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Original Research Article

Malaria and anaemia in pregnant and non-pregnant women of child-bearing age: a cross-sectional study

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ABSTRACT

Background: Malaria infection during pregnancy is a major public health problem globally. Anaemia is often an adverse outcome of severe parasitic infections during pregnancy in developing countries. Pregnant are more susceptible to *Plasmodium falciparum* infections than non-pregnant women of child-bearing age. The objective of this study was to comparatively investigate malaria and anaemia in pregnant and non- pregnant women of child-bearing age.
Methods: A cross-sectional comparative study, in which 380 pregnant women and 380 non-pregnant women were screened for the study. The study was conducted at the Index Medical College Hospital and Research Centre, Indore, Madhya Pradesh, India. Participants' demographic data were collected via the administration of questionnaires. In addition, their blood samples were analysed for haemoglobin level and *Malaria parasites*, while stool samples from the pregnant women were examined for intestinal parasites.
Results: The study revealed that pregnant women have higher malaria parasitaemia (12.6%) and anaemia (62.6%). The species *of Plasmodium* isolated from the pregnant women were *P. falciparum* (85.4%), *P. malariae* (4.2%) and *P. ovale* (10.4%). Malaria parasitaemia was higher in the primigravidae (14%). However multi-gravidae recorded the highest anaemia prevalence (67.1%). Age of pregnant women was a factor affecting malaria parasitaemia with a significant P-value and (P value = 0.0041).
Conclusions: Pregnant women were more susceptible to malaria and anaemia than non-pregnant women of child-bearing age. Most of the pregnant women reported at antenatal clinic during the second trimester. Primigravidae however recorded the highest malaria parasitaemia. The main species of *Plasmodium* observed in the blood samples was *falciparum*.

Keywords: Anaemia, Child bearing age, Malaria, Non-pregnant women, Pregnant women

INTRODUCTION

Malaria is a serious public health problem particularly in pregnant women.[1] *Plasmodium falciparum* is responsible for the majority of malaria infections that occur in pregnancy.[2] Its rate of infection in pregnancy is twice that in non-pregnant women due to physiological changes and suppressed immunity during pregnancy.[3] Without appropriate intervention, *P. falciparum* infection in pregnancy could have significant adverse consequences for both mother and foetus.[4] Anemia is a condition characterized by a decrease in the number of red blood cells (RBCs) and/or hemoglobin (Hb) concentration, resulting in a lower ability of blood to carry oxygen for physiologic needs.[5] Anemia in nonpregnant women (NPW) is considered severe when Hb concentration is <8 g/dL, moderate when it falls between 8 and 10.9 g/dL and mild when it falls between 11 and 11.9 g/dL.[5,6] Anemia is a global health problem; when anemia prevalence is ≥40%, 20-39%, and 5-19%, it is considered as severe, moderate, and mild public health problem, respectively.[6]

Severe anaemia predominates as the main feature of severe malaria in areas with high levels of transmission, while hypoglycemia, respiratory failure, and cerebral malaria may predominate in areas with low levels of malaria transmission.[7,8] Anaemia is more frequent in pregnant women, and more pronounced in primigravidae than in multigravidae.[9] In addition, more than half of pregnant women in the world have haemoglobin level indicative of anaemia (<11.0 gldl). The prevalence may however be as high as 56% or 61% in developing countries.[10] Anemia is usually multi-factorial in origin and although malaria is an important contributor, nutritional deficiencies (iron and folate), other infectious diseases (hookworm, schistosomiasis and HIV) and genetic red blood cell disorders (such as sickle cell and thalassemia) are also important contributing factors.[11]

Little information is currently available on the epidemiology and impact of malaria during pregnancy and in non-pregnant women of child-bearing age. This study focused on investigating comparatively malaria and anaemia, and the associated risk factors, among pregnant women and non-pregnant women of child-bearing age.

METHODS

The cross-sectional study was conducted at the Index Medical College Hospital and Research Centre, Indore. A total of 760 subjects comprising 380 pregnant women and 380 non-pregnant women of child-bearing age at-tending antenatal care at the hospital were enrolled. Blood samples were collected by venipuncture. The blood samples were analyzed for haemoglobin levels, using hematology analyzer. Thick and thin films of the blood samples were giemsa stained and examined for malaria parasites using standard procedures. Stool samples were collected from pregnant women to determine the presence of intestinal parasites. The specimens were examined microscopically using the Direct Wet Mount Technique to detect parasite ova and larvae. The results were presented as simple frequencies and percentages. Odds ratios were calculated with 95% confidence interval (CI) to measure the strengths of associations between variables. P-values provide a sense of the strength of the evidence against null hypothesis.

RESULTS

Pregnant women had 12.6% malaria prevalence while non-pregnant women of child-bearing age had 6.6%. Anaemia prevalence rates in pregnant and non-pregnant women were 62.6% and 53.2% respectively (Figure 1). The species of *Plasmodium* found in the pregnant women were *P. falciparum* (85.4%), *P. ovale* (10.4%) and *P. malariae* (4.2%). Among the non-pregnant women of child-bearing age, 76% *P. falciparum*, 16% *P. ovale*, and 8% *P. malariae* were found. There was no mixed infection and no *P. vivax* identified in the study (Table 1).

Intestinal nematodes found in the stool specimens analyzed included; *Ascaris lumbricoides* (2), *Trichuris trichiura* (1), and *Strongyloides stercoralis* (2). Out of the 380 pregnant women, 5 (1.3%) were infected with intestinal nematodes. Two (40%) pregnant women infected with intestinal nematodes had anaemia. However, this was not significantly associated with intestinal nematodes (Table 2). Co-infection of malaria with intestinal nematodes was not recorded in the pregnant women.

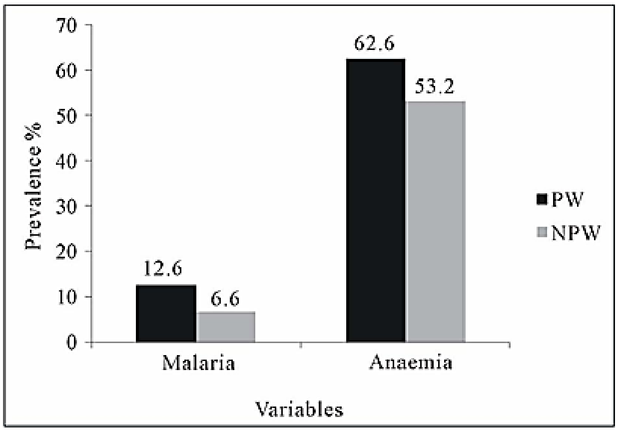


Figure 1. Comparison of prevalence of malaria and anaemia in pregnant and non-pregnant women of child-bearing age. PW = pregnant women, NPW = non-pregnant women.

The age of pregnant and non-pregnant women of child-bearing age ranged from 16 to 45 years. Young pregnant (<20 years) and young non-pregnant women (<20 years) had 5 (50%) and 3 (10.3%) malaria prevalence respectively. This gave an odds ratio (OR) of 7.61 at 95% CI (2.1 - 27.4) in the pregnant women and an OR of 1.73 at 95% CI (0.5 - 6.2) in the non-pregnant women of child-bearing age. Among the old women (≥20 years), 43 (11.6%) of the pregnant women and 22 (6.3%) of the non-pregnant women of child-bearing age had malaria parasites. The prevalence of anaemia at old age was higher than young pregnant women. Among women aged <20 years, 6 (60.0%) pregnant women and 17 (58.6%) non-pregnant women of child-bearing age had anaemia. At age < 20 years, there was a higher risk of anaemia (OR = 1.27, 95% CI = 0.6 - 2.7) among the non-pregnant women of child-bearing age than pregnant women (OR = 0.90, 95% CI = 0.2 - 3.2). The prevalence of anaemia in pregnant women was higher than in non-pregnant women of child-bearing age at age ≥ 20 years. At age ≥ 20 years, 232 (62.7%) pregnant women and 185 (52.7%) non-pregnant women were anaemic (Figure 2). *Malaria parasitaemia* was found in 22 (19.5%) nulliparous women and 26 (9.7%) women who had one or more pregnancies with successful delivery. Multiparous women, there was a significantly higher risk of malaria parasitaemia in the nulliparous women (OR = 2.24) (Figure 3). Sixty-eight (60.2%) of the nulliparous women and 170 (63.7%) multiparous women were anaemic. There was lower risk of anaemia in the nulliparous women (OR = 0.86) using multiparity as reference category (Figure 2).

Table 1: Prevalence of *Plasmodium* species in pregnant and non-pregnant women of child- bearing age.

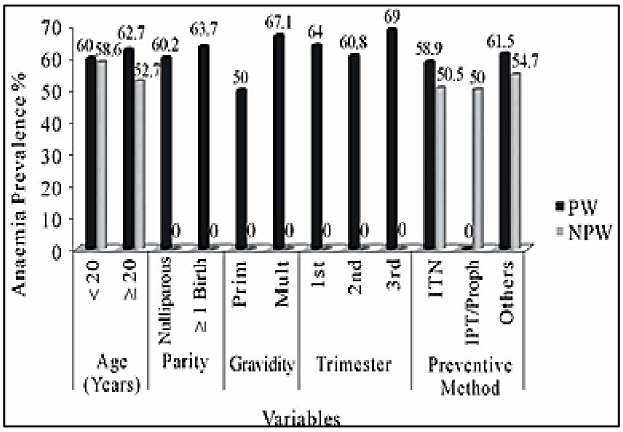
Plasmodium species	Pregnant women, n (%)	Non-pregnant women, n (%)
Plasmodium falciparum	41 (85.4%)	19 (76%)
Plasmodium ovale	5 (10.4%)	4 (16%)
Plasmodium malariae	2 (4.2%)	2 (8%)

Table 2: Prevalence of intestinal nematodes among the pregnant women.

	Hb <11 g/dl	Anaemia prevalence n (%)	Odds ratio (95% CI)	P-value
380 (100)		**Participants** 238 (62.6)		
		Stool examination		
Nematodes No	5 (1.3)	2 (40.0)	0.39 (0.06365 - 2.380)	0.3458
Nematode*	375 (97.6)	236 (62.9)		

*= Reference category; CI = Confidence interval; n = Number of subjects; Hb = Haemoglobin level.

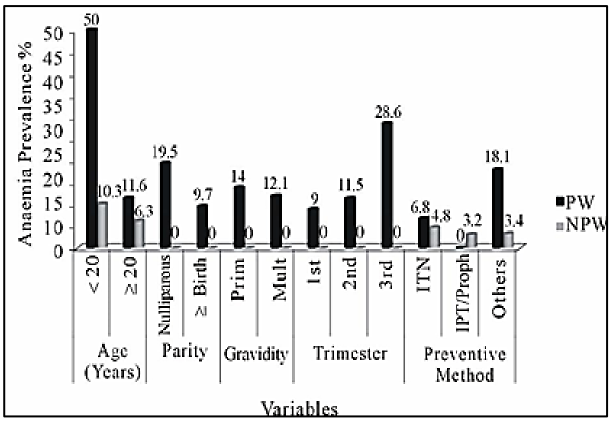
The pregnant women studied were divided into two gravidae; primigravidae and multigravidae. One hundred (26.3%) were primigravidae while 280 (73.7%) were multigravidae. The prevalence of malaria parasitaemia in multigravidae (12.1%) was lower than in primigravidae (14.0%), showing high risk (OR = 1.18, 95% CI = 0.6 - 2.3) (Figure 3). The prevalence of anaemia was higher in the multigravidae than in the primigravidae. Fifty (50.0%) primigravidae and 188 (67.1%) multigravidae were anae-mic with lower risk in the primigravidae (OR = 0.86, 95% CI = 0.5 - 1.4) (Figure 2).



PW = Pregnant women; NPW = Non-pregnant women; Proph = Prophylaxis; 1st = First trimester; 2nd = Second trimester; 3rd = Third trimester; Prim = Primigravidae; Multi = Multigravidae; Pos = Positive; Neg = Negative.

Figure 2: Comparison of anaemia in pregnant and non-pregnant women of child-bearing age.

The gestational period was divided into three stages; first trimester (0 - 12 weeks), second trimester (13 - 24 weeks) and third trimester (25 - 40 weeks). Among the pregnant women, 111 (29.2%), 227 (59.7%), and 42 (11.1%) were in the first trimester, second trimester and third trimester respectively. The prevalence of malaria was 10 (9.0%) in the first trimester, 26 (11.5%) in the second trimester, and 12 (28.6%) in the third trimester. Odds ratios of 0.25 at 95% CI (0.10 - 0.63), and 0.32 at 95% CI (0.15 - 0.71) were recorded in the first and second trimesters respectively with significant P-values (P-value = 0.0039 for first trimester, P-value = 0.0068 for second trimester) (Figure 3).



PW = Pregnant women; NPW = Non-pregnant women; Proph = Prophylaxis; 1st = First trimester; 2nd = Second trimester; 3rd = Third trimester; Prim = Primigravidae; Multi = Multigravidae; Pos = Positive; Neg = Negative.

Figure 3: Comparison of malaria parasitaemia in pregnant and non-pregnant women of child-bearing age.

The prevalence of anemia was 71 (64.0%), 138 (60.8%), 29 (69.0%) in the first, second, and third trimesters respectively. Women in the third trimester had the highest anemia prevalence (69.0%) compared to 60.8% in the second trimester and 64.0% during the first trimester. The risk of anemia was higher in the first trimester as compared to those in second trimester (OR = 0.80 at 95% CI = 0.38 - 1.70 versus OR = 0.70 at 95% CI = 0.34 - 1.41 for first and second trimesters respectively) (Figure 2).

Preventive methods used by the pregnant women and non-pregnant women of child-bearing age included the use of Insecticide Treated Net (ITN), Prophylaxis and "others". The "others" comprised insecticide sprays, mosquito coils, mosquito repellents and creams. The prevalence of malaria in pregnant women showed that, 17 (6.8%) were ITN users, 0 (0.0%) were IPT users, and 40 (18.1%) used "Others". There was a high risk in the use of "Others" (OR = 4.17, 95% CI = 1.90 - 9.19, P-value = 0.0001) as a preventive measure but low risk was associated with the use of ITN (OR = 0.23, 95% CI = 0.12 - 0.43, P-value < 0.0001) (Figure 3). Among the non-pregnant women of child-bearing age, malaria parasitaemia was found in 13 (4.8%) ITN users, 3 (3.2%) prophylaxis and 8 (3.4%) "others" users. There was low risk of malaria parasitaemia in the non-pregnant women of child-bearing age in relation to preventive measures; (OR 0.40, 95% CI = 0.17 - 0.90 for ITN, OR = 0.39, 95% CI = 0.11 - 1.33 for prophylaxis, and OR = 0.28, 95% CI = 0.12 - 0.66 for "others") (Figure 2).

In the pregnant women, anemia was recorded in 148 (58.9%) ITN users, 0 (0.0%) IPT users, and 136 (61.5%) "others" users. Odds ratios of 0.62 at 95% CI (0.40 - 0.98) for ITN usage, and 0.89 at 95% CI (0.59 - 1.36) for "others" was deduced from the analysis. There was an indication of low risk of anemia associated with preventive methods (Odds ratios < 1). Comparing this with non-pregnant women of child-bearing age revealed that, 138 (50.5%) ITN users, and 127 (54.7%) who used other means of control were anemic. There was no significant association between anemia and the use of "others" (OR = 1.18, 95% CI = 0.78 - 1.78) whilst low risk was associated with the use of ITN (OR = 0.69, 95% CI = 0.44 - 1.08) in the non-pregnant women (Figure 2).

DISCUSSION

Malaria parasitaemia and anemia differed between age groups. Most of the respondents studied were old, suggesting low level of teenage pregnancy in the studied communities. This might be due to education and creating awareness concerning teenage pregnancy. In general, parasite density was higher in the young than the old women. This agreed with a study in Gabon with younger women more at risk.[12] This may be due to host or environmental factors.[12] It may also be attributed to age related immunity as a result of previous exposure to malaria in child-bearing years.[12] The high anaemia prevalence observed in pregnant women contradicts a study in Ghana which indicated that lower prevalence of anaemia was significantly associated with pregnant women.[13]

Malaria parasitaemia was higher in nulliparous women than multiparous women. Women with successive births are believed to have had exposure to a variety of strains of malaria parasites, therefore developing somehow efficient immunity against most strains of the parasites.[14,15] Peripheral and *Placental parasitaemia* have been reported to decrease with increasing parity among pregnant women.[16] The present study confirmed that, parity is a variable that affects *Malaria Parasitaemia* (P-value < 0.05). Multiparous women had higher prevalence (63.7%) of anaemia than the nulliparous (60.2%). A study in Iran found similar results.[17] However, Glover-Amengor and his colleagues in their study reported lower prevalence of anaemia which was strongly associated with increasing parity.[13] Anaemia in pregnancy could be attributable to several factors including decrease of iron from tissue, malnutrition and insufficient iron consumption.[17]

The higher prevalence observed in primigravidae is consistent with other reports.[12,18-20] Anti-adhesion antibodies against chondroitin sulphate A-binding parasites are associated with protection from maternal malaria, but these antibodies develop only over successive pregnancies, hence the susceptibility of primigravidae to malaria infection compared to multigravidae.[21] Some authors also believed that primigravid women have little or no immunity against the infecting strains of *Plasmodium* and hence suffer adverse complications.[22] The occurrence of relatively more anaemia in multigravidae than in primigravidae confirmed an earlier study con-ducted in India where anaemia was found less in primigravidae.[1] This may be due to repeated pregnancies at shorter intervals without allowing for replenishment of the iron stores.[1]

Insecticide treated nets reduce human-vector contact by physically excluding vector mosquitoes, killing them if they land on ITNs or repelling them, thereby driving them away. Distribution of ITNs through ANC can help, but this does not address the effects of malaria before the first ANC visit.[23] Generally, anaemia was found to be higher in pregnant women than in non-pregnant women of child-bearing age who used ITNs. This prevalence is low compared to a study where 72% pregnant ITN users were anaemic.[24] With a significant P-value, ITN usage is effective in controlling anaemia during pregnancy. This is supported by other studies where ITNs effectively reduce the prevalence of anaemia during pregnancy.[25,26] In order to reduce the burden of malaria in pregnancy, it may be essential to establish a system of supervised intermittent preventive treatment with a safe and effective anti-malarial so as to control or reduce *Malaria Parasitaemia* in pregnant women.[27]

The current findings revealed lower prevalence of intestinal nematodes among pregnant women. An earlier study reported an overall prevalence of 25.7% intestinal nematodes in pregnant women.[28] In addition, a study in Kenya contradicts the present study where 73% pregnant women had intestinal nematodes.[29] Even though it is clear that there is significant association between anaemia and intestinal nematodes, the outcome of the current study however indicated otherwise.[30]

The predominant species isolated in both pregnant and non-pregnant women of child-bearing age was P. falciparum. This is because, *P. falciparum* is the main species found in the tropical and subtropical regions of Africa.[18] *Plasmodium falciparum* is also the most widespread species, accounting for up to 80% of malaria cases worldwide.[18] The present study agreed with a study in Pakistan, indicating 76.75% *P. falciparum* infection during pregnancy. In India, 58% *P. falciparum* infection was recorded in the non-pregnant women of child bearing age.[31,32]

In summary, prevalence of malaria and anaemia were higher in pregnant women compared with their non-pregnant counterparts.

CONCLUSION

In the present study, malaria *parasitaemia* and anaemia were common medical conditions associated with pregnancy. Pregnant women were more susceptible to malaria and anaemia than non-pregnant women of child-bearing age. Malaria was not the only cause of anaemia and the main species of *Plasmodium* isolated in the blood samples was *Plasmodium falciparum.* Most of the pregnant women reported at ANC during the second trimester. The absence of IPT during the time of the study might have resulted in the relatively high prevalence of malaria in the pregnant women.

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Ethical approval: The study was approved by the institutional ethics committee

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