinness, particularly among adolescents [20]. This may be due to various factors, such as stress, unhealthy eating habits, and lack of physical activity. From the results, although a slightly higher percentage of students (29.8%) in urban areas have good academic performance compared to rural areas (70.2%), the percentage of students with poor academic performance is lower (14.3%) than in rural areas (85.7%). These findings are consistent with some previous studies that have shown a positive association between living in rural areas and academic performance, potentially due to factors such as smaller class sizes, more individualized attention from teachers, and closer-knit communities that provide social and emotional support [21,22]. However, other studies have reported mixed or even opposite findings including [23] and [24], highlighting the need for further research to better understand the factors that influence academic performance in different settings. The results of the study suggest that attending a private school is associated with better academic performance than attending a public school (p=0.001). This finding is consistent with previous research, which has shown that private schools tend to have smaller class sizes, more resources, and higher levels of parental involvement, all of which may contribute to better academic outcomes for students [25]. However, more research is needed to understand this, as most of the private school teachers in Ghana are senior high school leavers with weak passes and unable to continue their education. There was a statistically significant association between class level and academic performance (p=0.004), with students in the Lower Primary class more likely to have poor

academic performance compared to students in the Upper Primary class. This finding is consistent with previous research that has shown that students' academic performance tends to improve as they progress through school [26]. The results suggest that children of parents or guardians who are separated/divorced are more likely to have poor academic performance than those who are married (a OR=7.22, 95% CI: 2.85-18.31, p<0.0001). This has been investigated in several studies, a study [27] found that children of divorced parents had significantly lower academic achievement compared to those with married parents. The results indicate that there is a significant association between academic performance and the educational level of the mother. This is consistent with previous research that has shown a strong correlation between maternal education and children's academic performance [28]. The results suggest a strong association between academic performance and the educational level of the father, which is consistent with previous research that has shown the importance of paternal education in children's academic achievement [29]. Paternal education can influence children's access to resources, educational expectations, and parenting practices [30]. The finding that individuals whose father had a higher education level are more likely to have good academic performance is also supported by previous [31]. The results suggest that the mother's occupation has a significant impact on the academic performance of their children. This finding is consistent with previous research that has demonstrated a strong association between parental socioeconomic status and academic achievement [32]. The finding that students whose mothers were self-employed had the highest proportion of poor academic performance is consistent with research that has found a negative association between parental income and their children's academic achievement [33]. The results suggest that the father's occupation has a significant impact on their children's academic performance. This finding is consistent with previous research that has demonstrated a strong association between parental socioeconomic status and academic achievement [34]. Parents with higher levels of education and income are more likely to provide their children with educational resources and opportunities that support academic success [35].

4. CONCLUSIONS

This study showed high coverage of essential vaccines such as BCG, Polio 1, DPTH Hepatitis B 2, and Polio 2, indicating a successful implementation of national immunization programs. However, low coverage of vaccines such as Pneumococcal and Rotavirus vaccines, as well as low coverage of Measles 2 and Meningitis A vaccines, highlights the need for improvement in vaccine distribution and administration. The study also highlighted the concerning proportion of individuals with low birth weight, which puts them at increased risk for adverse health outcomes. Addressing these issues will require national cooperation and investment in infrastructure, manufacturing, and equitable distribution of vaccines, as well as interventions to improve maternal and child health. The high coverage of Vitamin A supplementation is a positive development that can contribute to improving child health and well-being. This study found that there may be gender differences in the prevalence of wasting among students, with male students being more affected than female students. The prevalence of stunting was slightly higher in male students, but this difference was not statistically significant. The study also found that the prevalence of thinness was relatively high, while the prevalence of overweight and obesity was low. These findings suggest a need for public health interventions that are tailored to address the gender-specific differences in the prevalence of wasting and stunting, as well as the overall prevalence of thinness and overweight/obesity in the population. Future research is needed to further explore the underlying reasons for these gender differences in nutritional status among school-aged children, particularly in developing countries. This study has shown that there is a significant association between several factors and academic performance among primary school children in Ghana. The study found that Yellow Fever and Second IPTi vaccinations are associated with above-average academic performance, and birth weight is positively correlated with academic performance. Malnutrition,

stunting, thinness, attending public schools, being in the Lower Primary class, repeating a class, and having separated/divorced parents are all negatively associated with academic performance. The study has also highlighted the need for further research to better understand the factors that influence academic performance, especially in different settings. Overall, the findings of this study have significant implications for policymakers and education stakeholders in Ghana and beyond, as they suggest potential interventions to improve academic performance among primary school children.

5. RECOMMENDATIONS

Based on findings from this study, the following are recommended;

- Develop gender-specific interventions: There is a need for researchers, educators, public health professionals, advocates and policy makers to do more research to explore the various factors that contribute to gender differences in academic performance.
- Strengthen vaccination programs: it is recommended that Ghana's vaccination programs be strengthened to ensure all children receive the necessary vaccines, which can improve their academic performance.
- Increase investment in maternal and child health: Government policymakers, the Ministry of Health, healthcare providers, community organizations, international organizations and donors should address the high proportion of individuals with low birth weight requires national investment in maternal and child health.
- Address malnutrition: Stunting and thinness were found to be negatively associated with academic performance. Thus, it is recommended that programs aimed at improving children's nutritional status be implemented by government officials thought the Ministry of Health, healthcare providers, educators, non-governmental organizations, parents and caregivers to ensure that children are well-nourished and healthy.
- Address factors contributing to poor academic performance: The study found that attending public schools, being in the Lower Primary class, repeating a class, and having separated/divorced parents are all negatively associated with academic performance. Thus, it is recommended that interventions be developed by government officials, educators, non-governmental organizations, parents and caregivers to address these factors and support children in overcoming any challenges they may face.

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