Downloaded from https://journals.lww.com/phmj by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 10/15/2024

Original Article

Intestinal helminthiasis in pregnancy: Pattern and effect on packed cell volume amongst antenatal women in Delta state, South-South Nigeria

Williams Obukohwo Odunvbun

Department of Obstetrics and Gynaecology, College of Health Sciences, Delta State University, Abraka, Delta State, Nigeria

Abstract

Background: Pregnant women are vulnerable to the negative effects of intestinal helminthiasis, due to increased nutritional demands during pregnancy and in severe cases may contribute to anaemia in pregnancy.

Aim: The study was conducted to ascertain the pattern of intestinal nematodes among pregnant women in Delta State and the likely effect on their packed cell volume (PCV).

Methods: This was a prospective cross-sectional study, involving 300 eligible, consenting antenatal women at the booking clinic of Eku Baptist Government Hospital in Delta State, between 1 January 2019 and 31 March 2019. Stool and blood samples were collected from every participant for analysis and evaluation, respectively, for helminthic pattern and PCV. A self-administered, structured questionnaire was used to capture relevant data. Data analysis was done by SPSS version 24.

Results: Three-quarter of the women were below the age of 34 years. Over 80% (238/282) of the women were parous. Fifty-six per cent (158/282) of the women had secondary education. More than Fifty percent of respondents (154/282), were traders. Seventy-two (25.5%) women had a helminthic infestation. *Ascaris lumbricoides* accounted for the highest (62.5%) type of worm, followed by *Necator americanus* (23.6%). Pregnant women who had their toilet within their houses had a statistically significantly fewer helminthic infestation ($P < 0.001$). Hand washing was associated with a statistically significant reduction in helminthic infestation among the women ($P < 0.001$). There was no statistically significant difference in helminthic infestation across the trimesters ($P = 0.224$). Women with helminthic infestation had statistically significantly lower PCV ($P < 0.001$). Women with hookworm and mixed infestations had statistically significantly lower mean PCV ($P < 0.001$).

Conclusion: A high prevalence of *A. lumbricoides* and hookwoom infestation among pregnant women was found in this study. Helminthiasis was associated with reduced PCV. The routine antihelminthics for pregnant women attending Eku Baptist Government Hospital, is recommended by these findings.

Keywords: *Ascaris lumbricoides*, helminthiasis, packed cell volume, pregnancy

Address for correspondence: Dr. Williams Obukohwo Odunvbun, Department of Obstetrics and Gynaecology, College of Health Sciences, Delta State University, Abraka, Delta State, Nigeria.
E-mail: willymeg1@gmail.com

Received: 26.05.2020, **Accepted:** 23.07.2020, **Published:** 25.03.2021

Access this article online	
Quick Response Code:	Website: www.phmj.org
	DOI: 10.4103/phmj.phmj_18_20

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Odunvbun WO. Intestinal helminthiasis in pregnancy: Pattern and effect on packed cell volume amongst antenatal women in Delta state, South-South Nigeria. Port Harcourt Med J 2020;14:136-41.

Downloaded from https://journals.lww.com/phmj by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 10/15/2024

INTRODUCTION

Pregnant women are vulnerable to the negative effects of intestinal helminthiasis, due to increased nutritional demands during pregnancy.[1] The poor rural dwellers are frequently and chronically infected with different species of parasitic worms.[2] Over 24% of the world's population are reported to be infested with geo-helminths. Infestations occur most frequently in Americas, China, East Asia and sub-Saharan Africa.[3]

Findings from epidemiological surveys showed that poor sanitation, unhealthy environmental conditions, such as indiscriminate defecation, contamination of water bodies and geophagy are important predisposing factors to helminthic infestation.[4]

A study conducted revealed that pregnant women have a higher prevalence of parasitic infestations compared to non-pregnant women.[2] Helminthiasis have been shown to directly contribute to severe anaemia in patients through blood loss and micronutrient deficiencies.[5]

The safety and benefit of antihelminthics in pregnancy is a matter of concern to researchers. A systematic review aimed at determining the effect of antihelminthics on maternal, newborn and child health outcomes showed that antihelminthics significantly reduced the prevalence of soil-transmitted helminthic infestation.[6] Observational studies[7-9] suggest improved maternal iron status, with the use of antihelminthics.

Eku Baptist Government hospital is the largest secondary health facility serving the Ethiope East Local government area of Delta State. By the 2006 population census figure, the local government area had a population of 200,792.[10] The local government is named after the Ethiope River, and Eku community shares boundary with the river. Occupation of the people includes fishing, farming and petty trading. Water supply is from the Ethiope river and private boreholes. Waste disposal is by open dumping. Faecal disposal methods include open defaecation, sometimes directly into the Ethiope River, pit latrines and water closet. Pregnant women are not routinely dewormed during antenatal care. They are all placed on sulphadoxine/pyrimethamine, for intermittent prevention against malaria. The purpose of this study, therefore, is to determine the prevalence, pattern and possible effect of intestinal helminthiasis on packed cell volume (PCV), amongst pregnant women attending Eku Baptist government hospital. The findings from this study may assist in advising relevant authorities for routine deworming of antenatal patients attending the health facility at Eku and other government secondary health facilities in Delta State.

METHODS

This was a prospective cross-sectional study, involving eligible, consenting antenatal women at the booking clinic of Eku Baptist government hospital, Delta state. It is a 160-bed health facility. The antenatal clinic sees an average of eighty pregnant women every week. The study was conducted from 1 January 2019 to 31 March 2019.

A self-administered, structured questionnaire with information on sociodemographic characteristics, toilet location and hand washing practice after toilet use was administered to the patients (assistance was given to those who could not read or write), while information on trimester, types of helminthic infestation and PCV of women was entered after the laboratory investigation.

The minimal sample size for the study was calculated based on 95% confidence level and 5% marginal error; the sample size (n) was determined using the formula as described by Higgins and Shulman,[11] for descriptive studies:

$n = p\,(1 - p)\,Z^2/d^2$ where

n = sample size p = (11.8%)[12]

The minimum sample size (n) was calculated to be 169.

To allow for attrition, a sample size of 300 was used for this study.

Inclusion criteria

Included were all consenting eligible pregnant women at booking.

Exclusion criteria

Excluded were pregnant women who refused to give their consent; pregnant women who took antihelminthic within 3 months prior to being recruited; pregnant women with sickle cell anaemia and pregnant women with a history of bleeding in index pregnancy.

Sample collection, preparation and examination

At booking, eligible pregnant women were given containers for stool sample. This was returned the same day or the following day to the microbiology department. The examination was carried out using wet preparation. A drop of fresh physiological saline was placed on one end of a clean slide and a drop of iodine was placed on the other end of the slide. A small amount of the stool was

Downloaded from https://journals.lww.com/phmj by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 10/15/2024

mixed with the saline and also with the iodine, using a stick applicator. A coverslip was placed over each preparation and examined for an intestinal parasite, larvae, ova or cysts, with a microscope, using ×10 and ×40 objectives, with the condenser iris closed sufficiently to give good contrast. [13]

In addition, 5 ml of venous blood was collected in an ethylenediaminetetraacetic acid bottle for PCV determination in the haematology department, using a Capillary tube for collection of the blood. After sealing the ends of the tube with plastercine, it was centrifuged for 30 min with a haematocrit machine and read with a haematocrit reader.

Data analysis

Statistical analysis was performed using the IBM SPSS Statistics 24.0 software (IBM Corporation, Armonk, NY, USA). Frequency, percentage, mean and standard deviation were used to describe the dataset. For comparisons involving categorical variables, the Chi-square test or Fisher's exact test (for expected counts <5) was applied, while for comparisons involving continuous variables, the independent sample *t*-test was applied. The level of statistical significance was set at $P < 0.05$.

Ethical approval was obtained from the ethics and research committee of the institution. Informed consent was obtained from all participants, and they were assured that refusal to participate will not affect their management.

RESULTS

A total sample size of 282/300 (94%) was available for analysis.

Table 1 shows the sociodemographic characteristics of the women. Three-quarter of the women were below the age of 34 years. Over 80% (238/282) of the women were parous. Fifty-six per cent (158/282) of the women had secondary level of education. Only a single woman had no formal education. More than Fifty percent of respondents (154/282), were traders.

Seventy-two (25.5%) women had helminthic infestation.

Table 2 reveals the distribution of types of helminthic infestation. Among women with helminthiasis, *Ascaris lumbricoides* accounted for the highest (62.5%) type of worm. There were no *Trichuris trichiura* and *Enterobius vermicularis* in the stool samples submitted. Hookworm accounted for 23.6% of infestation, while eight women had mixed infestation.

The distribution of helminthic infestation according to toilet location, handwashing practice and trimesters of the pregnant women is shown in Table 3. Pregnant women who had their toilet within their houses had a statistically significantly fewer helminthic infestation ($P < 0.001$). Hand washing practice was associated with significant reduction in helminthic infestation among the women, even those who infrequently washed their hands after using the toilet had lower proportion of infestation compared to those

Table 1: Sociodemographic characteristics (*n*=282)

	Frequency (%)
Age of the respondents	
<20	15 (5.3)
20-26	79 (28.0)
27-33	124 (44.0)
34-40	59 (20.9)
41-47	5 (1.8)
Parity	
Nullipara (no previous vaginal delivery)	44 (15.6)
Primipara (P1)	53 (18.8)
Multipara (P2-P4)	150 (53.2)
≥P5	35 (12.4)
Respondents' level of education	
No formal education	1 (0.4)
Primary education	39 (13.8)
Secondary education	158 (56.0)
Tertiary education	84 (29.8)
Respondents' occupation	
Full-time homemakers	50 (17.7)
Civil servants	36 (12.8)
Farmers	26 (9.2)
Students	16 (5.7)
Traders	154 (54.6)

Table 2: Distribution of types of helminthic infestations

	Frequency (%)
Ascaris lumbricoides	45 (62.5)
Hookworm (*Necator americanus*)	17 (23.6)
Trichuris trichiura	0
Enterobius vermicularis	0
Strongyloides stercoralis	2 (2.8)
Mixed infestation	8 (7.1)

Table 3: Distribution of helminthic infestation according to toilet location, handwashing practice and trimesters of the pregnant women

	Helminthic infestation		χ^2	*P*
	Present	Absent		
Location of toilet				
Within house	21 (13.5)	135 (86.5)	26.754	<0.001
Outside the house	51 (40.5)	75 (59.5)		
Hand washed after toilet use				
Yes	8 (3.8)	200 (96.2)	197.686	<0.001
No	23 (95.8)	1 (4.2)		
Not always	41 (82.0)	9 (18.0)		
Trimester of pregnancy				
First trimester	5 (17.9)	23 (82.1)	2.989	0.224
Second trimester	49 (24.4)	152 (75.6)		
Third trimester	18 (34.0)	35 (66.0)		

Downloaded from https://journals.lww.com/phmj by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 10/15/2024

who never washed their hands ($P < 0.001$). There was no statistically significant difference in helminthic infestation across the trimesters ($P = 0.224$).

Table 4 shows a comparison of mean PCV of women with helminthic infestation versus those without helminthic infestation. Women with helminthic infestation had statistically significantly lower PCV ($P < 0.001$).

Table 5 shows that there was a significant difference in the mean PCV based on the type of infestations. *Post hoc* analysis showed that pregnant women with mixed infestations had statistically significantly lower PCV ($P < 0.001$).

DISCUSSION

Out of the 280 stool samples returned, 72 had helminthic infestation, giving an overall prevalence of helminthiasis amongst pregnant women attending Eku Baptist hospital to be 25.5%. This rate was only slightly higher than the 22.7% in an earlier study, [1] from the Niger Delta. In a study at the University of Nigeria, Enugu, the prevalence rate was 27.9%. [12] In Makurdi, located in Central Nigeria, there was a higher prevalence rate of 56.8%. [13] Helminthic infestations were found amongst women. The factors that contributed to this high prevalence included the high level of poor personal hygiene, with resultant faeco-oral transmission; others were poor environmental sanitation and the method of stool preparation, which was the formol ether concentration technique. [13] In Ibadan, the rate of intestinal nematodes was 43.4%, [14] whereas in Adamawa, northern Nigeria, the rate was 33.3%. [15] Various factors influence the prevalence of intestinal helminthiasis in any community. This includes environmental, parasitic and host factors. [16]

Table 4: Mean comparison of packed cell volume according to the presence of helminthic infestation

	n	Mean	SD	*t*	*P*
Present	72	29.15	3.50	6.279	<0.001
Absent	210	31.88	3.06		
Total	282	31.18	3.39		

SD: Standard deviation

Table 5: Mean comparison of packed cell volume of pregnant women according to the types of helminthic infestation

Types	*n*	Mean	SD	*F*	*P*
Ascaris lumbricoides	45	30.80[a]	2.83	21.105	<0.001
Hookworm (*Necator americanus*)	17	27.00[a,b]	1.62		
Strongyloidis stercoralis	2	31.00[a]	4.24		
Mixed infestation	8	24.00[b]	2.39		
Total	72	29.15	3.50		

Means with different superscripts are statistically significant at $P<0.05$. SD: Standard deviation

Elsewhere in the West African subregion, a prevalence rate of 41.2% was found in a study, conducted in northern Ghana. [17] In similar study, a prevalence rate of 76.2% was documented among 390 pregnant women in rural western Kenya. [18]

The high prevalence of helminthiasis amongst pregnant women may be indicative of faecal pollution of soil and contaminated domestic water supply around homes, due to poor sanitation, ignorance of the mode of transmission of these worms and improper sewage disposal. [14]

Helminthic parasites identified in this study were *A. lumbricoides*, Hookworm and *Strongyloidis stercoraralis*. *A. lumbricoides* accounted for over 60% of the parasites identified. This finding is similar to the pattern in other studies. [14,19,20] Fewer *A. lumbricoides*, 24.2% and 30.0%, were identified in studies from South-West and Edo Statem respectively. [21,22] Human ascariasis is transmitted through faecal pollution of soil; consequently, the intensity of infestation depends on the degree of soil pollution. [22] The significantly higher prevalence of helminthic infestation and ascariasis among women who defaecated outside their houses and those who had poor handwashing practice emphasises the importance of faecal and soil contact in helminthic infestation. The practice of soil eating is common among pregnant women in the sub-Saharan Africa. [4] A high prevalence of helminthiasis was associated with this practice in a study[8] conducted in Ghana. In another study in Kenya, [9] a significant proportion of clay eaters had helminthiasis compared to non-clay eaters.

Hookworm, with a prevalence of 23.6%, was the next common helminthic infestation among pregnant women in this study. This was lower than the 35.8% documented in Ibadan. [14] The low prevalence of 7.4% hookworm recorded in Port Harcourt may be related[1] to the fact that the total number of individuals was used as the denominator for calculating the prevalence of different types of helminths, rather than the number of individuals with nematode infestation. Elsewhere in Kenya, [4] the prevalence of hookworm was as high as 74.9%. In Tanzania, it was 56.6%. [4] The differences in sample sizes and the denominator used in determining the prevalence of the different types of helminth in various studies may have contributed to the variations in prevalence. Hookworm infestations occur by penetration of the L3 stage infective larvae. Poor sanitary disposal of human faeces and indiscriminate defecation are the main factors responsible for hookworm infestations. [22]

The 2.8% prevalence of *Srongyloidis stercoralis*, as well as the absence of *E. vermicularis* and *Trichuris trichura*, may

Downloaded from https://journals.lww.com/phmj by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 10/15/2024

not be unconnected with the sample size and method of stool analysis. Elsewhere in Nigeria, the prevalence of *Enterobiasis* was 3.5% amongst pregnant women in Ibadan[14] and 0.7% and 1.0% in Kenya[23] and Ghana, [8] respectively. The prevalence of *T. trichiura* from studies in Nigeria includes 2.9% in Ibadan[14] and 2.7% in Port Harcourt. [1] In Kenya, the reported prevalence in a study was 1.3%. [23] The prevalence of trichuriasis in the tropics is high because of increased humidity, associated with faecal contamination of the soil and water sources in rural communities, resulting in increased transmission. [23]

There was a statistically significant association between defaecating outside the house, the practice of not washing hands after defecation and helminthiasis ($P < 0.001$). In a similar study[14] conducted in the Niger Delta of Nigeria, majority of the women with helminthiasis defaecated in open field, stream and pit. The same finding was replicated in Ghana, [8] as the high prevalence of helminthiasis was indicative of poor sanitation and improper sewage disposal, as many of the participants had no toilet facilities in their homes.

The mean PCV of individuals with intestinal helminthiasis in this study was statistically significantly lower than those without (29.2% vs. 32.0%, $P < 0.001$). Hookworm infestation and mixed infestations were associated with even lower PCV values, 27.0% and 24.0%, respectively (*Z*1). The significant association of hookworm and anaemia has been reported in previous studies. [24,25] Anaemia during pregnancy is a public health problem, especially in developing countries, with associated adverse outcome. [26] Anaemia in the pregnant woman may result in fatigue, poor work capacity, impaired immune function, increased risk of cardiac diseases and mortality. [26,27] Anaemia in pregnancy is also associated with increased risk of preterm birth and low birth weight babies. [28-30] Antihelminthic is only prescribed when indicated during antenatal visits in public hospitals in Delta State. With the anaemia associated with hookworm and mixed helminthic infestation, amongst pregnant women in this study, there is a need to replicate this study in other health facilities in Delta State. This will allow for determination of the state prevalence of helminthiasis amongst pregnant women and the need to include antihelminthics routinely in antenatal drugs.

The study limitation included the relatively small sample size. This would have affected the prevance rate. The method of stool preparaion was saline and iodine. It did not include the concentration method. The saline/iodine stool preparation method is the practice followed in all Delta State's secondary health facilities. By using this method alone, a lower prevalence of the different types of intestinal nematodes may be recorded which may also have accounted for the non-identification of *T. trichiura* as well as *E. vermicularis*. The use of PCV alone, for diagnosis of anaemia, presented some weakness in this study. Studies have shown that spun haematocrit gives values approximately 1.5%–3.0% too high, due to plasma trapped in the red blood cell layer. [31] Other haematological parameters for anaemia such as haemoglobin, total serum iron and ferritin were not used because of cost. The study facility is a free maternity service center and provides all aspects of maternity services free of cost. The second reason is the simplicity and less time involved in performing PCV.

Although women were aggregated into trimesters for the determination of relationship between the prevalence of helminthic infestation in the trimesters, the insignificant effect of trimestester on the prevalence of nematodes may be due to the relatively small sample size.

CONCLUSION

A high prevalence of *A. lumbricoides* and hookworm infestation amongst pregnant women was found in this study. Helminthiasis was associated with lower PCV. Routine antihelminthics for pregnant women attending Eku Baptist Government Hospital is recommended. There is a need to replicate this study in other secondary health facilities in Delta State. Similar finding could form a basis for the recommendation of antihelminthics for pregnant women attending all secondary health facilities in the State.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Green KI, Ojule JD. helminthiasis in pregnancy in the Niger-Delta region of Nigeria. Nigerian Health J 2015;15:69-77.
2. Hotez PJ, Molyneux DH, Fenwick A, Kumaresan J, Sachs SE, Sachs JD, *et al.* Control of neglected tropical diseases. N Engl J Med 2007;357:1018-27.
3. Saboya MI, Catala L, Nicholls RS, Ault SK. Update on the mapping of prevalence and Intensity of Infestation for soil-transmitted helminth Infestations in Latin America and the Caribbean: A call for action. Plos Negl Trop Dis 2013;7:e2419.
4. Brooker S, Hotez PJ, Bundy DA. Hookworm-related anaemia among pregnant women: A systematic review. PLoS Negl Trop Dis 2008;2:e291.
5. Steketee RW. Pregnancy, nutrition and parasitic diseases. J Nutr 2003;133:1661S-1667S.
6. Imhoff-Kunsch B, Briggs V. Antihelminthics in pregnancy and

Downloaded from https://journals.lww.com/phmj by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3i3D0OdRyi7TvSFl4Cf3VC1y0abggQZXdgGj2MwlZLeI= on 10/15/2024

maternal, newborn and child health. Paediatr Perinat Epidemiol 2012;26 Suppl 1:223-38.
7. Rodriguez-Morales AJ, Barbella RA, Case C, Arria M, Ravelo M, Perez H, *et al*. Intestinal infestations among pregnant women in Venezuela. Infectious diseases in obstetrics and gynaecology. 2006;23125:1-5.
8. Baidoo SE, Tay SCK, Obiri-Danso K, Abruquah HH. Intestinal helminth infestation and anaemia during pregnancy: A community-based study in Ghana. J Bacteriol Res 2010;2:9-13.
9. van Dijk AM, Linblade KA, Odhiambo F. Geohelminth infestations among pregnant women in rural western Kenya: A cross-sectional study. PLoS Trop Dis 2009;3:e370.
10. Directorate of Local Government Affairs, Governor's office, Asaba, Delta State. Giant Development Opportunities in Delta State Local Government Areas. Ethiope East Local Government Area: Directorate of Local Government Affairs; 2012. p. 13-5.
11. Higgins JE, Shulman HB. Sample size and power. In: Wingo PA. Higgins JE, Rubin GL, Zahniser SC editors. An Epidemiologic Approach to Reproductive Health. Geneva: World Health Organization; 1994.
12. Ozumba UC, Ozumba NA. helminthiasis in pregnancy in Enugu, Nigeria. Nigeria J Health Sci 2005;51:291-3.
13. Amuta E, Houmsou R, Mker S. Knowledge and risk factors of intestinal parasitic infestations among women in Makurdi, Benue state. Asian Pac J Trop Med 2010;3:993-6.
14. Alli JA, Okonkwo IO, Kolade AF, Nwanze JC, Dada VK, Ogundele M. Prevalence of intestinal nematode infestation among pregnant women attending antenatal clinic at the University College Hospital, Ibadan, Nigeria. Adv Appl Sci Res 2011;2:1-13.
15. Gundiri MA, Kwalagbe BT, Gundiri EA, Godly C. Prevalence of Parasitic Infestations among School-age Fulani Children in Guduso, Girei Local Government Area of Adamawa State, Nigeria. The Nigeria Society for parasitology, 25Th Annual Conference in Yola; 2-5 September, 2001.
16. Cheesebrough M. District Laboratory Practice in Tropical Countries. Part 2. Cambridge: Cambridge University Press; 2004. p. 357.
17. Fuseini G, Edoh D, Kalifa BG, Knight D. Plasmodium and intestinal helminthes distribution among pregnant women in the Kassena-Nanhana district of Northern Ghana. J Nematol 2009;1:19-24.
18. Van-Eijk AM, Lindblade KA, Odhiambo F, Bles HM, Ayisi FB, lockland JG, *et al*. Geohelminth infestations among pregnant women in rural Western Kenya: A cross-sectional study. PLoS Neglected Trop Dis 2009;3:e370.
19. Ndamukong KJ, Ayuk MA, Dinga JS, Akenji TN, Ndiforchu VA, Tijani VP. The pattern of soil-transmitted nematode infestations in primary school children of Kumba Health District, South-West Cameroon. Afr J Health Sci 2000;7:98-102.
20. Egwuyenga OA, Ataikiru DP, Nmorsi QP. Studies on Intestinal Helminthes Infestation in Eku, Delta State, Nigeria. 28th Annual Conference, in Port Harcourt; 19-22 September, 2000.
21. Adeyeba OA, Akinlabi AM. Intestinal parasitic infestations among school children in the rural community, South-West Nigeria. Nigerian J Parasitol 2002;23:11-8.
22. Mordi RM, Ngwodo PO. A study of blood and gastro-intestinal parasites in Edo State. Afr J Biotech 2007;6:2201-7.
23. Wekesa AW, Mulambalah CS, Muleke CI, Odhiambo R. Intestinal helminth infestations in pregnant women attending antenatal clinic at kitale district hospital, Kenya. J Parasitol Res 2014;2014:200-4.
24. Kawai K, Saathoff E, Antelman G, Msamanga G, Fawzi WW. Geophagy (Soil-eating) in relation to Anemia and Helminth infection among HIV-infected pregnant women in Tanzania. Am J Trop Med Hyg 2009;80:36-43.
25. Muhangi L, Wooburn P, Omara M, Omoding N, Kizito D, Mpairwe H, *et al*. Associations between mild to moderate anaemia in pregnancy and helminth, malaria and HIV infestation in Entebbe, Uganda. Trans R Soc Trop Med Hyg 2007;101:899-907.
26. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, *et al*. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 2013;382:427-51.
27. Mbule MA, Byaruhanga YB, Kabahenda M, Lubowa A. Determinants of anaemia among pregnant women in rural Uganda. Rural Remote Health 2013;13:2259.
28. Kidanto HL, Mogren I, Lindmark G, Massawe SN, Nystrom L. Risk for preterm delivery and low birth weight are independently increased by severity of maternal anaemia. S Afr Med J 2009;99:98-102.
29. Msuya SE, Hussein TH, Uriyo J, Sam NE, Stray-Pedersen B. Anaemia among pregnant women in northern Tanzania: Prevalence, risk factors and effect on perinatal outcomes. Tanzan J Health Res 2011;13:33-9.
30. Levy A, Fraser D, Katz M, Mazor M, Sheiner E. Maternal anaemia during pregnancy is an independent risk factor for low birthweight and preterm delivery. Eur J Obstet Gynecol Reprod Biol 2005;122:182-6.
31. Linne JJ, Ringsrud KM. Clinical Laboratory Science, the Basic Science and Routine Techniques. 5th ed. St. Louis, Missouri: Mosby; 1999. p. 279-95.