INTRODUCTION

Malaria in pregnancy is a major contributor to adverse maternal and perinatal outcomes. Maternal malaria has been reported to be associated with up to 200,000 infant deaths yearly. Malaria is a common cause of anaemia in pregnancy in both immune and non-immune individuals and is aggravated by poor socio-economic factors. Co-infection with hookworm and malaria is common in Africa, but the exact number is unknown. Malaria and hookworm co-infection have been shown to have additive impact on anaemia resulting in adverse pregnancy outcomes. There have been few studies on the impact of malaria and hookworm co-infection among pregnant women in rural communities where these parasites are endemic. Hookworms infect more than 600 million people worldwide and it's the leading cause of maternal and child morbidity in the developing countries of the tropics and subtropics. It is estimated that a-third of all pregnant women in developing countries are infected with hookworm, 56% of all pregnant women...
Women in developing countries suffer from anaemia, while 20% of all maternal deaths are either directly or indirectly related to anaemia. *N. americanus* is the most common hookworm species worldwide, while *A. duodenale* is more geographically restricted. There is no known animal reservoir for *N. americanus* or *A. duodenale*. In pregnant women, anaemia caused by hookworm disease results in several adverse outcomes for both the mother and her infant, including low birth weight, impaired milk production, and increased risk of death for both the mother and the child. In children, chronic hookworm infection has been shown to impair physical and intellectual development, reduce school performance and attendance, and adversely affect future productivity and wage-earning potential. This study was aimed at ascertaining the impact of malaria and hookworm co-infection and its relationship with anaemia among pregnant women attending Antenatal Clinic at University of Calabar Teaching Hospital (UCTH), Calabar. 

**MATERIALS AND METHODS**

**Study area**
The study was carried out at University of Calabar Teaching Hospital (UCTH), Calabar, Cross River State, Nigeria. The University of Calabar Teaching Hospital is located on the latitude and longitude of 4°30’ and 4°40’N and 8°15’ and 8°15’E respectively. Calabar Municipality and Calabar-South Local Government Areas population density is estimated at 470, 950.

**Study design**
This was a cross sectional study of 300 pregnant women aged 12 years and above attending Antenatal Clinic in University of Calabar Teaching Hospital (UCTH), Calabar, Cross River State, Nigeria.

**Inclusion criteria**
Any pregnant woman who was aged 12 years and above at the time of study.

Any pregnant women who gave either written informed consent.

**Exclusion criteria**
Women aged 12 years and above who were not pregnant.

Any pregnant woman who had taken anti-malaria drug within two weeks prior to the study.

Any pregnant woman who had taken anthelmintics drug within two weeks prior to the study.

Any pregnant woman who was known HbSS-pregnant women.

Any pregnant woman known to have had chronic cardiac/kidney problems.

**Questionnaire administration**
Questionnaire was administered to the subjects.

**Ethical clearance and informed consent**
Ethical clearance was sought and obtained from University of Calabar Teaching Hospital health research and ethical committee. Informed or written consent was also obtained from the subjects prior to sample collection.

**Control subjects**
The pregnant women without both infections aged 12 years and above were used as control.

**Samples collection**
Five millilitre of blood sample was collected from each of the subjects by standard venipuncture method into EDTA container and mixed. That was used for the estimation of haemoglobin. One millilitre of blood from syringe non-EDTA, collected was used for *Plasmodium* detection. An aliquot of freshly passed stool sample was collected from each of the subjects into clean universal container. Both samples of blood and stool were also collected from the control subjects.

**Processing of samples**

**Estimation of haemoglobin**
Twenty microlitre of blood was collected from EDTA blood sample of each of the subjects and processed by cyanmethaemoglobin method for estimation of haemoglobin concentration.

**Detection of malaria parasites microscopically**
Detection and identification of malaria parasite from peripheral blood smear was done by Giemsa staining technique by World Health Organization (WHO) criteria. Calculation of plasmodium parasitaemia density: number of parasites/WBC counted X 8000WBC/ul. Also degree of anaemia was categorized using WHO standard; mild anaemia Hb 10-11.9g/dl; moderate anaemia Hb 7-9.9g/dl; severe anaemia Hb 6.0-6.9g/dl.

**Processing of stool sample**
Diagnosis for intestinal parasites was done using direct wet mount microscopic examinations and formol ether concentration technique as described by Cheesbrough. Stoll’s technique was used in counting ova of hookworm as described by Stoll.

**Statistical analysis**
Data were analysed using SPSS version 20 statistical package (SPSS, Inc. Chicago, IL USA). A Chi-squared test was used...
to examine the association between variables. The density of infections was determined by the use of the mean and standard deviation. P-value at 5% confidence interval of 95% was used to calculate the level of significance.

**RESULTS**

Of the 300 subjects examined, 19 (6.3%) were infected with hookworm, 45 (15.0%) had malaria parasitaemia, 9 (3.0%) were infected with both hookworm and malaria parasites. Table 1 shows the prevalence of malaria and hookworm co-infections, haemoglobin levels and degree of anaemia by age. The highest level of co-infection 4 (28.6%) occurred among the age of 26-30 years while age group 31-35 years, 36-40 years and 41-45 years had the lowest prevalence of 0.0%. The difference was not statistically significant. (X² = 5.383, (df)=2, p=0.371). Subjects in the age group 16-20 years had the highest mean malaria parasite count of 12266.0±0.0/µl of blood while age group 26-30 years had lowest mean parasite density of 2149.7±2813.3/µl of blood. The difference in distribution of mean parasite density was not statistically significant (X²= 0.838, (df)=2, p=0.477). Subjects in the age group 16-20 years had the highest hookworm ova density of 2500.0±0.0 e/g of stool while age group of 21-25 years had the lowest hookworm ova density of 975.0±531.5 e/g of stool. The difference in distribution of mean parasite density was not statistically significant (X²= 3.675, (df)=2, p=0.091). The highest mean Hb of 8.9±0.9g/dl was observed among the age group of 26-30 years while age group of 16-20 years had the lowest mean Hb of 6.0±0.0g/dl. The difference in mean Hb levels was statistically significant (X²=0.835, (df)=2, p=0.479). The highest prevalence of severe anaemia 1 (100.0%) occurred among the age group of 16-20 years while the lowest prevalence of severe anaemia 3 (75.0%) was observed among the age group of 21-25 years. The difference was statistically significant (X²= 7.687,(df)=1, p=0.002). Among the control subjects, the highest mean Hb levels of 11.0±1.9g/dl occurred among the age group of 41-45 while the lowest mean Hb of 9.3±2.2g/dl occurred among the age of 16-20 years. The difference in mean Hb was statistically significant (X²= 3.306, (df)=5, p=0.007). Those with age group of 16-20 years had the highest prevalence of severe anaemia 1 (4.8%) while age group of 21-25 years had lowest prevalence of severe anaemia 1 (1.7%). The difference was not statistically significant (X² = 7.425,(df)=2, p=0.191). Table 2 shows the prevalence of malaria and hookworm co-infections, haemoglobin levels and degree of anaemia by trimesters. Of 300 subjects, both infections of 4 (4.4%) occurred among the pregnant women in their 3rd trimester while those in their 1st trimester recorded 0 (0.0%). The difference in prevalence of co-infection according to trimesters was not statistically
Table 2: The prevalence of malaria and hookworm co-infection, haemoglobin (Hb) levels and degree of anaemia by trimesters

<table>
<thead>
<tr>
<th>Age group</th>
<th>Test (infected subjects)</th>
<th>Control (uninfected subjects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Mean malaria count + SD/µl of blood</td>
<td>Mean malaria count + SD/µl of blood</td>
</tr>
<tr>
<td></td>
<td>No (% with malaria infection)</td>
<td>No (% without malaria infection)</td>
</tr>
<tr>
<td></td>
<td>No (% with both infections)</td>
<td>No (% with neither infection)</td>
</tr>
<tr>
<td>2nd</td>
<td>Mean hookworm ova count + SD e/g of stool</td>
<td>Mean hookworm ova count + SD e/g of stool</td>
</tr>
<tr>
<td>3rd</td>
<td>Mean Hb + SD g/dl</td>
<td>Mean Hb + SD g/dl</td>
</tr>
<tr>
<td>Total</td>
<td>Mean degree of anaemia</td>
<td>Mean degree of anaemia</td>
</tr>
</tbody>
</table>

Table 3 show the prevalence of malaria parasite and hookworm infections, haemoglobin levels and degree of anaemia by age. The aged group of 16-20 years recorded the highest prevalence rate of 6(27.2%), while age group of 41-45 years recorded the lowest prevalence of 0(0.0%). The difference in prevalence of malaria parasite was not statistically significant (X² = 3.069, df= 4 and p = 0.689). The highest mean parasite densities of the subjects was recorded amongst the age group of 31-35 years with the highest parasites mean density of 5025±3252.6/µl of blood while the lowest mean parasite density of 674.9±910.3/µl of blood was observed amongst the age group of 26-30 years. The difference in distribution of mean parasite density according to age was not statistically significant (X² = 3.069, df= 4 and p = 0.689). The highest mean Hb levels of 9.9±1.6 g/dl occurred among the pregnant women in their 3rd trimester while the lowest mean Hb levels of 6.6±0.9 g/dl was observed among the subjects in their 2nd trimester. The difference in the mean Hb was statistically significant (X² = 16.727, df=0, p = 0.005). Severe anaemia was only observed in 2nd trimester prevalence of 4(80.0%). Amongst control subjects, the highest mean Hb level of 11.0±1.5 g/dl was observed among the subjects in their 1st trimester while the lowest mean Hb of 10.6±1.3 g/dl was observed among subjects in their 3rd trimesters. The difference was not statistically significant (X² = 1.461, df=2, p = 0.234).

Table 3: The prevalence of malaria and hookworm co-infection, haemoglobin (Hb) levels and degree of anaemia by trimesters

<table>
<thead>
<tr>
<th>Test (infected subjects)</th>
<th>Control (uninfected subjects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No (%)</td>
<td>No (% with both infections)</td>
</tr>
<tr>
<td>Mean malaria count + SD/µl of blood</td>
<td>Mean malaria count + SD/µl of blood</td>
</tr>
<tr>
<td>Mean hookworm ova count + SD e/g of stool</td>
<td>Mean hookworm ova count + SD e/g of stool</td>
</tr>
<tr>
<td>Mean Hb + SD g/dl</td>
<td>Mean Hb + SD g/dl</td>
</tr>
<tr>
<td>Mean degree of anaemia</td>
<td>Mean degree of anaemia</td>
</tr>
</tbody>
</table>

Table 4 shows the prevalence of malaria parasite and hookworm infections, haemoglobin levels and degree of anaemia by trimesters. Of 300 subjects, 45(15.0%) had malaria parasitaemia. The highest prevalence of malaria parasite infection of 20(22.2%) was observed among the pregnant women in their 3rd trimester while the lowest prevalence of 3(7.7%) was observed among the subjects in their 1st trimester. The difference in prevalence of malaria infection according to trimester was not statistically significant (X² = 4.310, df=2 and p = 0.116). The highest mean parasite density of 2592.1±8903.0/µl of blood was observed within the pregnant women in their 3rd trimester.
Table 3: The prevalence of malaria parasites infection, haemoglobin (Hb) levels and degree of anaemia by age Test (Infected subjects)

<table>
<thead>
<tr>
<th>Age group (yrs)</th>
<th>No examined</th>
<th>No (%) with malaria parasite infections</th>
<th>No (%) with hookworm infection</th>
<th>Mean hookworm ova count+SD e/g</th>
<th>Mean parasite count+SD/µl of blood</th>
<th>Mean Hb+SD g/dl</th>
<th>No (%) with mild anaemia</th>
<th>Degree of anaemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 – 20</td>
<td>22</td>
<td>6 (27.2)</td>
<td>1 (4.5)</td>
<td>2220.0+0.0</td>
<td>3823.7+7474.8</td>
<td>7.8+1.2</td>
<td>5 (83.3)</td>
<td></td>
</tr>
<tr>
<td>21 – 25</td>
<td>64</td>
<td>7 (10.9)</td>
<td>2 (3.1)</td>
<td>1500.0+111.4</td>
<td>816.2+751.6</td>
<td>9.6+2.6</td>
<td>1 (14.3)</td>
<td></td>
</tr>
<tr>
<td>26 – 30</td>
<td>114</td>
<td>18 (15.8)</td>
<td>9 (7.9)</td>
<td>1533.3+886.0</td>
<td>674.9+910.3</td>
<td>10.6+1.4</td>
<td>10 (55.6)</td>
<td></td>
</tr>
<tr>
<td>31 – 35</td>
<td>68</td>
<td>9 (13.2)</td>
<td>5 (7.4)</td>
<td>1140.0+559.5</td>
<td>5025+3252.6</td>
<td>10.7+0.9</td>
<td>7 (77.8)</td>
<td></td>
</tr>
<tr>
<td>36 – 40</td>
<td>29</td>
<td>5 (17.2)</td>
<td>2 (6.9)</td>
<td>115.0+70.7</td>
<td>879.8+1242.1</td>
<td>11.7+0.9</td>
<td>3 (60.0)</td>
<td></td>
</tr>
<tr>
<td>41 – 45</td>
<td>3</td>
<td>0 (0.0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>45 (15.0)</td>
<td>19 (6.3)</td>
<td>1421.1+748.8</td>
<td>2010+6534.7</td>
<td>10.2+1.8</td>
<td>21 (46.7)</td>
<td></td>
</tr>
</tbody>
</table>

Grading of Anaemia by WHO (2008): Mild anaemia PCV 30‑36%/Hb 10‑11.9 g/dl; Moderate anaemia PCV 21‑30%/Hb 7‑9.9 g/dl; Severe anaemia PCV 18‑21%/Hb 6.0‑6.9 g/dl

Table 4: The prevalence of malaria parasites infection, haemoglobin (Hb) levels and degree of anaemia by trimesters

<table>
<thead>
<tr>
<th>Age group (yrs)</th>
<th>No examined</th>
<th>No (%) with malaria parasite infections</th>
<th>No (%) with hookworm infection</th>
<th>Mean hookworm ova count+SD e/g</th>
<th>Mean parasite count+SD/µl of blood</th>
<th>Mean Hb+SD g/dl</th>
<th>No (%) with mild anaemia</th>
<th>Degree of anaemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>39</td>
<td>3 (7.7)</td>
<td>2 (5.1)</td>
<td>2000.0+4243.0</td>
<td>694.5+970.3</td>
<td>9.2+1.1</td>
<td>1 (33.3)</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>171</td>
<td>22 (12.9)</td>
<td>10 (5.8)</td>
<td>1469+6811.6</td>
<td>1600.8+419.4</td>
<td>10.1+1.9</td>
<td>12 (54.5)</td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>90</td>
<td>20 (22.2)</td>
<td>7 (7.8)</td>
<td>1200.0+8813.9</td>
<td>2592.1+8903.0</td>
<td>10.6+1.7</td>
<td>20 (22.2)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>45 (15.0)</td>
<td>19 (6.3)</td>
<td>1421.1+728.8</td>
<td>2010.3+6534.7</td>
<td>10.2+1.8</td>
<td>21 (46.7)</td>
<td></td>
</tr>
</tbody>
</table>

Grading of Anaemia by WHO (2008): Mild anaemia PCV 30‑36%/Hb 10‑11.9 g/dl; Moderate anaemia PCV 21‑30%/Hb 7‑9.9 g/dl; Severe anaemia PCV 18‑21%/Hb 6.0‑6.9 g/dl

P-value

Grading of Anaemia by WHO (2008): Mild anaemia PCV 30‑36%/Hb 10‑11.9 g/dl; Moderate anaemia PCV 21‑30%/Hb 7‑9.9 g/dl; Severe anaemia PCV 18‑21%/Hb 6.0‑6.9 g/dl
while the lowest prevalence of $694.5 \pm 970.3 / \mu l$ of blood was observed amongst the subjects in their 1st trimester. The difference in distribution of mean parasite density was not statistically significant ($X^2 = 0.165$, (df)=$2$, $p=0.848$). Pregnant women in their 3rd trimester had highest prevalence of 7(7.8%) while the subjects in their 1st trimester had the lowest prevalence of 2(5.1%). The difference in prevalence of hookworm infection was not statistically significant ($X^2 = 1.772$, df=5, $p=0.617$). Subjects in their 1st trimester had the highest hookworm ova density of $2000.0 \pm 4243.0$ e/g of stool while subjects in their 3rd trimester had the lowest worm burden of $1200.0 \pm 8813.9$ e/g of stool. The difference in distribution of mean parasite density was not statistically significant ($X^2 = 0.907$, (df)=$2$, $p=0.424$). Pregnant women in their 3rd trimester had highest prevalence of 7(7.8%) while the subjects in their 1st trimester had the lowest prevalence of 2(5.1%). The difference in prevalence of hookworm infection was not statistically significant ($X^2 = 1.772$, df=5, $p=0.617$). Subjects in their 1st trimester had the highest hookworm ova density of $2000.0 \pm 4243.0$ e/g of stool while subjects in their 3rd trimester had the lowest worm burden of $1200.0 \pm 8813.9$ e/g of stool. The difference in distribution of mean parasite density was not statistically significant ($X^2 = 0.907$, (df)=$2$, $p=0.424$). The highest mean Hb of $10.6 \pm 1.7$g/dl occurred among the subjects in their 3rd trimester while the lowest mean Hb $9.2 \pm 1.1$g/dl occurred among the subjects in their 1st trimester The difference in mean Hb levels was not statistically significant ($X^2 = 0.903$, (df)=$2$, $p=0.413$). Severe anaemia had the highest prevalence of 2(9.1%) among the subjects in their 2nd trimester and the lowest prevalence of 0(0.0) among the subjects in their 1st and 3rd trimesters. The difference was not statistically significant ($X^2 = 2.188$, (df)=$0$, $p=0.335$). Table 5 shows the distribution of haemoglobin levels of study subjects with independent Plasmodium parasitaemia, hookworm infection and co-infection. The highest prevalence of infection $45(15.0\%)$ was among the malaria alone and the lowest prevalence of $9(3.0\%)$ was among the both infections. The highest of mean Hb $10.5 \pm 1.4$g/dl was among hookworm alone while the lowest mean Hb of $8.1 \pm 2.1$g/dl among those with co-infections. The difference in mean Hb level of co-infected was statistically significant ($F_{3,20} = 0.0413$, $p=0.003$).

DISCUSSION

The result of this research work has revealed that 3.0% of the test subjects were co-infected with Plasmodium and hookworm. The prevalence observed in this study is lower than 13.0% observed by Ekejindu et al. in a semi-urban area of Anambra State, Nigeria. This lower prevalence of malaria and hookworm co-infection may be due to differences in the socio-economic status and hygienic levels of the study subjects. The conduct of the study in dissimilar areas of urban and sub-urban settlements could enhance the inconsistency of the findings. There was a higher prevalence of independent malaria infection (15.0%) than hookworm (6.3%). Women living in malaria endemic areas have an increased risk of malaria parasitemia during pregnancy. Also there is a hypothesis that multicellular organism like hookworm causes polarization of host immune Response it infection without causing same to unicellular organism like Plasmodium, a protozoan. This variation in stimulation of host immune response may be accountable for more increased prevalence of malaria than a hookworm.

Pregnant women in their second trimester of pregnancy had the highest prevalence of malaria and hookworm co-infection and the highest prevalence of severe anaemia 80.0%. From the results of this study, The prevalence of co-infection of malaria and hookworm is proportionate to the degree of anaemia in the study subjects. The analysis between malaria and hookworm positive (test) subjects and malaria and hookworm negative (control) subjects with the mean Hb shows that there was a significant difference statistically between the mean Hb among the malaria infected women and the control subjects, but there is no significant difference in mean Hb levels among hookworm positive and control subjects.

Table 5: Distribution of Haemoglobin (Hb) levels of pregnant women with plasmodium Parasitaemia and hookworm infection (n = 300)

<table>
<thead>
<tr>
<th>Pregnant subjects</th>
<th>No. (%) infected</th>
<th>Mean parasite count±SD/µl</th>
<th>Mean Hb±SD g/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>45 (15.0)</td>
<td>2010.3±6534.7</td>
<td>10.2±1.8</td>
</tr>
<tr>
<td>Hookworm</td>
<td>19 (6.3)</td>
<td>1421.1±748.8</td>
<td>10.5±1.4</td>
</tr>
<tr>
<td>Both infections</td>
<td>9 (3.0)</td>
<td>a. 725.9±10402.3</td>
<td>8.1±2.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. 1188.9±666.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>73 (2.4)</td>
<td></td>
<td>10.9±6.6</td>
</tr>
</tbody>
</table>

Key: a) Mean malaria parasite count for both infections. b) Mean hookworm ova count for both infections.
What has remained unclear is the extent to which hookworm and malaria is associated with anaemia during pregnancy. The result of this study shows that intensity of infection with hookworm and Malaria parasites is proportionate to the Hb levels. Layrisse and Roche16 had similar findings in a study among school-aged children. Anaemia in developing countries like Nigeria has multiple causes, including micronutrient deficiencies, infectious diseases and inherited disorder.17 Other factors that can also cause anaemia include, parity owing to repeated drain in iron stores, fetal demand and underlying maternal diseases, untreated malaria in early pregnancy18,19 as such the observed relationship between haemoglobin and hookworm- malaria co-infection may be confounded by other causes of anaemia. In this study, anaemia was most prevalent in the third trimester of pregnancy than the second and third trimesters. The first trimester had the lowest prevalence. These results contradict the WHO20 report that anaemia was more prevalence in the first trimester than in the second and third trimesters in Sub-Saharan African.

The definition of what constitutes anaemia in pregnancy has been the subject of lively debate for several years. According to WHO,20 the normal haematocrit values and haemoglobin levels for classifying anaemia in pregnancy lies between 33% and 36% and 11g/dl and 12g/dl respectively. Also WHO11 categorized the degree of anaemia using the PCV/Hb values of mild anaemia 30%-36%/10-11.9g/dl; moderate anaemia 21%-30%/7-9.9g/dl; severe anaemia 18-21%/6.0-6.9g/dl.

Malaria and anaemia differed between age group in this study. This might be due to host or environmental factors; it might also be attributed to age related immunity as a result of previous exposure to malaria in child-bearing ages.14 The higher anaemia prevalence observed among the subjects in this study contradicts a finding in Ghana which indicated a lower prevalence of anaemia.21 Pregnant women with successive births are believed to have had exposure to a variety of strains of malaria parasites and hookworm ova thereby developing somehow efficient immunity against most strains of the parasites.22,23 A study in Iran found similar results.24 However, Glover-Amengor and his colleagues in their study reported lower prevalence of anaemia which was strongly associated with increasing parity.21

Many of the respondents in this study registered for antenatal care in their second and third trimester. This seems to be a common practice in Africa.25 In a study conducted in Zaire, most of the pregnant women attended antenatal clinic (ANC) for the first time in their sixth or seventh month of gestation and made three to four visits before delivery.25 Also in Nigeria Mockenhaupt et al26 Had a similar observation. This practice is detrimental as it does not allow for early detection and correction of pregnancy associated complications such as anaemia. It is therefore very important to educate women on the need to register early for antenatal care.

The current findings revealed lower prevalence of intestinal nematodes, especially hookworm among pregnant women. An earlier study by Shulman et al,27 reported an overall prevalence of 25.7% hookworm in pregnant women which is higher compared To that obtained in this study (9.3%). Even though it is clear that there is significant association between anaemia and hookworm infection, the outcome of this study however indicated otherwise.

The only Plasmodium species detected among the pregnant women in this research was P. falciparum, the species predominantly found in the tropical and subtropical regions of Africa.3 Plasmodium falciparum is also the most widespread species, accounting for up to 80.0% of malaria cases worldwide.3

In the present study, 15.0% prevalence of malaria parasitaemia in pregnant women was lower compared with 23.0% reported in Mozambique28 and 26.8% reported in Malawi.29 The prevalence of malaria in the present study among pregnant women was much lower than 47.5% reported in Onitsha, Nigeria, 42.0% reported in Ghana,30 57.5% reported in Gabon,31 and 41.0% observed in Uyo, Nigeria.32 The low rate of malaria prevalence observed in the present study could be due to better awareness and improved preventive measures.

It has been recognized that a temperature range of 20°C - 30°C and relative humidity of 60.0% and above were suitable for malaria parasite transmission.32 Delay in starting pre-natal care during pregnancy may also have contributed to this prevalence. In addition, the transient depression of cell-mediated immunity in pregnancy that allows foetal allograft retention but also interferes with resistance to various infectious diseases such as malaria could be a contributing factor. The prevalence of degree of anaemia observed in this study (42.6%) was lower than the mean percentage for Africa which is 61.0%,34,35 Any strategy aimed at combating this important public health challenge should aim at addressing all the potential causal factors after their elucidation.

The relatively low prevalence rate of hookworm infections in this studied population could also be indicative of good sanitation and proper sewage disposal, as shown by the fact that the participants may had good toilet facilities in their respective homes. Findings from a city of Thailand...
study disclosed an increase in the prevalence of clinical malaria in individuals with helminthes like hookworm infections. Awareness of the importance of co-infections is increasing, and suggestions have been made that helminth infection may influence susceptibility to other infections, including malaria. Several hypotheses have been put forth to explain this observation. It has been suggested that helminthes infection creates a cytokine milieu favorable to the production of non-cytophilic antibodies, thus making individuals more susceptible to clinical malaria. It is also thought that the presence of T-regulatory cells is amplified during helminthes infection, and if present in sufficient numbers, could induce a non-specific suppression, making individuals susceptible to infections such as malaria.

Hookworms shed eggs intermittently according studies; therefore, the prevalence of this infection is likely to be underestimated in this study. This study shows relatively low prevalence rates of malaria and hookworm co-infection in pregnant women in University of Calabar Teaching Hospital. Other intestinal parasites observed and recorded in this study alongside with hookworm include Ascaris lumbricoides, Entamoeba histolytica, and Taenia species. But they played no impact in this study because they were not the objective of this research.

CONCLUSION

The work has shown a low prevalence of malaria and hookworm co-infection among pregnant women in Calabar. The degree of anaemia among pregnant women who had malaria and hookworm co-infection was more severe than those that had independent malaria infection and independent hookworm infection and subjects without any of the infection. Also the prevalence of malaria infection/density and hookworm infection increases from first trimester to the third trimester. It is therefore recommended that there is the need to put in place necessary strategies to control these infections amongst this category of subjects.

ACKNOWLEDGEMENT

Management and staff of Microbiology Laboratory Department, UCTH, Calabar.

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