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Original Research Article

Correlation between hemoglobin levels of mothers and children aged less than two years attending the immunization clinics in Puducherry: a cross-sectional analytical study

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ABSTRACT

Background: Insufficient attention has been paid to the impact of maternal anemia on the hemoglobin status of children. This study aimed to estimate the correlation between the hemoglobin levels of mother's antenatal and their current hemoglobin levels with the hemoglobin levels of their children and to find the co-occurrence of anemia among the family members of the children.
Methods: A total of 200 children aged nine months to two years with their mothers were enrolled in the immunization clinics in a tertiary care hospital, and from health centres attached to it. For assessing the triple burden of anemia within the family members of the children, 50 mother-child-sibling triads were approached. The hemoglobin values of the mothers during their third trimester in the antenatal period was noted from the antenatal records.
Results: 62% of the children aged less than two years were anemic and the mean hemoglobin level of the children was 10.33±1.33 gm/dl. The correlation between hemoglobin levels of children and mothers during their antenatal period was 0.15 (p: 0.03, 95% CI: 0.007 to 0.279) and 0.10 (p: 0.15, 95% CI: -0.038 to 0.236) was the correlation between current hemoglobin levels of children and mothers. 7 (14%) mother-child-sibling triads had co-occurrence of anemia in the sub-sample of 50.
Conclusions: The multiple linear regression analysis confirmed that there is a weak correlation between the hemoglobin levels of mothers and children. We concluded that treating an anemic individual in a family can somehow prevent anemia in other family members.

Keywords: Anemia, Antenatal, Co-occurrence, Correlation, Immunization clinic, Under-five

INTRODUCTION

Anemia is a serious global public health problem that mainly affects young children and women. Anemia is most often caused by iron deficiency, the symptoms of iron deficiency anemia are most severe in infancy and early childhood, and they include poor cognitive and motor development in infants as well as diminished job capability in adults. According to a WHO report, 42% of children under the age of five, 40% of pregnant women, and 30% of women of reproductive age globally are affected by anemia.[1] There is no reduction in anemia even after the implementation of the Anemia Mukt Bharat program. NFHS-5 data shows that anemia has affected 67% of under-five children in India, followed by 57% among women of reproductive age.[2] Among the factors

that affect anemia in infancy, maternal anemia is considered to be one of the most important.[1] Blood loss during delivery time and menses for women might lead to iron deficiency anemia.[1]

As far as we are aware, there are no studies assessing the relationship between mothers and children's postnatal hemoglobin levels in terms of correlation in India. Studies that looked at the connection between infant anemia and maternal anemia have produced conflicting results.[3] While some studies found no correlation, others find evidence that, in comparison to children of mothers without anemia, children born to anemic mothers are more likely to experience anemia during the first year of life.[4] We are looking for an indirect way to prevent anemia in children by assessing the co-occurrence of anemia in their family members to address the problem. Also, if we could establish that hemoglobin levels of mothers and young children are correlated, we could prioritize those children for testing and closely ensure supplementation is received by them when they age greater than nine months, or it may focus more on treating anemia in women during the antenatal period.

Using a new perspective, this study investigated the simultaneous prevalence of anemia within a single household. As far as we know, this is the initial research that examines the co-occurrence of anemia among combinations of mothers, children, and siblings in India. So, the objective of the study was to estimate the correlation between mothers' hemoglobin levels during pregnancy and at present with the hemoglobin levels of their children and also to assess the co-occurrence of anemia among the children's family members.

METHODS

A cross-sectional analytical study design was used and this study was carried out in the rural, urban areas of Puducherry from March 2022 to March 2023. Puducherry is a town in the union territory that is bordered by the Indian state of Tamil Nadu to the southeast. Puducherry has 24 PHCs in rural areas and 15 PHCs in urban areas.[5] This study was organized in the immunization clinic of the department of pediatrics in a tertiary care hospital and the immunization clinics of urban and rural health centers attached to the tertiary care hospital. Pilot research was done to determine the sample size and to know the ease of data collection applying the study-specific questionnaire. Children aged nine months to two years attending the immunization clinics with their mothers were approached for data collection. Siblings aged ≤10 years of the children residing in the service areas of the tertiary care hospital in Puducherry were screened to find the co-occurrence of anemia within the family members. Children, mothers, and siblings without any known hemoglobinopathies were included.

Sample size

'Sample size calculators for designing clinical research' was used to calculate the sample size, assuming the expected correlation coefficient, r=0.5 from a reference study with 5% alpha error and 80% power.[6]

The standard normal deviate for $\alpha = Z_\alpha = 1.9600$

The standard normal deviate for $\beta = Z_\beta = 0.8416$

$C = 0.5 * \ln[(1+r)/(1-r)] = 0.5361$

Total sample size = $N = [(Z_\alpha+Z_\beta)/C]^2 + 3 = 30$

We recruited 30 children each from age group of 9-15 months and 16-24 months in respective immunization clinics.

So, 60 children each from immunization clinics in tertiary care hospital, rural and urban health centres attached to the hospital.

60×3=180.

With a non-response of 10%, the minimum required sample size was 200.

A sub-sample of 50 mother-child-sibling triads was approached in the service area of a tertiary care hospital to assess the co-occurrence of anemia within a family. Consecutive sampling was followed at the immunization clinics in the tertiary care hospital and in the primary health centers till the required number was reached.

Data collection was carried out from October 2022 to January 2023. After getting written consent from the participants, a close-ended questionnaire was used to collect the sociodemographic details, anthropometric details, dietary details, and other basic details from the parent/guardian of the participant. All eligible children, their mothers, and siblings were screened for anemia status by point-of-care testing using the HemoCue301 instrument. The latest maternal hemoglobin concentration of mothers during the last trimester of their recent pregnancy was obtained from their antenatal records. Health education was given to the mothers about the importance of iron-rich foods and prophylactic IFAS to prevent anemia and to improve the development of both mother and child. Anemia in children and during the antenatal period of mothers was defined as a hemoglobin level of less than 11 gm/dl and less than 12gm/dl in non-pregnant women.[7] Here, co-occurrence is defined as if anemia was present in both mother and child within the family or if anemia was present in any one of the siblings and the child within the family or if the child, mother, and sibling triad within a family is anemic.

Statistical analysis

Data was entered in Epicollect and analysis was done in IBM SPSS statistics version 23. Independent variables which are continuous such as the age of mother and child, birth weight, current weight and height of the child, and hemoglobin levels of mothers and children were described as mean (SD) or median (IQR) based on the normality of the data. Categorical variables such as gender of the child, place of residence, mother's education, mother's occupation, poverty level, current IFAS intake, exclusive breast-feeding status, deworming status, recent illness in a child, hemoglobin testing status in child, hemoglobin testing status after delivery were summarized as frequency and percentage (n, %).

The latest hemoglobin values of mothers during the third trimester and the current hemoglobin levels of children and mothers were compared using the Pearson/Spearman correlation test based on normality. The co-occurrence of anemia among the family members of the children was presented as a proportion and prevalence ratio with a 95% CI and p value.

RESULTS

200 mother-child dyads were recruited from the study setting with consecutive sampling and no one was excluded. The results showed that 30% of mother-child dyads participated from the immunization clinics in tertiary care hospitals and the urban and rural health centers attached to them. The majority of the study participants (60%) belong below the poverty line and most of the children aged nine months to two years were males (54%) and 66% of them were aged more than one year. The median (IQR) age of children was 15.7 months (10.5-18.4) and the minimum age was 9 months and the maximum age was 24 months. Approximately 23% of the children were low birth weight and more than 80% of them were exclusively breast-fed for 6 months. Nearly 18% of the children consumed other types of milk other than breast milk, for e.g.: cow milk, powder milk, etc. during the first six months and 98% of the mothers started complementary feeding for their children after 6 months. Out of the children aged more than one year (N=133), nearly 50% of them took the albendazole tablet six months preceding the data collection. Two weeks preceding the survey, 31% and 4% of the children suffered from an acute respiratory infection and diarrhoea respectively.

Table 1: Distribution of severity of anemia among children, their mothers and their siblings.

Categories	Total anemia, n (%)	Mild anemia n (%)	Moderate anemia n (%)	Severe anemia n (%)
Children[a]	124 (62)	60 (48.4)	60 (48.4)	4 (3.2)
Mothers[b]	90 (45)	48 (53.3)	41 (45.6)	1 (1.1)
Mothers' status during their antenatal period[a]	82 (41)	44 (53.6)	36 (44)	2 (2.4)
Siblings[c]	23 (46)	8 (34.8)	14 (60.9)	1 (4.3)

[a]Mild, moderate, severe anemia cut-off for children (6-59m) and pregnant women are 10-10.9, 7-9.9, <7mg/dl
[b]Mild, moderate, severe anemia cut-off for non-pregnant women is 11-11.9, 8-10.9, <8 mg/dl.
[c]N=50 and Mild, moderate, severe anemia cut-off for children 5-11 years is 11-11.4, 8-10.9, <8 mg/dl.

The mean (SD) weight of the children was 9 kg (1.4) and the median (IQR) height of the children was 72 cm (68-76) and 82% of them were having normal weight for their age. Only 25 children were ever tested for anemia and only 33% of them were taking the prophylactic IFAS in which 70% were regularly taking (twice a week). The median (IQR) hemoglobin level of the children was 10.6 gm/dl (9.6-11.2). Only 15 children were taking iron-rich food properly, which means they were taking three types of iron-rich foods more than five to six times per week. Nearly 50% of the children were taking eggs and iron-rich vegetables more than five to six times per week. Out of 200 mothers, nearly 60% of them were in the age group of 26-35 years and the median (IQR) age was 28 (25-31) years. Most of them were graduates (57%) and homemakers (60%) and 21% of the mothers were previously working and currently not working. Only 21% of the mothers had undergone hemoglobin testing after their recent delivery and only 16% of them were taking prophylactic IFAS currently. The current mean hemoglobin level of the mother was 11.9 gm/dl (1.2) and the median (IQR) hemoglobin level of mothers during their antenatal period was 11 gm/dl (10-12). The mean age of siblings was 5.13 years (2.1) and the mean hemoglobin level of siblings was 11.4 (1.4) gm/dl.

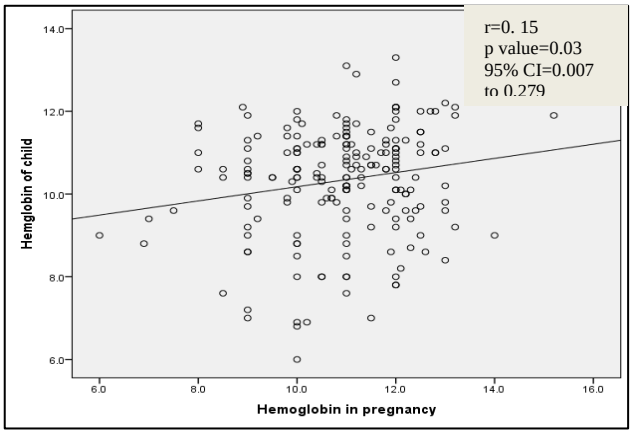

Figure 1a: Scatter plot showing correlation between hemoglobin levels of children and mothers during their antenatal period (n=200).

Distribution of severity of anemia among different categories is shown in (Table 1). Figures 1a and 1b depict the correlation between hemoglobin levels of mothers and children.

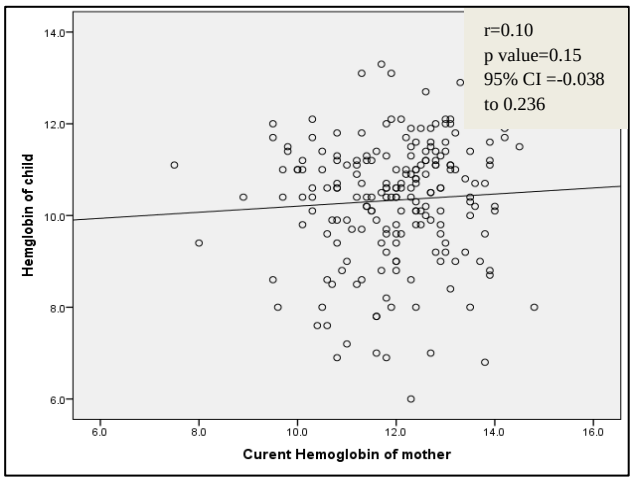

Figure 1b: Scatter plot showing correlation between current hemoglobin levels of children and mothers (n=200).

Among 50 mother-child-sibling triads, 76%, 46%, and 40% of children, their siblings and mothers were anemic and 32% of mother-child dyads and 36% of child-sibling dyads had co-occurrence of anemia. 7 (14%) mother-child-sibling triads had co-occurrence of anemia in the sample of 50.

The proportion of anemic children among anemic mothers was 80% and a similar proportion of anemic children among their anemic siblings was 78% (Table 2). The proportion of children with anemia was 1.1 times more among mothers with anemia compared to those mothers without anemia with a p value of 0.61 and 95% CI ranging from 0.80-1.48.

Table 3 shows that the proportion of anemic children among their mothers who were anemic currently was 65% and the prevalence of anemic children among the mothers who were anemic during their pregnancy period was 68%. The prevalence of children with anemia was 1.1 times more among mothers with anemia compared to those mothers without anemia with a p value of 0.35 and 95% CI ranging from 0.89 to 1.37.

Table 2: Co-occurrence of anemia among the children and their siblings (N=50).

		Children's status			
		Anemic n (%)	**Normal n (%)**	**Prevalence ratio (95% CI)**	**P value**
Siblings' anemia status	Anemic	18 (78.3)	5 (21.7)	1.1 (0.77-1.44)	0.74
	Normal	20 (74.1)	7 (25.9)		

Table 3: Co-occurrence of anemia among children and their mothers (N=200).

		Status of children			
		Anemic n (%)	**Normal n (%)**	**Prevalence ratio (95% CI)**	**P value**
Mothers' current anemia status	Anemic	59 (65.6)	31 (34.4)	(0.89-1.37)	0.35
	Normal	65 (59.1)	45 (40.9)		
Mothers' anemia status during pregnancy	Anemic	56 (68.3)	26 (31.7)	(0.95-1.46)	0.12
	Normal	68 (57.6)	50 (42.4)		

DISCUSSION

The primary objective of our study was to determine the correlation between maternal and childhood hemoglobin levels. The most prevalent nutritional deficiency during pregnancy is iron deficiency, which has a significant effect on mother and foetal morbidity and mortality.[3] We found a positive weak correlation between the current hemoglobin levels of mothers and children which was 0.1, though it was not statistically significant. A similar study was conducted in Brazil by Rosa de Fatima da Silva Vieira Marques et al on the correlation between hemoglobin levels of mothers and children during exclusive breastfeeding in the first six months of life. They found out that among 221 mother-child binomials, the hemoglobin levels of mothers and children correlated at four months (r=0.578) and at five months (r=0.601), with the correlation coefficients ranging from 0.253 at three months to 0.601 at five months.[6] As their study result shows, the hemoglobin levels of mothers and newborns were correlating in the first six months, so we were looking at whether it is still correlating after nine months and found out that it is weakly correlated.

In the present study, the proportion of anemia during mothers' third trimester period was high (45%) compared to NFHS-5 data (42%) in Puducherry.[8] We observed a weak positive correlation (0.15) between hemoglobin levels of children aged nine months to two years and hemoglobin levels of mothers during their third trimester which was statistically significant. Similar results were found in another cohort study conducted in Bihar on

pregnant anemia and child health. They concluded that a 1 gm/dl increase in hemoglobin during pregnancy was associated with a 0.17 gm/dl increase in Hb levels in the newborn.[9] Also, a study conducted in southeastern Brazil found a weak association between hemoglobin levels of maternal and newborns in multiple linear regression analysis.[3] To the best of our knowledge, there are no studies estimating the correlation between hemoglobin levels of mothers during their pregnancy period and hemoglobin levels of new-borns, though association studies are there. In northern China, the connection between maternal hemoglobin levels and the risk of infant anemia was studied. Their finding was maternal Hb level of 109 gm/l at 24-28 weeks of pregnancy was linked to a high risk of new-born anemia at five to seven months of age.[10] As the literature portrays, anemia during the pregnancy period is a risk for getting anemia in children in the first six months and our study results showed that it was weakly correlated after nine months.

The secondary objective of the study was to assess the triple burden of anemia in the same home where the focus was on the mothers, children aged nine months to two years, and their siblings (aged ≤10 years). In the sub-sample of 50 mother-child-sibling triads, 76% of children, 46% of siblings, and 40% of mothers were anemic. The burden of anemia is very high in children aged nine months to two years and slightly higher among siblings compared to DLHS-4 statistics.[11] In a study conducted by Kumar et al in 2021 to look at the triple burden of anemia among mother-father-child triads, 10% of fathers, 57.5% of mothers, and 58% of children reported anemic. Nonetheless, the study found that 4.7% of mother-father-child combinations had a triple burden of anemia. The limitation of the study while examining the co-existence of anemia was, they did not measure anemia for all the children born to the couple.[12]

We observed that if the mother or one of her children is anemic in the same family, there is a chance of getting anemia in another child of the mother. That is, we can initiate testing and treating the anemic members of a family, to prevent anemia in others. The strength of the study was the utilization of Hemocue 301 which is a rapid, effective method and uses only less amount of blood. The study eliminated the recall bias by taking the antenatal hemoglobin value of mothers from records instead of self-reporting. As of our knowledge, this is the first study in India to examine the triple prevalence of anemia among mother-child-sibling triads. Although few limitations were present, the sample size was not adequate to give valid co-occurrence status, and children less than six months were not included to find the correlation.

CONCLUSION

This study concluded that there was a high prevalence of anemia among under two years children in Puducherry Even though there are program recommendations, there is no reduction in anemia compared to NFHS data. So, that should be corrected by ensuring anemia testing, and intake of prophylactic IFAS among under-five children. The multiple linear regression analysis confirmed that there is a weak correlation between the hemoglobin levels of mothers and children. However, it has been hypothesized that mothers' anemia or iron deficiency only affects their children's nutritional health during their initial six months of life, not thereafter. Consequently, more research is required to study the correlation of hemoglobin levels between mothers and children with follow-up of newborns from six months to two years. We found out the high triple burden of anemia among mother-child-sibling triads. We observed that if any of the family members is anemic, there is a chance of getting anemia in others. So, we can initiate testing and treating the anemic members in a family, to prevent anemia in others. Community-based studies with a large sample size are needed to explore the co-occurrence of anemia among all the family members including the father.

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