ORIGINAL ARTICLE

Prevalence of Anemia and Vitamin B12 Deficiency in Children of Brick Kiln Workers, Aged Six to 59 Months: A Cross-Sectional Descriptive Study

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ABSTRACT

Background: The brick kiln workers migrate with their families, which decreases health service utilization, leading to adverse effects on their children's health. Anemia studies on these children are scarce. **Aim and Objectives**: To estimate the prevalence of anemia and vitamin B12 in children of brick kiln workers. **Methodology**: It was a cross-sectional descriptive study. The study enrolled children aged 6–59 months from brick kilns. We took a detailed history and conducted a thorough physical examination. A blood sample was collected to estimate hemoglobin, Mean Corpuscular volume, Mean Corpuscular hemoglobin, Red Cell Distribution Width, serum ferritin, and vitamin B12 levels. **Results**: We assessed 90 children. The study observed that 61.1% of children had anemia (80.4% mild), mostly due to iron deficiency (94.5%). About 25% had vitamin B12 deficiency. All children with anemia were malnourished. Only age below 24 months, birth order ≥2, and exclusive breastfeeding less than six months were significantly associated with anemia. There was no significant association between the demographic characteristics and Vitamin B12 deficiency. **Conclusion**: Iron deficiency anemia and B12 deficiency proportion among brick kiln workers' children in was high. Hence, relevant community interventions to address the problem should be strengthened.

KEYWORDS

Anemia; Iron deficiency; Vitamin B12 deficiency; Under-five children; Brick kiln workers

INTRODUCTION

The brick kiln industry in India is next to China in terms of global production. (1) The seasonal migration usually occurs post-monsoon. (2)

The migrant workers' children are neglected in the provison of health and other services available from Anganwadis. (3) The proportion of anemic children in India rose by 10%, in 2020-21 as per National Family Health Survey (NFHS). (4)

Anemia in children aged 6–59 months is a major health problem in nearly all developing countries. (5) According to the WHO, iron deficiency is India's single most crucial nutritional risk factor, accounting for more than 3% of all disability-adjusted life years (DALYs) lost. (6)

In India childhood anemia is mostly due to iron deficiency though, it may also result from folate and Vitamin B12 deficiency. National-level surveys have revealed the anemia control program's failure. (7) and it is still prevalent amongst children. (8)

Vitamin B12 is also an essential micronutrient during infancy and early childhood.

The seasonal brick kiln migrants face unique challenges as the relevant government child health programs do not reachthem. (9)

The NFHS does not capture migrants as a category. The authors conducted the present study because there is a paucity of data on biochemical investigation of anemia and Vitamin B12 deficiency in children of brick kiln workers aged 6 to 59 months old. The aim was to assess important micronutrient deficiencies.

Objectives

1. To estimate the prevalence of anemia among 6 to 59 months aged children of brick kiln workers in one block in Pune district
2. To estimate prevalence of iron deficiency through biochemical investigations among the under-five children
3. To estimate prevalence of B12 deficiency among the under-five children
4. To evaluate association between socio-demographic factors and anemia and B12 deficiency
5. To evaluate association between under-nutrition and anemia

Material & Methods

Study Design

It was cross sectional descriptive study.

Setting

We carried out the study in the field practice area of 'Rural Health Training Center' (RHTC), of a Deemed University Medical College, Pune, Maharashtra state in India. The estimated population under the center is 49,414 scattered in 13 villages. The center had registered 55 brick kilns in five villages during the study period.

Study period

The investigators enrolled and assessed the children from March 2022 to December 2022.

Data collection

The principal investigator prepared and validated the proforma. It was converted to Google Form. The investigator trained the study team members (medical interns) on the study proforma i.e., 'Google form,' which was filled on site by them.

The study team members conducted a door-to-door survey to identify potential study participants. After taking the written informed consent from the parent, the team members obtained a detailed history of the child aged 6-59 months from the parents, preferably the mother. In the case of illiterate parents, the team members took a thumb impression of the parent and a signature with the date of an impartial witness before any study procedure. A thorough physical examination of the child was carried out, details of which were entered in the proforma.

Participants

The mothers and their children from the brick kiln sites were the participants.

Inclusion criteria

All children of brick kiln workers residing with them aged 6 to 59 months.

Exclusion criteria

A child suffering from acute illness was the only exclusion criteria.

Variables definitions and normal ranges

Anemia: Hemoglobin (Hb) value less than 11.0 g/dL was considered anemia and classified as mild (10–10.9 g/dL), moderate (7–9.9 g/dL), and severe (<7 g/dL).

B12 level normal range: 187- 883 pg/ml

Normal Ferritin levels ≥ 12 ng/ml

MCV (Mean Corpuscular Volume): 70-85fl in children up to 2 years of age and for children 2-5 years lower limit is 70+age in years

MCH (Mean Corpuscular hemoglobin): 27-31pg

RDW (Red Cell Distribution Width): 11.5-14.5%

Definitive iron deficiency anemia: low Hb, low MCV, low MCH, low ferritin, increased RDW levels, and the peripheral blood smear revealing hypochromia, microcytosis, anisopoikilocytosis, occasional pencil cells and teardrop cells.

Likely iron deficiency anemia: low Hb, low MCV, low MCH, increased RDW levels, hypochromia, microcytosis, but serum ferritin >12 ng/ml.

Blood processing and management: A trained, experienced phlebotomist collected approximately three ml. of venous blood from the child into vacutainers, i.e., one ml. in an EDTA tube and two ml. in the plain bulb, taking all universal precautions. The blood sample was sent to the NABL-accredited laboratory for estimating the Hemogram, serum ferritin, and vitamin B12 level. A hemogram was done using Beckman Coulter DxH8007, and serum ferritin and B12 estimation was done by chemiluminescence microparticle immunoassay (CMIA -Abbott Alinity).

The authors informed the subject's parents of the blood investigation results and provided the necessary treatment. They also gave dietary advice as appropriate.

Sample size calculation

The reported 58.7% of anemia among children in Pune district (10), was considered as basis for sample size calculation in the following formula.

Sample Size 'n' = Z^2 p * q/d^2. Where,

Z = value associated with 95% confidence, considered as 2

p = prevalence of anemia (58.7%)

q = 100 – p

d = 10.5

The minimum sample size required as per the formula was 88.

Sampling

The study decided to include at least three sites form each village. We randomly sequenced the five

villages having brick kiln sites. Then we visited villages one by one. In each village minimum three sites or more based on probability proportional to the size (number of brick kilns in the village) were visited. We continued the process till we reached the desired size. We assessed all the available children form the last kiln site in which the desired number was achieved.

Statistical analysis: The data entry operator entered the data into an Excel sheet and then analyzed it in SPSS Version 28. The study presents the qualitative and discrete data as numbers and percentages. The investigators applied a chi-square test for the comparison of anemia and B12 deficiency percentages between socio-demographic parameters, and a *P*-value less than 0.05 was considered significant. The investigators calculated odds ratio with 95% confidence interval.

Ethical clearance: Institutional Ethics Committee approved the study vide, REF: BVDUMC/MC/IEC/1, Date: 27/01/2021. The investigators obtained written informed consent for participation and publication from mother or father of the child.

RESULTS

The investigators visited 20 brick kiln sites located in five villages. One village Nande had only one brick kiln during the study period. The study enrolled 90 children aged 6 to 59 months. Table 1 gives the age and sex distribution of these children. Among the enrolled children, 29 were first birth order, 37 were of second order, 15 third birth order, four of fourth order and five children were fifth or higher order.

Figure 1 shows that about 61% (55 children) had anemia and about 40% (35 children) of them had mild anemia. The results of assessment of all children for iron deficiency are given in Figure 2. Most anemic children had iron deficiency. Among non-anemic children 20% had iron deficiency.

Table 1: Age and sex distribution of children from brick kiln sites, Pune, India

Age in Months	M	F	Total
6-11	2	2	4
12-23	10	6	16
24-35	11	11	22
36-47	5	8	13
48-59	18	17	35
Total	46	44	90

Figure 1 Anemia among under-five children at brick kiln sites, Pune, India.

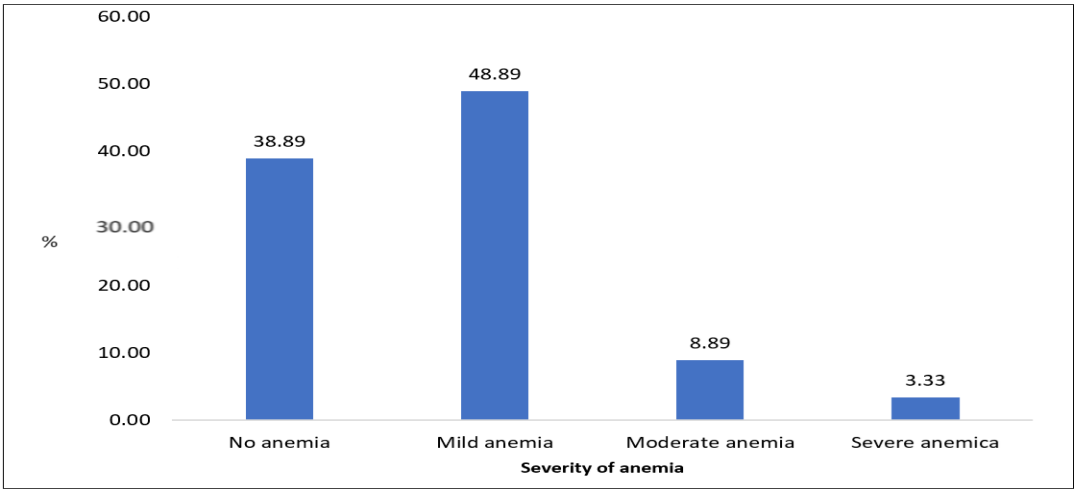
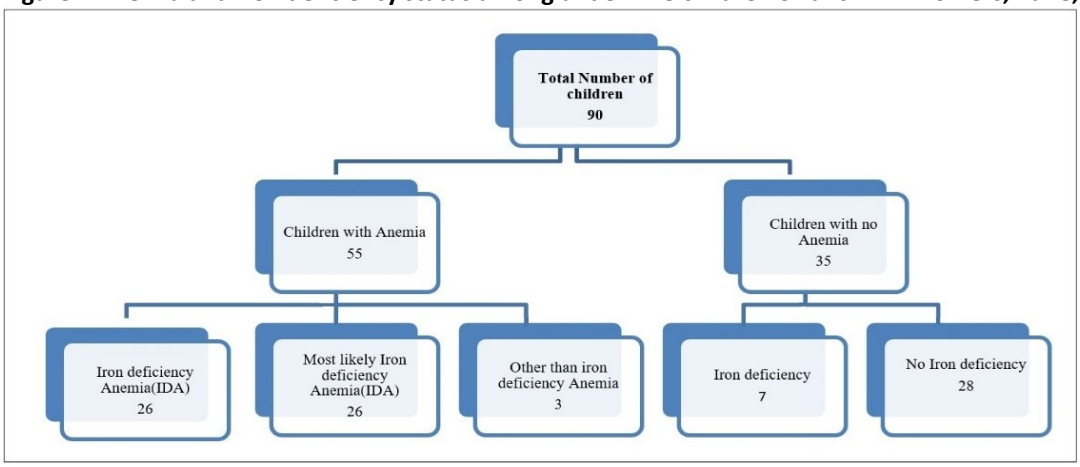


Figure 2 Anemia and iron deficiency status among under-five children of brick kiln workers, Pune, India.



Vitamin B12 deficiency was prevalent in 23/90 (25.6%) children out of which 13 children had anemia also (chi-square = 0.27; P = 0 .60). Majority of children having anemia 52 /55 (94.5%) had low Mean Corpuscular Volume (MCV) which was significantly associated with anemia (P value < 0.001). Ferritin levels were low only in 26 (47.3%) anemic children (P=0.010).

Table 2 shows adjusted odds ratio using multiple logistic regression for anemia. Exclusive breast feeding for more than six months had adjusted odds ratio 0.109 (95% CI; 0.022 to 0.539). Similarly, children aged less than two years had adjusted odds ratio 0.133 (95% CI; 0.027 to 0.669).

Table 2: Demographic characteristics of children with anemia and Vitamin B12 deficiency

		No.	Anemia	No.	OR (95% CI)	B12	OR (95% CI)
Gender	M	46	29	17	1	14 (30.4%)	1
	F	44	26	18	0.85 (0.36 – 1.98)	9 (20.5%)	0.59 (0.22-1.54)
Age	< 2 years	20	17	3	4.77(1.28 –17.76)	5 (25%)	0.96 (0.31-3.03)
	≥2 years	70	38	32	1	18 (25.7%)	1
Birth order	1	29	12	17	1	8 (27.6%)	1
	≥2	61	43	18	3.38 (1.28 –7.76)	15 (24.6%)	0.86 (0.31-2.33)
Breast feeding*	< 6 M	21	19	2	9.87 (2.09 –6.64)	6 (28.6%)	1.72 (0.53-5.54)
	>=6 M	53	26	27	1	10 (19.9%)	1
Maternal education	Illiterate	49	29	20	0.84 (0.36 – 1.96)	9 (18.4%)	2.3(0.87-6.07)
	Literate	41	26	15	1	14 (34.2%)	1

***= data of breastfeeding duration is not available for 16 children**

Anemia was not found to be significantly associated with the sex of the child and maternal education. Whereas age below 24 months, birth order ≥2 and exclusive breastfeeding less than 6 months were significantly associated with Anemia.

There was no significant association of Vitamin B12 deficiency and the demographic characteristics under study.

All children with anemia were under-nourished (stunting or wasting or under-weight or combination) whereas prevalence of under-nutrition in children without anemia was 88.6%.

DISCUSSION

Anemia among under-five children has serious consequences and needs timely identification, treatment, and prevention, as cognitive impairment resulting from Iron Deficiency Anemia may be irreversible. (11) In the current study more than sixty percent children were anemic and majority had mild anemia. Majority of the anemic children has definite iron deficiency.

The prevalence of anemia observed in the present study is more than anemia prevalence in Pune district (58.7%) reported in National Family Health Survey 5. (10) The observed proportion of mild, moderate, and severe anemia in the present study is common. (12) Although 26/55 (47.3%), children with anemia had hematological parameters similar to those of iron deficiency anemia their serum ferritin was normal i.e. >12 ng/ml. The mean ferritin level was below 30 ng/ml. We presumed that the serum ferritin values may have been normal due to previous, subclinical infection, inflammation etc. and most likely these children also have iron deficiency anemia. The serum ferritin <12 ng/ml is a sensitive, with high false negative rates being common as it is an acute phase reactant. (13) Thus, in our study, majority of children 52/55 (94.5%) were considered to have iron deficiency anemia. In the remaining 3/55(5.5%) children with anemia, Hb and MCH were low, but RDW and MCV was within normal range, Ferritin levels were normal and the peripheral blood smear was normochromic, normocytic, so less likely to be iron deficiency anemia and further studies would be needed to determine cause of anemia.

There was significant association of anemia with low Mean Corpuscular Volume (P value < 0.001) in our study, similar to study by Vibha Awad et al. (14) Iron deficiency (ID) without anemia was observed in 7/90(7.8%) study children who had normal Hb, but low ferritin, low MCV and low MCH, which is similar to the study by Branly Kilola Mbunga et al. (15), who have reported that among children aged < 5 years, anemia was highly prevalent (68.1%) while ID without anemia was remarkably low (12.9%).

Iron deficiency is the most common cause of anemia among children in low-income and middle-income countries like India. (16) It's reported that globally, including India over fifty percent of anemia

cases are caused by iron deficiency. (8,17,18,19) According to the Indian Council of Medical Research (ICMR), dietary iron deficiency contributed to 11% of all disability in India in 201.6 (8) Children are particularly vulnerable to iron-deficiency anemia because of their increased iron requirements during periods of rapid growth, especially in the first five years of life.

In our study the prevalence of anemia was significantly higher in children below 24 months i.e. 85.7 % (P=0.009). Various authors have also reported higher incidence of anemia in infants and toddlers, as compared to older children. (5,17,20,21) Solomon Gedfie et al. (22) have reported that children under the age of 2 years were 1.26 times more likely to acquire anemia, which may be attributed to lack of iron intake during the period of rapid growth and development. Literature has reported a similar trend that the risk of having anemia prevalence decreases with age. (23) We didn't observe any significant difference between prevalence of anemia and gender of the child similar to few other studies. (23, 24) Birth order ≥2 was significantly associated with anemia mostly due to improper care & nutrition which was similar to prior studies. (5,16,23) It has been reported by many previous authors that the children of less educated mothers have higher prevalence of anemia, though we didn't find such association, probably because majority of mothers were involved in brick making and children were looked after by other family members.

Socio-economic status of the family has a significant effect on degree and prevalence of anemia, which has been reported by many previous authors. (7,8,12,14,22,23,25,26) A study by Ketan Bharadva et al. (13), have reported that migrant worker parents is an additional risk factor for anemia along with low socioeconomic status. This study was carried out in rural area where brick kilns operate, the anemia prevalence is shown to be higher in rural as compared to urban, by many authors. (6, 7, 27, 28)

Prevalence of anemia in children who were exclusively breastfed for less than 6 months was significantly high i.e. 90.9% (p value = 0.00073) similar to report by Wubet Takele et al. (27) Exclusive breastfeeding not only gives adequate nutrition but also has immunological and anti-inflammatory properties which protects baby against lot of illnesses and diseases.

The Vitamin B12 levels were low in 23 (25.6%) children out of which 13 children had anemia, but macrocytosis i.e. high MCV, was not seen in any of these children. Swati Umasanker et al. (29), have stated that there is varying prevalence of B12 deficiency in developing countries and is reported as 21-45%. Iron deficiency is common in under-five children, while vitamin B12 deficiency is higher among school going and adolescent age groups as reported by Jagdish Chandra et al. (11)

Malnutrition is more prevalent among children from the marginalized population. (30) A high proportion malnutrition was observed in brick kiln workers' children in neighboring district. (31) That study did not measure hemoglobin and only clinical signs of nutritional deficiency were recorded. In our study all children with anemia (100%) were undernourished. This is due to the fact that undernourishment leads to both macronutrient and micronutrient deficiencies, such as protein, iron, and vitamin A, which are responsible for iron deficiency & also causes recurrent infections. It's known that multiple factors do contribute for anemia in young children e.g. increased demand, dietary insufficiency, cow's milk consumption, acute or chronic blood loss, intestinal malabsorption of iron, worm infestation, high phytates in vegetarian diet, less intake of non-vegetarian food, malnutrition, poor sanitation, low wages, poor housing, low education, living in rural areas, etc. Distance from brick kiln has been acknowledged as one of the strong determinants of anemia. (32) Present had two vulnerable factors; the children and living at the brick kiln sites.

In tertiary care hospitals biochemical investigations are routinely carried out for assessing etiology of anemia. The present study is probably the first, estimating prevalence, type of anemia and B12 deficiency among under-five children of brick kiln workers, in rural area. These workers are from low socio-economic strata and are migrant laborers. The number and sites of brick kilns are not static; each year may change. The diagnosis and management of anemia in these children is essential.

LIMITATIONS

In the present study the sample size was small and due to funding constraints, additional tests for anemia diagnosis could not be performed.

CONCLUSION

A high proportion of kiln workers' children have iron deficiency anemia and B12 deficiency. All children with anemia were malnourished. Although it is well-known that the elimination of iron deficiency anemia in children is a public-health priority and a cost-effective strategy; The benefits of relevant program do not reach to brick kiln workers' children, mainly being migrant.

Recommendation

While implementing anemia prophylaxis program attention must be given to migrant population. A few large community base studies involving counseling of parents, treatment/management, cross referral to their usual place of residence for continuous follow-up and results are needed. Such studies will demonstrate the ideal mechanism and feasibility of cross referral system for implementation in the community.

Relevance of the Study

The public health sector presently may not be giving adequate attention to children of migrant population including brick kiln workers.

Authors Contribution

All authors have contributed equally. NH conceived the study concept and design, collected the data, drafted the manuscript. AN helped in finalizing the study concept and design, and collection of data. AD analyzed the data and assisted the manuscript writing. PD finalized the study concept and design, assisted in data analysis, and finalized the manuscript.

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Nil.

Conflict of Interest

There are no conflicts of interest.

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Declaration of Generative AI and AI Assisted Technologies in the Writing Process

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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