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Helminthiasis burden and nutritional status of non-enrolled school-aged children in irrigated farming communities in Bongo district, Ghana

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ABSTRACT

Most studies in children of school-age have focused on enrolled pupils because of ease of access, organization and logistics. As a result there are few reports on their non-enrolled counterparts. A randomized case-control study to assess the prevalence of helminths infection and nutritional status (anthropometry, anaemia and diet history) of non-enrolled (cases), and enrolled school-age children (controls) was conducted in irrigated farming communities in the Bongo District of Ghana. Out of the 329 children, 148 (44.98%) non-enrolled and 181 (55.02%) enrolled children were used for the studies. Enrolled children significantly benefitted from the national deworming programme (OR = 115.65, 95% CI = 22.29 – 599.95, p < 0.001). Three parasites; hookworm, Schistosomamansoni and Schistosoma. Haematobium were recorded. The prevalence of S. mansoni in non-enrolled children was 14.94% significantly higher than 5.52% in their enrolled counterparts (χ^2 = 42.20, df = 19, p = 0.002). Macro-haematuria was observed in 8.8% of the non-enrolled and 1.8% enrolled children which was significantly different (χ^2 = 16.48, df = 2, p = 0.000). Also, 25% of non-enrolled had trace to high micro-haematuria compared to 15.88% of their enrolled counterparts which was significantly higher (χ^2 = 18.42, df = 6, p = 0.005). 36.49% of non-enrolled had proteinuria compared to 38.24% of enrolled children which was significantly lower in the former (χ^2= 15.11, df = 6, p = 0. 017). 83% of the 5-8 years age group were anaemic and was significantly high compared to the other age group (OR = 5, CI 95 = 2.34 – 10.68, p = 0.000). The mean daily vitamin C intake was significantly higher in non-enrolled (102.1± 33.8) than enrolled children (76.4 ± 24.2), [p = 0.000].Policymakers and health practitioners should expand the national deworming programme to the non-enrolled children. The School feeding and nutritional supplements should also be considered.

Key words: non-enrolled school-aged children, schistosomiasis, *S. mansoni*, *S. haematobium,* nutritional status

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INTRODUCTION

Soil-transmitted helminth (STH) infections are common, mainly affecting children in poor rural communities and poor urban areas of sub-Saharan Africa, Asia and Latin America(1).The high prevalence of these infections is closely associated with poverty, poor hygiene and sanitation, and impoverished health services(2). The most common of these are infections with *Ascarislumbricoides*, *Trichuristrichiura*, *Ancylostomaduodenale* and *Necatoramericanus*(3, 4). It has been estimated that more than two billion of the world's population are chronically infected with STH with an estimated4.5 billion individuals at risk of STH (5). Heavy infections cause an array of morbidities, including dietary deficiencies and delayed physical and cognitive development (6-9) of which hookworm and *T. Trichiura* infections are major contributors of iron deficiency anaemia (3, 4).

Schistosomiasis is also another disease of poverty that affects almost 200 million people worldwide, and more than 650 million people in endemic areas being at risk of infection. In chronic urinary schistosomiasis, there is damage to the bladder, ureters and kidneys whilst in chronic intestinal schistosomiasis there is enlargement of the liver and spleen, intestinal damage and hypertension of the abdominal blood vessels(10). Preventive chemotherapy, that is, treating children or whole populations on a routine basis for morbidity control is being implemented in many STH-endemic countries(11) It has been argued that mass administration of anthelminthic to school-aged children by taking advantage of the existing education infrastructure and administrative system is the most cost-effective approach in minimizing the intensity of infections with both major intestinal nematodes and schistosomes in resource-limited countries(12). As a result most research studies and interventions have been conducted in school settings which are reflected in the number of publications being skewed towards enrolled children. However in Africa, the enrolment rates which has been estimated to be approximately 68% (13) is low. The WHO estimates that there are about 1.2 billion school age children in the world and of these, 700 million were registered in schools, but only about 400 million of them were actually present in school each day(14)

In the Upper East Region (UER) where the study site Bongo District (BD) is located, enrolment of children aged 6-15 years in 1999 was estimated to be 37% (15) which may have increased substantially with the introduction of the capitation grant policy in 2005. The basic primary schools benefit from the nationwide deworming programme which was initiated in 2007 by the Ghana Education Service and Ghana Health Service with UNICEF support. Schistosomiasis control with praziquantel in schools is also being implemented on annual basis by the Ghana Health Service. This notwithstanding, non-enrolled children form a significant proportion of rural communities in BD and are potentially sources of re-infection of STH and schistosomiasis to their enrolled counterparts, who benefit from the school-based interventions. The magnitude of this problem remains unknown in Ghana hence this study was conducted on out-of-school children with the sole aim of evaluating it in one of the marginalized districts in Ghana.

Studies on the nutritional status of the non-enrolled children in the communities was also included in the survey since it is a key indicator of achievement of the millennium development goals (MDGs).A questionnaire survey to establish knowledge, attitude and practices (KAP) of children and parents, and socio-economic demographics was conducted.

MATERIALS AND METHODS

Study site

The Bongo District is one of the nine districts in the UER. The district has a total population of 84,545 inhabitants with 40,084 and 44, 461 being males and females respectively (16). The main occupation of the people is subsistence farming and to a lesser extent handcrafting.

The major sources of drinking water are boreholes and hand-dug wells. In 2009, there were approximately 335 boreholes in BD, out of which 25 were not functional due to faulty parts and 35 were capped due to high fluoride content. Thus reducing the total number of functional borehole in the district to 275 (17). About 65% of the people have access to potable water and in terms of distance and litres only 32% have access to potable water (17). The excessive amounts of fluoride in ground water cause fluorosis predominantly among children. Most houses do not have latrines and sanitation is also poor, a result of inadequate funds and limited resources(17).

Ethical considerations

Approval for this work was given by the Ethical Review Board of the School of Allied Health Sciences, University of Ghana. Then permission to conduct the study was obtained from both district directors of education and health, and the medical superintendent of the Bongo District Hospital. Permissions were also sought from the head-teachers of the three primary schools as well as from the chiefs and elders of the communities. Any child found infected with either intestinal helminths or urinary schistosomiasis was treated with the recommended single dose of albendazole (400mg) or praziquantel (40 mg/kg) respectively.

Enrolment of study participants
Three out of the seven sub-districts of BD were randomly selected and then non-enrolled children aged between 5 and 18 years living there were similarly selected. The recruited non-enrolled children were then matched for age and sex with enrolled children living in the same household and community. Each child in the study was identified by a unique code that denoted the individual, his/her enrolment status, name of the school if enrolled, household and community. Informed consents were obtained from all parents/guardians as well as from all the participating children.

Questionnaire survey
Self-structured questionnaires for the parents/guardians sought, socio-demographic information, conditions of water and sanitation, and knowledge of the topic. Demographic, habits and dietary information for children were sought.

Parasitological survey
Fresh faecal sample was collected and then processed using the ether sedimentation technique and examined microscopically to detect eggs of intestinal helminths. The Kato-Katz method was used to determine the intensity of infections which was expressed as number of eggs/gram of faeces (18). Each urine sample collected was first observed for visible haematuria and then 10 ml filtered and the schistosome eggs counted under the microscopy to determine the intensity of infection (19). The prevalence of light, moderate and heavy intensity infections were determined using the WHO criteria for helminths infection(20).The urine was also tested for the presence of protein and blood using reagent strips for urine analysis (URS-10, TECO Diagnostics, Anaheim, CA, USA). The colour change was matched with that provided by the manufacturer and scored as either negative, trace, low, moderate, high or very high.

Estimation of haemoglobin levels
Twenty microlitres of finger-pricked blood was obtained from each child and haemoglobin concentration (grams/decilitre) estimated using the Drapkin's method (21). To 5ml of Drapkin's dilution fluid the20ml of blood was added and mixed gently. The optical density (OD) of the solution was measured at540nm using a colorimeter (UK). The anaemia status was classified as normal (≥11 g/dL), slightly anaemic (7-11 g/dL) or severely anaemic (<7.0g/dL) (10, 22).

Anthropometric measurements
Height and weight were taken and used in calculating the body mass index (BMI) expressed in terms of z-scores or standard deviation units from the median inferred from the international reference growth curves (23).Acute and chronic malnutrition, classified as either underweight, normal weight, overweight or obese were determined by plotting the BMIs against their ages (BMI-for-age). The BMI-for-age that fell below two standard deviations of the median were considered as either underweight, thin or wasted.

Dietary history
A dietary history interview was conducted to assess each child's food intake. This involved a repeated three-day (two weekdays and one weekend day) 24 hour recall of dietary intake of all meals and snacks. This was followed with questions to verify intakes including portion sizes and food preparation techniques. Graduated food models were used to aid in portion size delineation. The United States Department of Agriculture (24) nutrient database for standard reference was used to determine total dietary energy and macro and micronutrient intake (24).

Data analyses
A database was created using Microsoft Access™ for Windows and then imported into Statistical Package for Social Sciences software version 16.0 (SPSS Inc., USA) for the analyses. Entry in the information sheets was visually checked for accuracy and the data entered by two separate individuals and corrections made where necessary. Descriptive statistics i.e. means, median, standard deviations and ranges were calculated for continuous variables while proportions were calculated for categorical (non- parametric) variables. Differences in the various indicators - nutritional status and STH and Schistosome infections as well as other variables of interest (energy intake, haemoglobin level, etc.) were tested for statistical differences using analysis of variance (ANOVA). Chi-square tests were used to determine the associations between enrolment status and qualitative measured variables.

Logistic regression analysis was also used for comparison between non-enrolled and enrolled children of some of the parameters.

RESULTS

Demographic characteristics of study populations

A total of 329 children comprising of 148 (45%) non-enrolled and 181 (55%) enrolled participated in the study, and 161 (48.9%) were males and 168 (51.1%) females. Of the non-enrolled children 77 (52%) were males and 71 (48%) were females, whilst for the enrolled children 88 (48.6%) were males and 93 (51.4%) females.

The distributions among the age-groups 5-8, 9-13 and 14-18 years were 24.9% (n=82), 47.4% (n=156) and 27.7% (n=91) respectively. The 5-8 year group (yrs) comprised of 58.5% (n=48) non-enrolled and 41.5% (n=34) enrolled children. The 9-13 yrs comprised of 36.5% (n=57) non-enrolled and 63.5% (n=99) enrolled, and for the 14-18 yrs47.3% (n=43) were non-enrolled and 52.7% (n=48) were enrolled.

The mean age of the total participants was 10.74 (SD = ±2.79) years and were 10.5 (SD = ±3.07) and 10.9 (SD =±2.53) for the non-enrolled and enrolled children respectively.

Knowledge, attitude and practices of children

Table 1 summarises the socio-demographic characteristics of the children. Of the 148 non-enrolled and 181 enrolled respondents 47.3% and 48.1% respectively indicated that they ate from the same bowl with others, which was not significantly different between them (OR β = 1.39, CI 95 = 0.53-3.66, p = 0.51). When asked if they washed hands regularly 72.1% (106/147) of the non-enrolled responded yes and 1.4% (2/147) and 26.5% (39/147) respectively responded 'no' and 'sometimes'. Of the 169 enrolled respondents the corresponding figures were 81.8% (106/169), 1.11% (2/169) and 10.5% (19/169) respectively. With regards to benefiting from the GNDP 39.46% of 147 non-enrolled children responded that they were beneficiaries against 94.1% (n=159) for their 169 enrolled counterparts, which was statistically different (OR β = 115.65, CI 95 = 22.29-599.95, p <0.001). Of the 144 non-enrolled respondents 18.1%, 63.9% and 18.1% lived in households with 1-3, 4-6 and greater than six children respectively. The corresponding figures for the 169 enrolled respondents were 26.6%, 55.6% and 17.8% respectively, which were not significantly different between the two enrolment categories.

Table 1: Summary of socio-demographics characteristics of enrolled and non-enrolled school-age children

Variable	*β(OR)*	95% CI	p value
Eating from same bowl			
Yes	1.39	0.53-3.66	0.510
No	1.00	_	
Hand washing			
Yes	Not Estimable		
No	1.00		
Sometimes	Not Estimable		
Benefit from GNDP			
Yes	115.65	22.29-599.95	<0.001*
No	1.00	_	
No. of children per household			
1-3	0.66	0.13-3.65	0.620
4-6	0.68	0.149-3.09	0.616
>6	1.00		

**= p<0.05, B (OR) = Odds Ratio, CI= Confidence Interval*

Knowledge, attitude and practices of parents/guardians

Table 2 details the results of the statistical analysis that compared children's enrolment status and parents' responses. With parent's knowledge of the topic 43.06% of parents of non-enrolled children (N=144) responded "*yes and very well*" compared to56.8% of parents of enrolled children (N= 96)who did. For those who responded "*yes, but not very well*'',37.5% were parents of non-enrolled children, whilst corresponding parents of enrolled children were 34.32% which was significant compared to those who responded "no" (reference) [P = 0.005]. Likewise for the parents who responded "*yes, but not very well*" of which 36.73% were non-enrolled and 34.32% were enrolled children (P = 0.041).

Parents who "personally de-wormed their children were significantly more likely to have their children enrolled in school than parents who responded in the negative (reference) [P = 0.003]. In terms of parents' age and enrolment status, statistical differences were observed between all other age groups and those who were 50 years and above (reference). For the below 30, 30-39 and 40-49 age groups the significances were P=0.012, P= 0.002 and P = 0.034 respectively.

None of the parents of non-enrolled children and two of the enrolled parents was separated. Parents who were married or widowed were significantly different in terms of enrolment compared to parents who were never married (reference variable). For married parents/guardians, the significance was P=0.046 and for widowed parents the value was P=0.04 married (reference variable).

None of the parents of non-enrolled received education beyond junior secondary level and majority of them 89.1% either attended kindergarten or had no formal education. Likewise for parents of enrolled children which was 72.8%. The only observed significant difference was between those who attended elementary school only and those who attended only kindergarten (KG) or never attended school (p=0.004).

Table 2: Demographic characteristics of parents of the study participants

	β(OR)	95% CI	p value
Variables			
Knowledge about Topic			
No	1.00		Reference
Yes, but not very well	7.04	7.04-1.09	0.041*
Yes very well	17.35	2.37-12.18	0.005*
Personally Deworming of Child			
Yes	0.176	0.056-0.558	0.003*
No	1.00		Reference
Parent Age			
<30	0.06	0.01-0.54	0.012*
30-39	0.04	0.01-0.31	0.002*
40-49	0.13	0.21-0.86	0.034*
>50	1.00	_	Reference
Marital Status			
Married	0.05	0.002-0.94	0.046*
Never married	1.00	_	Reference
Separated	Not Estimable	_	_
Widowed	0.03	0.001-0.85	0.040*
Educational Level			
Tertiary or more	Not Estimable	_	
SHS	Not Estimable	_	
JHS	3.114	0.34-28.17	0.312
Elementary	20.89	2.57-169.7	0.004*
KG/ Never		_	Reference

**= p<0.05, B (OR) = Odds Ratio, CI= Confidence Interval*

Prevalence of intestinal helminths and urinary schistosome infections

The 308 children who provided stool comprised of 145 non-enrolled and 163 enrolled and of the 318 who provided urine 148 were non-enrolled and 170 were enrolled. Only three parasites; hookworm species, *Schistosoma mansoni* and *S. Haematobium* were recorded. The single hookworm infection was found in one enrolled female child.

31.7% of 145 non-enrolled children were positive for *S. mansoni* infections which comprised of light (n=26), moderate (n=14) and heavy (n=6) infections. The mean intensity was 51.16 eggs/gram of stool (range = 0–364, group median = 0.43). In the enrolled group 5.5% of 163 were infected with *S. mansoni* distributed as; light (n=7), moderate (n=1) and heavy (n=1) infections. The mean intensity of infection was 0.31eggs/gram of stool (range = 0 – 24, group median = 0.06). The observed difference in the prevalence of *S. mansoni* was highly significant (λ^2= 42.198, df = 19,p = 0.002). Logistic regression analysis confirmed that non-enrolled children had significantly more light *S. mansoni* infections than their enrolled counterparts (OR = 0.46, 95 CI = 0.06 – 0.36, p = 0.003).

The prevalence rate of *S. mansoni* infections in females was 28.22% (n=159) and the mean intensity was 4.07 eggs/epg (range = 0 – 19, group median = 0.38). The prevalence rate in the males was 35.48% (n=149) and the mean intensity of infection was 0.78 eggs/epg (range = 0 – 19, group median = 0.19). The observed gender differences however was not significant (λ^2 = 13.442, df = 19, p = 0.815).

The prevalence rates of *S. mansoni* of non-enrolled females and males were 37.68% (n=69) and 26.3% (n=76) respectively which was not significantly different between them.(λ^2 = 16.528, df = 18, p = 0.251) The correspondent prevalence rates for their enrolled counterparts were 4.44% (n=90) and 6.85% (n=73) respectively which was also not significantly different (λ^2= 4.716 df = 8, p = 0.581).

The prevalence rates of *S. mansoni* infections in the three age groups were19.23% (15/78), 15.82% (28/177) and 22.64% (12/53) for the 5-8, 9-13 and 14-18 year olds respectively, which was not significantly different (λ^2= 37.2, df =38, p = 0.506).

With *S. haematobium* infections 35.1% (52/148) non-enrolled children were infected out of which 32 were light and 20 were heavy. The mean intensity was 51.16 eggs/10 ml urine (range = 0 – 2450, group median = 0.52). In their enrolled counterparts 29.5% (48/170) were infected with 34 and 14 respectively being light and heavy. No individual with moderate infection was observed in both groups. The mean intensity of infection was 15.11 eggs/10 ml blood (range = 0 – 611, group median = 0.38). The observed difference in the prevalence rates was not significant (λ^2 = 60.125 df = 58, p =0.399).

The prevalence rate of *S. haematobium* in females was 28.22% (n=163) and the mean intensity was 25.15 eggs/10 ml blood (range = 0 – 2450, group median = 0.38). The prevalence rate in the males was 35.48% (n=155) and the mean intensity of infection was 38.99 eggs/10 ml blood (range = 0 – 1743, group median = 0.51). The observed gender differences however as also not significant (λ^2= 45.826, df = 58, p = 0.876).

For *S. haematobium* infections 40% (30/77) and 31% (22/71) non-enrolled males and females respectively were positive and the difference was not significantly different (p = 0.389). In the enrolled group the corresponding figures were 30.3% (23/76) males and 26.6% (25/94) females were positive and this difference was also not significant (p = 0.611).

The prevalence rates of *S. haematobium* infections in the three age groups were 23.46% (19/81), 32.42% (59/1182) and 41.82% (23/55) for the 5-8, 9-13 and 14-18 year olds respectively, which was not significantly different (λ^2= 1.27^{E2}, df =116, p = 0.229).

Co-infections with both schistosome species were observed in 24 of the 46 non-enrolled *S. Mansoni* cases and in four of the nine *S. Haematobium* infected enrolled children.

Urine analysis
Visible haematuria in the urine was observed in 12 (8.8%) of the 148 non-enrolled and in 3 (1.8%) of 170 enrolled children. The observed difference was significant (λ^2 = 16.48, df = 2 and p = 0.000).Among the 163 females visible haematuria was observed in 7 (4.29%) and in 8 (5.16%) of the 155 males, which was not significant between them (λ^2 = 1.076, df = 2, p = 0.0584).Among the age groups visible haematuria was observed in 4.94% (7/81), 3.30% (6/182) and 9.09% (5/55) in the 5-8, 9-13 and 14-18 year groups respectively which were also not significantly different between them (λ^2 = 6.399, df = 4, p = 0.171).

Haematuria
The micro-haematuria profile of the 148 non-enrolled children was; 75% negative, 5.41% trace, 6.76% each for low and moderate and 6.08% high. The profile of the 170 enrolled counterparts was; 84.12% negative, 1.76% trace, 4.12% low, 2.94% moderate, 5.88% high and 1.18% very high. The observed profile difference was highly significant (λ^2 = 18.42, df = 6, p = 0.005).The micro-haematuria profile of the 163 females was; 81.6% negative, 2.45% trace, 4.29% low, 6.13% moderate, 4.91% high and 0.61% very high. The profile of the 155 males was; 78.06% negative, 4.52% trace, 6.45% low, 3.23% moderate, 7.1% high and 0.65% very high. The observed profile difference was not significant (λ^2 = 4.799, df = 6, p = 0.570).

The micro-haematuria profile of the 81 4-5 year olds was; 79.01% negative, 2.47% trace, 3.7% low 5.49% each for moderate and high, and 1.23%. That of the 182 9-13 year olds was; 82.97% negative, 2.2% trace, 3.85% low, 5.49% each for moderate and high and of the 55 14-18 year olds it was; 70.91% negative, 9.09% trace, 12.73% low, 1.82% moderate, 3.64% high and 1.82% very high. The observed profile difference was significant (λ^2 = 22.152, df = 12, p = 0.036).

Proteinuria

The proteinuria profile of the 148 non-enrolled children was; 63.51% negative, 6.76% trace, 13.51% low 11.49% moderate, 4.05 % high and 0.68% very high. The profile of the 170 enrolled children was; 61.76% negative, 14.71% trace, 11.76% low, 8.82% moderate, 2.35% high and 0.59% very high. The observed profile difference was significant (λ^2 = 15.407, df = 6, p = 0.017). The proteinuria profile of the 163 females was; 63.19% negative, 12.27% trace, 12.27% low, 8.59% moderate, 3.68% high and none was very high. The profile of the 155 males was; 61.94% negative, 9.68% trace, 12.90% low, 11.61% moderate, 2.58% high and 1.29% very high. The observed profile difference was not significant (λ^2 = 4.604, df = 6, p = 0.596). The proteinuria profile of the 81 5-8 year olds was; 65.43% negative, 4.94 % trace, 12.35% low 11.11% moderate,4.94% high, and 1.23% very high. That of the 182 9-13 year olds was; 62.09% negative, 12.09% trace, 13.74% low, 9.89% moderate,2.20% high and none for very high. Of the 55 14-18 year olds it was; 60% negative, 16.36% trace, 9.09% low, 9.09% moderate, 3.64% high and 1.82% very high. The observed profile difference was not significant (Pearson chi-square = 12.917, df = 12, p = 0.375).

Anaemic status

The mean haemoglobin levels all the participants was 10.7g/dl (SD = ±1.50), that of the non-enrolled and enrolled children were 10.6g/dl (SD = ±1.57) and 10.8g/dl (SD = ±1.51) respectively and the difference was not statistically significant (p>0.05).The anaemia profile of the 148 non-enrolled children was 44.6% (n=66) normal, 54.05% (n=80) slightly anaemic and 1.4% (n=2) severely anaemic. Of the 169 enrolled children it was 48.52% (n=82) normal, 48.52% (n=82) slightly anaemic and 2.96% (5) severely anaemic. For the purpose of comparison the slightly anaemic were grouped as anaemic and no statistical difference in anaemic status was found between the two groups (β OR = 0.854, CI = 0.548-1.33, p = 0.485). In terms of gender 56.3% (40/71) females and 54.5% (42/77) males in the non-enrolled group were anaemic and the remaining was normal. Similarly, among the enrolled children 56.4% (53/94) females and 45.3% (34/75) males were anaemic and the rest were normal. No statistical difference was observed between the gender and anaemic status in the two enrolment categories (p>0.05).

Irrespective of enrolment, 92.5% (n=74) of children aged 5-8 years, 79.56% (n=144) of 9-13 years and 61.82% (n=61.82%) of 14-18 years were respectively anaemic which was significant ($\lambda 2$ = 19.006, df = 2, p = 0.000). The anaemic profile of non-enrolled children was 83.3% (n=40), 47.4% (n=57) and 34.9% (n=43) for the 5-8, 9-13 and 14-18 year groups respectively were anaemic. For their enrolled counterparts 48.5% (16), 56.4% (53) and 42.9% (18) for the 5-8, 9-13 and 14-18 year groups respectively were anaemic. A statistical difference (Chi Square test) was observed between the age ranges and anaemic status among the non-enrolment (p<0.005).

Regression analysis revealed that 5-8 year group anaemia was significantly high in the non-enrolled children (β OR = 5, CI = 2.34-10.682, p = 0.000).

Table 3:Age and gender distribution of anaemia status among enrolled and non-enrolled children

Age Groups		**Anaemic Status**				
Non-Enrolled Age groups	**N**	**Normal** n (%)	**Anaemic** n (%)	***B* (OR)**	**95%CI**	**p value**
5-8	48	8 (16.70)	40 (83.30)	5.00	2.34-10.682	0.000*
9-13	57	30 (52.60)	27 (47.40)	1.11	0.535-1.514	0.691
14-18	43	28 (65.10)	15 (34.90)	1.00	Reference	
Enrolled Age groups						
5-8	33	17(51.50)	16 (48.50)	1.06	0.476-1.863	0.862
9-13	94	41(43.60)	53 (56.40)	1.29	0.860-1.943	0.217
14-18	42	24 (57.10)	18 (42.90)	1.00	Reference	

**P value significant at p < 0.05 level*

Nutritional status

Of the 148 non-enrolled children, 29.1% (n=43) were underweight/wasted, 64.86% (n=96) were of normal weight and 6.08% (n=9) were overweight. For the 169 enrolled children 30.77% (n=52) were underweight/wasted, 65.68% (n=111) were of normal weight, 2.96% (n=5) were overweight and 0.59% (1) was obese. The observed difference in weight distributions was not statistically significant (p>0.05).

Table 4. Mean nutrient intake by enrolment status

Variable	Non-Enrolled Mean±SD	Enrolled Mean±SD	Total Mean±SD	p value
Energy (kcal)	1337.1±305.9	1279±255.7	1305.7±280.7	0.067
Protein (g)	33.6±8.1	31.9±9.2	32.6±8.7	0.082
Iron (mg)	9.1±2.1	8.7±1.9	8.9±1.9	0.076
Vitamin C(mg)	102.1±33.8	76.4±24.2	88.1±31.6	0.000*

**p<0.05 significant*

Dietary intake

The mean vitamin C intake of the non-enrolled children was 102.1g (±33.8g) which was significantly higher than the 76.4g (±24.2g) recorded for the enrolled children (p=0.000). The estimated mean intake of total energy (kcal) was 1337.1 (SD = ±305.9) for non-enrolled children and 1279 (SD = ±255.7) for their enrolled counterparts which was not significantly different (p = 0.067). The estimated mean protein (g) intake was 33.6 (SD = ±8.1) for non-enrolled and 31.9±9.2 for their enrolled counterparts which was also not significantly different (p = 0.082). The estimated mean intake of iron (mg) was 9.1 (SD = ±2.1) and 8.7 (SD = ±1.9) for non-enrolled and enrolled children respectively and the observed difference was not significant (p = 0.076).

DISCUSSION

There are a number of factors that impact on the health and nutritional status of the school-age children in low income countries. Whilst interventions are being implemented in school settings because of ease of organization, non-enrolled children who form substantial proportion of children in rural poor communities are to a large extent excluded and also the least studied.

The main focus of this study was to investigate the helminths burden and the nutritional status of non-enrolled children (cases), matched enrolled children (controls) in three communities and schools in the Bongo District of Ghana. It also considered the knowledge and practices of parents and guardians of the children in the communities as well as the dietary intake assessment.

The study revealed that parents who personally dewormed were 5.7 times more likely to have their children enrolled in school. Also parents who had knowledge of the topic were 17.35 times more likely to have their children enrolled in school. Moreover parents of non-enrolled children above 50 years were found to be 25 times less likely to have children enrolled as compared to those in the same age group with enrolled children. Furthermore, widowed parents of the non-enrolled children were also 33.3 times more likely not to enrol their children in school. Parents of enrolled children who received elementary school were found to be 20.9 times more likely to have their children enrolled. Thus by inference, health awareness and socio-economic status of parents are key determinants in the enrolments of children in Bongo. A single case of hookworm infection was encountered and none of the children were infected with *A. lumbricoides*and *T. trichiura*. This contradict what Ziem, Olsen (25)found hookworm prevalence to range from 50-100% in six communities in nearby Bawku District of the Upper East Region and *A. lumbricoides*and *T. trichuira* are common helminths infections elsewhere in Ghana. The low prevalence of hookworm infections and none of these two parasites may be due to the dry and sandy soil type found in the communities which may not favour their transmission.

Of the total 329 children examined (both non-enrolled and enrolled children) for helminth infection 30.4% (n=100) were infected with *Schistosomahaematobium*, which is high. *Schistosomamansoni* was observed in 16.7% (n=55) of the total, most of them in non-enrolled children. With *S. mansoni* infections, non-enrolled children were twice more likely to have slight *S. mansoni*infection than their enrolled counterparts (OR = 0.46, CI = 0.06 – 0.36, p= 0.003). On the other hand, no significant difference in *S. haematobium* prevalence was found between non-enrolled and enrolled children. However in Bongo most non-enrolled children are mainly engaged in irrigation farming thus it is likely that working on irrigation farms could be the reason for the recorded high *S. mansoni* prevalence. *Biomphalaria* species the intermediate vectors of *S. mansoni* are known to dwell in mud (26) as opposed to *Bulinus*species whose preferred habitat is slow flowing water and streams(27).Thus, it likely that irrigation farmingis placing the non-enrolled children at more risks of *S. mansoni* infections.

No significant difference was found between non-enrolled and enrolled children in terms of *S. haematobium* prevalence rates. The mode of transmission of *S. haematobium* in Bongo must be such that it places all children at risk irrespective of enrolment status, and recreational activities and chores that equally place them in contact with water in irrigation canals could account for this.In both the non-enrolled and enrolled children, the 9-13 years olds were the most infected with *Schistosomes* being 36.8% and 32.1% with *S. haematobium* and *S. mansoni* respectively in non-enrolled and 32.6% and 5.50% respectively in the enrolled children. It is known that the children that harbour most helminths infections fall into this age group (28).Behavioural changes that, as children grew older and became more important to their families economically, by engaging more in occupational activities such as fishing and farming predisposes children to helminth infections.

Our study has revealed that nutrition is a problem in the Bongo District with enrolled children being worse off. Non-enrolled children significantly met their daily intake of vitamin C and protein.With Dietary Reference Intake (DRI) vitamin C it was observed that non-enrolled children were 2.8 times more likely to meet their vitamin daily requirement than not to meet it. This could be attributed to non-enrolled children having a greater access to farm fruits and vegetables that are high in vitamin C. For DRI protein the non-enrolled children were found to be 1.7 times more likely to meet their daily protein requirement than not to meet it.These observations are contrary to the findings of Hall and Kirby (29)that the nutritional and health status of non-enrolled and enrolled girls were comparable.

With regards to anaemic status, the mean Hb values for the non-enrolled and enrolled children in our study were 10.6g/dl and 10.8g/dl respectively which were not significantly different. However 54.1% non-enrolled children and 48.5% of enrolled counterparts were 'slightly anaemic', thus close to half of both categories of children were slightly anaemic. Contrary to our findings Mitchikpe, Dossa (30)found enrolled children to have significantly higher Hb levels than non-enrolled children in Benin. (28) found 70% of primary school-age Ghanaian children to be anaemic, irrespective of their enrolment status. Our study also revealed that non-enrolled children within 5-8 years age range were 5 times more likely to be anaemic than the 14-18 year (reference) group ($p<0.001$).

Our study did not find any relationship between the two enrolment groups in terms of infection and anaemia, thus whether a child was enrolled or not enrolled, and infected by helminths or not, it did not affect their anaemic status. Thus the observed high prevalence of anaemia could be due to factors other than helminth infections such as asymptomatic malaria and poor nutrition.

No statistical difference was observed between the weight status classifications and enrolment status of the children. This finding contrasts that ofBeasley, Hall (31) who found non-enrolled children to be more wasted than enrolled children in Zanzibar ($p=0.0001$). Ulukanligil and Seyrek (32) have shown that school children living in better socio-economic conditions experienced a low prevalence of chronic under-nutrition, anaemia and helminth infections. However, in this study, both non-enrolled and enrolled children live in similar socio-economic conditions, thus this could explain why no association with between helminth infections and under-nutrition and enrolment status. Similarly, no association was found between helminth infections and weight status and enrolment.

In conclusion, helminthiasis especially schistosomiasis and poor nutrition are major health problems of children in the studied communities. With this knowledge there is the need for control to include out-of-school children in Bongo by extending the school-based interventions into communities. There is also an urgent need to reflect on proper nutrition status among the children by improving on school feeding programmes with food fortification and nutritional supplements in schools and communities.

The study did not investigate factors that could contribute to anaemia such as malaria parasites or sickle cell anaemia. Thus to fully understand issues related to under-nutrition among children, other factors have to be considered. Also, the need for intensive health education and regular mass treatment of helminths infections cannot be over emphasized. Good sanitation practices should also be taught in both the schools and the communities to reduce re-infections**.**

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