Impact of intestinal helminthes infections on stunting, wasting, normal biochemical and hematological values on school children in Gondar town, Ethiopia.

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Abstract

Abstract Background: Ethiopia, the second populous nation in Africa, has been grouped under low income countries. Stunting, underweight and wasting in school children in Ethiopia are very common. The aim of this research was to evaluate the nutritional status compared to WHO standards and impact of intestinal helminthes on normal growth, normal hematological and biochemical values in the school children in Azezo Elementary School in Gondar Town. **Methods:** Demographic data and information about possible risk factors were obtained using standard pre-tested questioners for all study subjects. WHO AnthroPlus software version 1.04 (WHO, Geneva, Switzerland) were used to classify school children as normal, stunted, wasted and obese after height and body weight measurements were obtained. The Kato Katz technique was performed to screen students for intestinalhelmenthinfections and calculate eggs per gram stool (epg). Haematological and biochemical normal values were obtained from hematology fully-automated cell counter (Mindray BC-3200) and Mindray BS-200E chemistry analyzer. **Results:** A total of 384 school children with age ranged from 7 to 15 years old were recruited in this study. Of the total school children analysed for body mass index and height for age Z scores (BAZ and HAZ scores), 103 (26.8%) were wasted (Z scores < -2SD) and 47 (12.2%) stunted (< -2SD). Gender showed no statistically significant differences ($p>0.05$) for BAZ and HAZ. The prevalence of overall stunting in 7-10 age group was 0.7% (1/146) compared to 19.5% (46/236) in 11-15 age group ($p=0.000$). Intestinal helminthes infections were statistically significantly associated ($p = 0.000$) with hypo-glycemia, hypo-proteinaemia and anemia compared with non-infected school children. The likelihood of anemia in intestinal helminth infected school children, when it was compared with uninfected was 148 times higher for both *Ascarislumbricoides*-*Schistosomamansoni* co-infection, 38 times for Hook worm, 20 times for *Schistosomamansoni* and 3 times for *Ascarislumbricoides* mono-infection. **Conclusion:** Malnutrition and intestinal helminthes infections are serious problem in normal growth of the school children. Poverty associated malnutrition is the most important risk factor for stunting. **Key Words:** School children; Malnutrition; Intestinal Helminth infections; Nutritional status ; Gondar town

Background

According to food and agriculture (FAO) estimates, around 1.02 billion people are undernourished worldwide [1]. In spite of some progress in achievements of the nutrition related Millennium Development Goals like reducing maternal mortality, problems associated with children malnutrition and hunger have not been showing significant improvement [2, 3]. In 2016, approximately 5.6 million children under age five died in the world with the highest proportion in Africa [4]. According to world food program report in 2012 [5], of 66 million primary school-age children attended classes hungry in developing world, 23 million or 34.8% were found in Africa. Globally, an estimated 165 million (26%) stunted, 101 million (16%) underweight and 52 million (11%) wasted children of under-five years of age were reported in 2011 [3]. According to the 2015 Millennium development goal (MDG) report, more than 30% of the global under nutrition for under 5 years children was found in Sub-Saharan Africa (SSA) [3, 6]. In Africa, 58 million stunted, 13.9 million wasted, 10.3 million overweight and 220 million calorie deficient under five children were also been reported [3]. The severity of children mortality, delayed mental development, poor school performance, reduced intellectual capacity and reduced immunity for diseases are related with severity of stunting and wasting [7]. The percentage of stunting and wasting reflect the cumulative effects of malnutrition and parasites infections [7, 8]. Helminth parasites infections are the major factors in causing malnutrition [9, 10].

Globally in 2010, 819 million *Ascaris*, 438.9 million Hook worm and 464.6 million *Trichuristrichiura* infections were reported in Asia (70%), in Sub-Sharan Africa (16 %) and other part of the world (22%) including the 1.01 billion infection prevalence in school age children in Asia (70%), Sub-Sharan Africa (16%) and Latin America and Caribbean (13%) [11]. Declined food intake and/or an increase in nutrient wastage through blood loss, vomiting or diarrhea related to helminthes infections mostly affects the nutritional status of an individual or aggravate protein energy malnutrition, anemia and other nutrient deficiencies [12]. Chronic schistosomiasis contributes to anemia and under-nutrition, which, in turn, can lead to growth stunting, poor school performance, poor work productivity, and continued poverty while blood loss due to Hook worm infection can cause iron deficiency anemia and hypo-proteinaemia[13]. Ascariasis cause malnutrition in addition to pathology associated the worm migration in the body. Chronic dysentery associated with Trichuriasis is also a major problem in health of school children [14]. Heavy *S. mansoni* infected children in Brazil (above 400 eggs/g of stool) showed 2.74 fold higher risk of stunting compared to uninfected children [15].

Ethiopia, second populous nation in Africa, has been classified as low income countries with 20% of poverty in both urban and rural areas [16]. The prevalence of wasting in Ethiopia was 12% in under 5 years children in 2011 and stunting reduced from 64% in 1990 to 47% in 2008 [1, 16, 17]. Of the total 4,921 under five children analyzed in 2014 to determine their nutritional status, the percentages of stunted, underweight and wasted were 40.4%, 25.2% and 8.7% respectively [18]. Low socio-economic status or low accessibility of food (poverty) in Ethiopia could be the main cause of malnutrition [19, 20]. Factors that increase the risk of intestinal parasitic infections such as swimming, bar foot walking (lack of shoes), bad hand washing habits and low Education status of parents were also reports to be associated with malnutrition [19, 21, 22]. In Ethiopia, intestinal parasitic infections in under 5 years children were reported to cause malnutrition, anemia, and growth retardation [23, 24]. Researches describing the role of helminth infections and their intensity on nutritional status, anemia and normal hematological and biochemical values of primary school children are rare. The aims of this research was to evaluate the nutritional status of school children in Azezo primary school in Gondar town and compared it to WHO standards in addition to analyzing the impact of intestinal helminthes (infections and intensities) on normal growth, normal hematological and biochemical values in the school children.

Results

Stunting was statistically significantly associated with poor family status (without enough available food) compared to other factors (table 1). Intestinal helminth infections were highly prevalent in rural (57.1%) compared to urban residence (30.1%) in statistically significant different ($p=0.000$) manner. But, stunting or wasting were not associated with urban or rural residence ($p>0.05$). Swimming or washing in the rivers was more common for rural residences

($p=0.04$), but it was not associated with intestinal helminth infections or stunting. Almost all the community has shoes wearing and hand washing habits. Stunting, wasting and anaemia were not associated with these behaviour ($p>0.05$)(Table 1).

Table 1 .Risk factor analysis table.Binomial regression analysis was used to relate low accessibility of food, residence, education status of parents, shoes wearing habit, hand washing habits, Intestinal helminth infections and swimming or washing in the rivers as possible risk factors associated with stunting and wasting

Table 2.Regression analysis between nutritional status and haematological and biochemical values. The table indicates binomial regression analysis to show relationship among growth status of school children and haematological and biochemical values.

The overall prevalence of helminthes infections in the school children was 45.8% (178/384) with the leading *Ascaris* infection (20.6% or 79/384). The second and third leading infections were *Schistosomamansoni* and Hook worm infections with prevalence of 17.4% (67/384) and 13.3% (51/384) respectively. The prevalent of the remaining *Tricuristrichura*, *Hymenolopis* nana and *Taeniaspp* were 3.4%, 1% and 0.3% respectively. Of the total 178 school children found infected, 37(9.6%) were with double infections (16 *Ascaris* – *Schistosoma*, 12 *Ascaris* – Hookworm, 4 *Schistosoma* – Hookworm and 5 *Ascaris* and others) and 2.8%(5/178) triple infections (4 *Ascaris* -*Schistosoma* –others and 1 *Ascaris* - Hook worm - *Tricuristrichura*).

Ascarislumbericoides, *Schistosomamansoni* and Hook worm mono-infection or *Ascarislumbericoides* – *Schistosomamansoni* and *Ascarislumbericoides* – Hook worm co-infections were statistically significantly associated ($P\leq 0.001$) with protein malnutrition (hypoproteinemia) and Anaemia (Table 3) compared to non-infected school children. The overall infection was also statistically significantly associated with hypoglycemia, hypoproteinaemia and anemia ($p=0.000$).

Table 3.Table indicating multiple regression regression analysis to show relationship of different intestinal helminth infections with age groups, stunted and normal, hypo-proteinemic and hypo-glycemic school children.

Of total 384 school children, 209 were none infected compared to 56 light infections, 47 moderate infections and 75 heavy infections. Of total 47 stunted school children, the percentage with light, moderate, heavy and none infections were 34%, 4.3% 12.8% and 48.9% respectively. Of 337 school children who were not stunted, the percentage with light, moderate, heavy and none infections were 11.9%, 13.4%, 20.5% and 54.3% respectively. intestinalhelminthes infection, intensity, mono or co-infection between stunted and normal school children were not statistically significantly different ($P>0.05$)(Table 4). Kruskal Wallis and Mann – Whitney analysis of variance indicated intestinal helminth infections were not statistically significantly different ($p>0.05$) for different Gender (Table 4).

Table 4 Comparison of variance in Helminth infections, intensity and mono and co-infection in school children. Mann -Whitney Test (ANOVA test) was used to lack statistically significantly difference between male and female with prevalence of helminth infections, intensity of infection, mono or co-infections in addition to prevalence of anaemia and stunting.

Discussion

The prevalence of intestinal helminthes infections in this study (45.8%) has showed helminthes as one of the important parasites in school age children in Gondar as already reported in Gondar University Community Primary School (34.2%) [21]and Azezo Primary School (72.9%) [22]. These previous investigations were conducted before the Gondar City Administration Health office started regular deworming program in all primary schools. The difference in prevalence of intestinal parasites between the two previous studies could be related with relatively better standard of life of the University community and other people living in Central Gondar compared with semi-rural conditions in the peripheral Azezo areas where most students were

coming from the surrounding rural villages. The prevalence of *Schistosomamansoni* and *Ascarislumbericoides* decreased from 43.5% and 28.8% in 2008 [22] to 17.4% and 20.6% in 2018 by this study respectively in the same Azezo primary school. Lack of elimination of intestinal helminth infections in school children, after regular annual deworming practices, had indicated the magnitude of problems associated with helminthes re-infections in school children. This is an indication for inability of deworming program alone to control soil transmitted helminthiasis. Targeted hygiene education, sanitation measures and clean water supply could be among measures to be done in integration with deworming program to control helminth infections in school children as already reported[37]. Poor hand washing habits, unhygienic conditions, swimming habits, wading bare foot and education status of parents were reported for high incidence of intestinal infections which worsen the situation of malnutrition in children [19, 21, 22]. In this study, higher incidence ($p<0.00$) for intestinal helminth infections was observed for rural residence. Rural and urban conditions, with no difference in poverty level, did not show difference in stunting or

wasting in school children ($p>0.05$) (Table 1). But, stunting was associated with low accessibility of food in poor families compared with families without shortage of food availability ($p=0.000$). Malnutrition due to low accessibility of food could be the main source stunting in the study area. In Ethiopia low accessibility of food due to low income of parents were reported to be statistically significant associated with stunting, wasting and underweight in school children [19, 20, 33, 34]. The prevalence stunting and thinness including wasting in school children in different part of Ethiopia were ranged from 11 to 41 % for stunting and from 8.7- 34 % for thinness or underweight [19, 24, 33-36].

In Ethiopia, intestinal parasitic infections in children reported to be associated with malnutrition, anaemia, and growth retardation [23]. Intestinal parasitic infections could result in malnutrition as they decline appetite for food, increase nutrient wastage through blood loss, vomiting and diarrhea and result in protein and energy deficiencies, anaemia and other nutrient deficiencies

Except 1 school children (0.3%), there was no problem of overweight. Only 34.9% of the school children were within WHO normal range based on BAZ scores. Majority (65%) were in state of thinness or underweight (thin, wasted or sever wasted). Thinness (underweight) or stunting were not statistically significantly associated ($p>0.05$) with Age, sex, age groups, Haematological and biochemical values. All these results could show malnutrition was very common in all children and might be related with the low socio-economic background of the community in Azezo areas. But, 97.9% of stunting was found in 10 - 15 years age group ($P=0.000$). A statistically significantly differently different ($p=0.000$) high stunting prevalence (56.4 %) in 10-15 age group compared to lower (33.6%) in 5-10 age group was reported in school children in Macha district in Northwest Ethiopia [24]. A total of 50.1% stunting in 12-14 age group School children compared to 36.9% in 6-11 age group ($p=0.000$) was also reported in Arbaminch town (Southern Ethiopia) [38]. Frequent stunting in children above 10 years compared to those under 10 was reported in Angola due to prolonged problem of food shortage during previous war time [39]. From the fact that anemia prevalence, glucose or protein malnutrition were not different between the age groups ($p>0.05$) (almost the same probability) in addition to lack of difference in incidence of intestinal helminth infections between stunted and normal school children ($P=0.49$) at present study (Table 2), most probably, stunting was the result of prolonged malnutrition related to poverty and parasitic infection during childhood. Stunting may not be restricted to areas with war and prolonged shortage of food as indicated by Olivera et al. [39]. School feeding is highly recommended in countries like Ethiopia where the nation is classified as low income county with majority of rural and urban people living in poverty.

Ascarislumbericoides, *Schistosomamansoni* and Hook worm mono-infection or *Ascarislumbericoides* – *Schistosomamansoni*, *Ascarislumbericoides*– Hook worm co-infections and overall infections were statistically significantly associated ($P \leq 0.001$) with protein malnutrition (hypo-proteinemia) and anaemia (Table 3). This type of association between severe malnutrition and infections reported to be common in children [40]. Intestinal helminthes infections could aggravate the situation of malnutrition. Prevalence of stunting and anaemia were reported higher in male than in female [41]. But, gender did not show any difference ($p>0.05$) for prevalence of stunting or anaemia in school children studied (Table 3). Intensity of infection and species of intestinal helminth infections were affected the prevalence of anaemia in statistically significant ways ($p=0.000$) compared with none infected school children (Table 4). The likelihood of anemia in school children, when it was compared with uninfected, increased 148 times for both *Ascarislumbericoides*-*Schistosomamansoni* co-infection, 38 times for Hook worm, 20 times for *Schistosomamansoni* and 3 times for *Ascarislumbericoides* mono-infection (Table 4). But in Kenya *S. mansoni* mono-infection was reported to associate with anaemia and the likelihood of anemia in *Schistosoma* infection was 3.68 times compared with non- infected children [41]. Probably, Swimming habits of school children in the rivers in the study areas, unhygienic and bare foot walking habits mentioned as risk factor for high incidence of Intestinal infections in the school children (Mengistu et al 2010) [22] might have contributed for such very high incidence of anemia in Azezo school children. *Ascarislumbericoides*, *Schistosomamansoni* and Hook worm infections were statistically significantly associated with lower MCH values ($P \leq 0.001$). Similarly, *Schistosomamansoni* and Hook worm infections were associated with below normal MCHC level ($p=0.000$). Below normal concentration of MCH and MCHC were statistically significantly associated with anaemia (Table 2). Similar study in Thailand has indicated statistically significantly lower ($P<0.000$) MCH, and MCHC levels in helminthes infected group compared to the helminth-free group [42].

Conclusions

Helminthes infection is associated anaemia and hypo-proteinaemia, lower MCH and MCHC levels. The likelihood of anemia is very high in mono-and co-infected compared to uninfected school children. Stunting is the product of prolonged malnutrition and repeated reinfection of intestinal helminth infections in school children. Intestinal helminthes most probably aggravate the malnutrition in school children with low accessibility of food supply due to weak economic background. Regular monitoring of nutritional status of school children and screening intestinal Helminthes, integrated control which involve school feeding, deworming, clean water supply and public health awareness are required.

Abbreviations

BAZ – Body mass index for age Z-score

EPG – Egg per gram

HAZ – Height for age Z-score

SD – Standard Deviation

WBC - white blood cells

RBC - red blood cells

Hgb- hemoglobin concentration

PCV - packed cell volume

MCV-mean corpuscular volume

MCH-mean corpuscular hemoglobin

MCHC-mean corpuscular hemoglobinconcentration

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from Gondar University after proposal was reviewed by ethical review board of the University.

Consent for publication

The author consents to Editorial Board of the journal BMC to publish the paper. The author(s) accept responsibility for publishing this material in his own name, if any.

Availability of data and materials

The data analysed is available in the corresponding author and could be available on reasonable request.

Competing interests

The authors declare that he has no competing interests.

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Authors' contributions

MB, DT and LW designed the research and participated in the research. DT collected the samples and processed them. MB and WL supervised the processes. DT and WL analyzed the data. WL prepared this manuscript.

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Authors' contributions

DT, MB and WL developed the proposal and designed the study. DT collected the samples and MB and WL supervised the processes. WL prepared this manuscript.

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Tables

Table 1

	Low accessibility of food Yes: 172(45%) No: 212(55%)				Residence Urban=153(39.8%) Rural= 231(60.2%)				Education Illiterate: 196(51%) Literate: 188(49%)				Shoes wearing habits Yes: 371(96.6%) No: 13(3.4%)				Hand washing habits Yes:373(97.1%) No:11(2.9%)				Swimming or in the ri Yes: 324(84.4%) No: 60(15.7%)	
	yes	no	Sig.	OR	Urban	Rural	Sig.	OR	Illiterate	Literate	Sig.	OR	yes	No	Sig.	OR	Yes	No	Sig.	OR	yes	No
Wasted:	15.7%	18.4%	.5	.8	18.3%	16.5%	.5	1.2	17.3%	17%	0.8	1.1	17.5%	7.7	0.3	2.8	16.9%	27.3%(3)	.34	.5	15%	25.4%
Yes	(27)	(39)			(28)	(38)			(34)	(32)			(65)	(1)			(63)				(51)	(15)
Norm	84.3%	81.6%			81.7%	83.5%			82.7%	83%			82.5%	92.3%			83.1%	702.7%			85%	74.6
	(145)	(173)			(125)	(193)			(162)	(156)			(306)	(12)			(310)	(8)			273	(44)
Stunted:	21.5%	5 %	.00	5.4	14.4%	10.8%	.2	1.6	11.2%	13.3%	.7	.8	12.5%	15.4%	0.8	0.8	11.8%	27.3%(3)	.29	.5	18.3%	6.8%
Yes	(37)	(10)			(22)	(25)			(22)	(25)			(45)	(2)			(44)				(43)	(4)
Norm	78.5%	95%			85.6%	89.2%			89.8%	86.7%			87.5%	15.4%			88.2%	702.7%			81.7%	93.2
	(135)	(201)			(131)	(206)			(174)	(163)			(326)	(11)			(229)	(8)			(281)	(55)
Anaemic:	34.3%	23.6%	.1	1.6	23.5%	38.5%	.7	1.1	37.8%	27.1%	0.9	1	32.9%	23.1%	0.2	2.4	32.7%	27.3%(3)	.98	1.02	32.7%	32.2%
Yes	(59)	(50)			(36)	(89)			(74)	(51)			(122)	(3)			(122)				(106)	(19)
Norm	65.7%	59%			76.5%	61.5%			62.2%	72.9%			67.1%	76.9%			67.3%	702.7%			67.3%	67.8%
	(113)	(125)			(117)	(142)			(122)	(137)			(249)	(10)			(151)	(8)			(218)	(40)
IHI:	45.3%	39.2%	.2	.7	30.1%	57.1%	.00	.3	55.1%	37.2%	0.09	1.6	46.1%	53.8%	0.4	0.6	46.6%	36.4%(4)	.55	1.6	46.3%	45%
Yes	(78)	(83)			(46)	(132)			(108)	(70)			(171)	(7)			(174)				(150)	(27)
Norm	54.7%	43.4%			69.9%	42.9%			44.9%	62.8%			53.9%	46.2%			53.4%	63.6%(7)			53.7%	55%
	(94)	(92)			(107)	(99)			(88)	(118)			(200)	(6)			(199)				(174)	(32)
Abs poverty:	-	-	-	-	46.4%	43.7%	.7	1.1	44.4%	45.2%	0.9	1.0	44.7%	46.7%	0.9	0.9	44%	72.7%(8)	.12	0.3	47.5%	30%
Yes					(71)	(101)			(87)	(85)			(166)	(6)			(164)				(154)	(18)
No					53.6%	52.3%			53.6%	54.8%			55.3%	53.3%			56%	27.3%			52.5%	70%
					(82)	(129)			(108)	(103)			(204)	(7)			(209)	(27)			(170)	(41)
Residence:	41.3%	38.9%	.6	1.1	-	-	-	-	26%	54.3%	00	.3	40.7%	18.4%	0.04	5.2	39.9%	36.4%(4)	.35	1.9	37%	54.2%
Urban	(71)	(82)							(51)	(102)			(151)	(2)			(149)				(120)	(32)
Rural	58.7%	61.1%							74%	45.7%			59.3%	18.4%			60.1%	63.6%(7)			63%	45.8%
	(101)	(129)							(145)	(86)			(220)	(11)			(224)				(204)	(27)
Education:	50.6%	41.5%	.9	1.04	26%	62.8%	.00	.4			-	-	51.6%	38.5%	1.8	2.3	51.5%	36.4%(4)	.31	1.9	53.7%	35.6%
Illiterate	(87)	51.2%			(51)	(145)							(191)	(5)			(192)				(174)	(21)
Literate	49.4%	48.8%			74%	37.2%							48.4%	41.5%			48.5%	63.6%(7)			46.3%	64.4%
	(85)	(103)			(102)	(86)							(180)	(8)			(181)				(150)	(38)
Shoes wearing habits:	96.5%	96.7%	.8	.9	98.7%	95.2%	.1	4.7	51.5%	95.7%	0.2	2.3			-	-	96.5%	11(100%)	.999	.00	96.9%	94.9%
Yes	(166)	(204)			(151)	(220)			(191)	(180)							(360)				(314)	(56)
No	3.5%	7			1.3%	4.8%			48.5%	4.3%							3.5%	0%(0)			3.1%	5.1%
	(6)				(2)	(11)			(5)	(8)							(13)				(10)	(3)
Hand washing habits:	95.3%	98.6%	.1	.3	97.4%	97%	.4	1.8	98%	96.3%	.3	1.9	97%	100%	.99	0.00			-	-	97.2%	96.6%
Yes	(164)	(208)			(149)	(224)			(192)	(181)			(360)	(13)							(315)	(57)
No	4.7%	1.4%			1.4%	3%(7)			2%(4)	3.7%			3%	0%(0)							2.8%	3.3%
	(8)	(3)			(4)				(7)				(11)								(9)	(2)
Swimming or Washing in the river:	89.5%	80.1%	.017	.451	88.8%	79.8%	.050	1.85	84.6%					76.9%	.2	2.3	84.5%	81.8%(9)	.6	1.6	-	-
Yes	(154)	(169)			(171)	(150)			(314)					(10)			(315)					
No	10.5%	20%			21.6%	11.7%			11.2%	20.2%			15.4%	23.1%			15.5%	18.2%(2)			-	-
	(18)	(41)			(33)	(27)			(22)	(38)			(56)	(3)			(58)					

Table 2

Variables(number)	Age group:			Helminthes infection:			Stunted:			Wasted:			Anaemic:		
	7-10 years(n=151) 11-15years(n=233)			Yes(n=178) No(n=206)			Yes:47 No:337			yes(66) No (318)			Yes:127 NO=257		
	%(N)	P-value	OR	%(N)	P-value	OR	%(N)	P-value	OR	%(N)	P-value	OR	%(N)	P-value	OR
Hypo-glycemic yes(N=49) N0(N=135)	19(38.8) 30(61.2)	.895	1.1	41(83.7)	.278	.6	4(8.2)	.709	1.3	9(18.4)	.846	1.1	37(75.5)	.021	.4
				137(50.9)			43(12.8)			57(17)			88(26.3)		
Hypo-proteinemic (N=125)	54(43.2) 71(56.8)	.059	1.7	93(74.4)	.000	3.4	10(8)	.237	.6	23(18.4)	.991	1.0	76(60.8)	.007	2.4
				85(32.8)			37(14.3)			43(16.6)			49(18.9)		
Below Normal RBC (N=18)	5(27.8) 13(72.2)	.607	1.4	16(88.9)	.132	0.2	2(11.1)	.842	1.2	4(22.2)	.455	.6	15(83.3)	.151	.3
				16244.3(			45(12.3)			62(16.9)			110(30.1)		
Below Normal WBC (N=32)	14(43.8) 18(56.3)	.936	1.0	11(34.4)	.239	1.8	1(3.1)	.107	5.6	6(188)	.433	.7	8(25)	.684	1.3
				167(47.4)			46(13.1)			60(17)			117(33.2)		
Below Normal MCH (N=75)	26(34.7) 49(65.3)	.566	1.2	50(66.7)	.908	1.0	11(14.7)	.157	.5	8(10.7)	.019	2.9	46(61.3)	.010	
				128(41.4)			36(11.7)			58(18)			79(25.6)		
Below Normal MCHC (N=143)	58(40.6) 285(53.4)	.273	.8	75(52.4)	.747	1.1	18(12.6)	.774	.9	26(18.2)	.253	.7	64(44.8)	.003	.4
				102(42.5)			29(12.1)			39(16.3)			60(25)		
Above Normal Lymph (N=124)	46(37.1) 18(62.9)	.385	1.0	69(55.6%)	.011	1.0	15(12.1)	.623	1.0	15(12.1)	.775	1.0	45(36.3)	.787	1.0
				109(41.5)			32(12.3)			51(196)			80(30.8)		
Below Normal Neut. (N=181)	69(38.7) 112(61.9)	.584	1.1	87(48.1)	.925	1.0	21(116)	.586	1.2	27(14.9)	.331	1.3	61(33.7)	.856	.9
				91(44.8)			26(12.8)			39(19.2)			64(31.5)		
Helminth infec.: (N=178)	54(30.3%) 124(69.7)	.000	.4		-	-	24(13.5)	.198	1.7	36(20.2)	.389	1.4	108(60.7)	.000	12
							23(11.2)			30(14.6)			17(8.3)		
Stunted (N=47)	1(2.1) 46(97.9)	.001	.03	24(51.1%)	.387	1.4		-	-	7(14.9)	.492	.7	11(23.4)	.194	.5
				158(45.7)						59(17.5)			114(33.8)		
Wasted: (N=66)		.225	.7	36(54.5)	.489	1.3	7(10.6)	.590	.8		-	-	26(39.4)	.399	1.4
				142(44.7)			40(44.7)						99(31.1)		
Anemic yes: (N=125) No(n=259)	47(37.6) 78(62.4)	.394	1.3	108(86.4)	.000	13	11(8.8)	.135	.5	26(20.8)	.349	1.4	-	-	-
				70(27)			36(13.9)			40(15.4)			-		

Table 3

	Anaemia					Hypoproteinaemia					Gender				
		A	Sig.	Odd Ratio (OR)	95% CI for OR		%	Sig.	Odd Ratio (OR)	95% CI for OR		%	Sig.	Odd Ratio (OR)	95% CI for OR
Ascaris						Hypo(n=20)					M=15				
Yes(N=42)	An(n= 10)	23.8	.009	3.1	1.3-7.3	nor (n= 105)	47.6%	.000	4.6	2.3-9.4	F=27	35.7(15)	.11	.6	0.3-1.1
Nor(N=342)	Nor(n= 115)	33.6	.	.	.		30.7%	.	.	.		7.9(27)	.	.	.
Schistosoma	An(n= 27)		.000	20.6	9.1-46.3	Hypo(n=26)	65%	.000	9.5	4.5-19.9	M=19	47.5(19)	.8	.9	.5-1.8
Yes(N=40)	Nor(n=98)	67.5	.	.	.	norm(n= 99)	28.8%	.	.	.	F=21	6.1(21)	.	.	.
nor (n=344)		28.5	.	.	.			.	.	.			.	.	.
Hook worm	An(n=27)		.000	38.2	14.7-99.3	Hypo(n= 12)	35.3%	.012	2.8	1.3-6.1	M=16	47.1(16)	.8	.9	.4-1.9
Yes(N=34)	Nor(n= 98)	79.4%	.	.	.	Nor(n= 113)	32.3%	.	.	.	F=18	5.1(18)	.	.	.
No(N=350)		28.4%	.	.	.			.	.	.			.	.	.
Asca- Schisto	An (n=15)		.000	148.4	18.6-1186	Hypo(n= 15)	93.8%	.000	76.3	9.8-597.3	M=7		.7	.8	.3-2.2
Yes(N=16)	Nor(n=110)	93.8%	.	.	.	norm(n= 110)	29.9%	.	.	.	F=9	46.7(15)	.	.	.
No(N=368)		29.9%	.	.	.			.	.	.		2.4(9)	.	.	.
Asca-Hook W	-	-	-	-	-	Hypo(n=7)		.001	7.1	2.1-23.8	M=6		.961	1.029	.3-3.3
YES(N=12)						Norm(n=118)	58.3%	.	.	.	F=6	50(6)	.	.	.
NO(N=372)							31.7%	.	.	.		2.6(6)	.	.	.

Table 4

Mann -Whitney Test: ANOVA			
	Chi-Square	df	P-value
1. Male vs Female			
Helminth infection(178) and none infection(206)	2.041	1	.153
Light(56), moderate (47),heavy(75) and none(206) infection	1.209	1	.272
Mono-infection(133), Co-infection(45) and none infection(206)	2.588	1	.108
Ascaris, Schistosoma, Hook worm, Trichuris, Ascaris - Schistosoma, Ascaris-Hookworm , and so on	1.556	1	.212
2. Anemic (N=127) vs normal			
Helminth infection and none infection	62.846	1	.000
3. Anemic (N=127) vs normal			
Light, moderate and Heavy infection	50.444	1	.000
Mono-infection, Co-infection and none infection	40.223	1	.000
Ascaris(, Schistosoma, Hook worm, Trichuris, Ascaris - Schistosoma, Ascaris-Hookworm , and so on	28.457	1	.000
4. Stunted (N=47) vs Normal			
Helminth infection and none infection	.476	1	.490
Light(34%), moderate(4.3%),Heavy(12.8%) and none(48.9%) infection	2.915	1	.088
Mono-infection, Co-infection and none infection	1.939	1	.164
Ascaris, Schistosoma, Hook worm, Trichuris, Ascaris - Schistosoma, Ascaris-Hookworm , and so on	1.139	1	.286