Prevalence of Vitamin B12 Deficiency in Malnourished Children: A Cross-Sectional Study

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Abstract

The objective of this research paper is to determine the frequency of Vitamin B12 deficiency in malnourished children presenting in outpatient clinics in a Pediatrics Department and to identify associated risk factors using a cross-sectional study design. The research was carried out at the Department of Pediatrics, Dr. Ruth Pfau Civil Hospital Karachi, for 6 months from 22-01-2020 to 21-07-2020. All pediatric patients, aged 6 to 60 months of either gender, either visiting and/or admitted to the Department of Pediatrics, Civil Hospital, were evaluated. Blood samples were obtained from 91 malnourished patients to measure Vitamin B12 levels. Forty-two (46%) children were found to be Vitamin B12 deficient. Children younger than 15 months (19%) and those aged 36 to 60 months (55%) had a high prevalence of Vitamin B12 deficiency. Mean Vitamin B12 levels were136.93±93.23pg/ml. The Regression analysis showed a significant relationship of Vitamin B12 deficiency with socioeconomic status and dominant breastfeeding, (p-value < 0.05).

Malnourished children have a higher frequency of vitamin B12 deficiency. Public health initiatives should emphasize balanced feeding practices, combining breastfeeding with adequate complementary foods rich in Vitamin B12.

Keywords: *Vitamin B12, malnutrition anemia, cobalamin, dominant breastfeeding, pediatrics.*

INTRODUCTION

Vitamin B12 is a water-soluble vitamin that plays a vital role in nerve cell maintenance, red blood cell formation, and methyl donation in DNA formation. It is also referred to as Cobalamin. It is one of the basic 8 B vitamins and its function integrates closely with that of Folate, another B Vitamin [1]. Vitamin B12 and Folate are essential micronutrients during infancy and childhood to promote effective mental nourishment, physical growth, and other metabolic functions.

Deficiency of Vitamin B12 and Folate could be catastrophic during infancy and childhood, manifesting itself in poor growth, megaloblastic anemia, increased infections, and irreversible neurological impairment to the growing brain [2]. Moreover, studies on human subjects suggested that the lack of sufficient Vitamin B12 intake affected hematologic and immunologic parameters among children [3]. Medical research highlighted the consequences associated with Vitamin B12 deficiency ever since its discovery and characterization more than 60 years ago. Vitamin B12 can prevent Pernicious anemia, a disease associated with fatal neurological functions and autoimmune destruction of gastric parietal cells and their output in the form of intrinsic factor that plays an effective role in Vitamin B12 absorption [4].

The major reason for Vitamin B12 deficiency is inadequate micronutrient intake in the diet. Vitamin B12 is exclusively contained in animal-derived foods such as meat, eggs, milk, and fish, and its deficiency is due to insufficient intake of these foods [5]. Vegetarian mothers of infants may suffer from Vitamin B12 deficiency, thus transferring the deficiency to children [6]. There are various reasons for inadequate intake of proper nutritious diet including poor socioeconomic status, lack of availability, high cost, poor absorption, and false beliefs linked to eating habits.

There are roughly 165 Million malnourished children in the world below five years of age [7]. At least 50% of all childhood deaths occur due to malnutrition [8]. Child malnutrition is mainly an issue in developing and underdeveloped countries like Pakistan [9]. Unfortunately, Pakistan ranks quite high among those developing countries with a high frequency of malnourished children. As per statistics obtained from the National Nutrition Survey, 33% of children were underweight, 15% were wasted, 44% were stunted, 50% were anemic, and 33% had iron deficiency [10]. These statistics are quite overwhelming from a risk assessment of micronutrient deficiency point of view, especially Vitamin B12. Therefore, it is essential to focus research efforts on the domain of Vitamin B12 deficiency among malnourished children in Pakistan.

Folic acid and Vitamin B12 deficiency manifest itself as megaloblastic anemia that severely affects children in developing countries of the world [11]. Inadequate dietary intake, coeliac disease, malabsorption due to giardiasis, and some other bowel diseases are common contributing factors for folic acid deficiency [12].

The research studies discussed above clearly depicted the significant prevalence of deficiency of Vitamin

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B12 and folate acid among malnourished children in developing countries like Pakistan [7-10]. Folic acid and Vitamin B12 are essential nutrients for DNA synthesis. Folic acid directly plays a role in this process, while Vitamin B12 plays a secondary role. When either of these nutrients is deficient, the overall cell maturation process is disrupted and leads to megaloblastic anemia. Diseases like Pancytopenia due to deficiency of these nutrients are more prevalent in malnourished children.

The present study was planned to determine the frequency of Vitamin B12 deficiency in malnourished children presenting in outpatient clinics in a Pediatrics Department and to identify associated risk factors. As Pakistan has high levels of child malnutrition as compared to other developing countries of the world and the global statistics of malnourished children are also overwhelming, this area of research is crucial.

MATERIALS AND METHODS

The present study was an analytical, Cross-sectional study. The study was conducted at the Department of Pediatrics, Dr. Ruth K.M Pfau, Civil Hospital, Karachi. The study duration was Six months after approval of the synopsis from 22-01-2020 to 21-07-2020. The study used a non-probability, consecutive sampling technique. The inclusion criteria for the study were: Children with age 6 Months to 60 Months, with severe Malnutrition. Patients whose parents didn't give consent, who had already received Vitamin B12 supplements, children having congenital heart disease, congenital malformations, malabsorption syndromes, and genetic and chromosomal malformations were excluded.

All pediatric patients, 6 Months to 60 months of age, of either gender visiting the outpatient department and/or admitted in the patient in the department of pediatrics, Civil Hospital fulfilling inclusion criteria were enrolled after due consent. Blood samples were obtained from the selected patients for the measurement of vitamin B12 levels. A predesigned Performa was used to collect the basic demographic information and investigation findings. Patient confidentiality was maintained throughout the study. Management was done as per standard protocol.

Severe acute malnutrition is defined as severe wasting or bilateral edema according to WHO child standard growth chart. Severe wasting is extreme thinness manifested through a weight-for-length (or height) below 3 Standard Deviation of the WHO Child Growth Standards. Moreover, the children aged 6-59 months, a mid-upper-arm circumference < 11.5 cm is also representative of wasting. Measurements were taken using length boards, a stadiometer, and measuring tapes by using standard methods.

Vitamin B12 cut-off value less than 200pg/ml was labeled as deficient [5].

Dominant Breastfeeding: It means feeding based solely and mostly on breast milk, and little or no dependence on other foods or food supplements from other sources.

Balanced Feeding: It refers to a feeding practice that involves a proper combination of breastfeeding alongside complementary foods or food supplementation.

The socioeconomic status of the patients included in the study was categorized into three groups based on poverty-level considerations at the standard wage level in Pakistan. These are the three groups: Low (<10000 PKR Income), Medium (10000-3000 PKR Monthly Income), and High (>30000 PKR Monthly Income) socioeconomic status.

The data entry and analysis were carried out using Statistical Package for Social Sciences version 20 (SPSS). Qualitative data such as gender, socioeconomic status, ethnicity, number of children, and breastfeeding were expressed in the form of percentages. Numerical/ Quantitative data such as age, weight, height, mid-upper arm circumference, and Vitamin B12 levels were represented as mean and standard deviations. Effect Modifiers like age, ethnicity, socioeconomic status, breastfeeding, and number of children were controlled through stratification. Regression analysis was applied by taking the following independent variables; Socioeconomic status and breastfeeding status, whereas the dependent variable was Vitamin B12 levels. P-value≤ 0.05 as taken statistically significant.

RESULTS

A total of 91 malnourished children of either gender were enrolled. The proportion of male children in the sample population was 44 (48.35%), (**Table 1**). The mean age of the children was determined to be 32.2±15.5 Months. The age was further stratified into six groups as mentioned in Table **1**. Various age groups had different prevalence. The highest prevalence of Vitamin B12 deficiency was seen in the 36-55 months age group (**Table 1**).

The mean Mid-Upper-Arm-Circumference (MUAC) of the children was 10.08±0.77cm. The statistics show that MUAC lies below the 11.5cm standard criteria for malnourished children. The mean value of serum Vitamin B12 level is 136.93±93.23pg/ml. As mentioned earlier, the criteria for declaring patients as Vitamin B12 deficient are ≤200pg/ml. The number of malnourished patients with Vitamin B12 deficiency was 42 out of 91 (**Table 1**). Vitamin B12 levels in Vitamin B12 deficient children were 63.22±20.26pg/ml.

Vitamin B12 deficiency is stratified in terms of the socioeconomic status of parents of children as "Low", "Medium", and "High", numerically converted to Scale 1, 2, and 3 respectively for regression analysis. Moreover, Vitamin B12 deficiency is also stratified in terms of the feeding history of children in terms of either "Dominant Breastfeeding" (Scale =1 for regression analysis) indicating that the mother used breastfeeding as the

Table 1: Descriptive statistics of malnourished children.

Variable	Category	Statistics
Gender	Male, n(%)	44 (48.4)
	Female, n(%)	47 (51.6)
Vitamin B12 Deficiency Prevalence	Total Deficient	42 (46.2)
Age (Months)	Mean ± SD	32.23 ± 15.54
	Median (IQR)	34 (22-42)
	Range	6-58
Age Group Stratification for Vitamin B12 Deficiency	6 to 15 Months, n(%)	8 (19)
	16 to 25 Months, n(%)	5 (11.9)
	26 to 35 Months, n(%)	6 (14.3)
	36 to 45 Months, n(%)	11 (26.2)
	46 to 55 Months, n(%)	10 (23.8)
	56 to 60 Months, n(%)	2 (4.7)
Vitamin B12 Levels (pg/mL)	Mean ± SD	136.93 ± 93.23
	Median (IQR)	112.2 (78-170)
	Range	30.3-377
Vitamin B12 Levels (pg/mL) for Deficient Children	Mean ± SD	99.47 ± 47.9
	Median (IQR)	92.25 (148-60)
	Range	30.3-194.4
Vitamin B12 Levels (pg/mL) for Normal Children	Mean ± SD	299.99 ± 60.47
	Median (IQR)	276.6 (364.5-241.6)
	Range	221.9-377
Breastfeeding Status	Dominant Breastfeeding	61 (67.0)
	Balanced Feeding	30 (33.0)
Socioeconomic Status (Deficient Children)	Low	34 (81.0)
	Medium	6 (14.3)
	High	2 (4.7)

dominant mode of diet for children and relied negligibly on food supplementation and "Balanced Feeding" as category representing mothers used proper combination of breastfeeding with food supplementation (Scale = 2 for regression analysis). 67% of children were breastfed whereas 33% were fed on breastfeeding and food supplementation. 59.34% belonged to the Low socioeconomic group, 27.47% belonged to the Medium group, and 13.2% belonged to the High status. The prevalence of Vitamin B12 deficiency in malnourished children came out to be 42 (46.15%) while 47(53.85%) children had normal Vitamin B12 levels (**Table 1**).

Stratification concerning modifiers of socioeconomic status, feeding history, and their combination was made to observe their effect on the prevalence of Vitamin B12 deficiency. Results showed that 34 children with Vitamin B12 deficiency belonged to Low (<10000 Income), 6 Children with Medium (10000-3000 Monthly Income), and 2 Children with High (>30000 Monthly Income) socioeconomic status. On the other hand, 20 children with normal Vitamin B12 levels belonged to Low (<10000 Income), 19 Children with Medium (10000-3000 Monthly Income), and 10 Children with High (>30000 Monthly Income) socioeconomic status.

Table 2: Regression analysis summary for predictors of vitamin B12 deficiency.

Source	Degrees of Freedom (df)	The sum of Squares (SS)	Mean Square (MS)	Significance
Regression	2	164,542.51	82,271.25	<0.001
Residual	88	617,780.28	7,020.23	
Total	90	782,322.79		

Socioeconomic status was found to be significantly associated with Vitamin B12 deficiency (p<0.001). Results showed that 25 Vitamin B12-deficient children were from the Low-income group with a "Dominant Breastfeeding" history, 6 from Medium income, and 2 from High income. Conversely, 7 children with normal Vitamin B12 levels were from Low income, 11 from Medium income, and 9 from High income, all with a "Dominant Breastfeeding" history.

Regression analysis results are presented in Table **2**. Table **2** displays that the applied regression model was predicting the dependent variable. Table **3** showed that Vitamin B12 deficiency is significantly associated with feeding history (p=0.024). The results (**Table 2**) also showed that the multivariable regression model with both independent variables: socioeconomic status with "Dominant Breastfeeding" history had a significant association with Vitamin B12 deficiency (p<0.001). Stratification concerning feeding history showed results that 33 children with a "Dominant Breastfeeding" history had Vitamin B12 deficiency, while 9 children with a "Balanced Feeding" history had Vitamin B12 deficiency. Moreover, 28 children with a "Dominant Breastfeeding" history had normal Vitamin B12, while 21 children with a "Balanced Feeding" history had normal Vitamin B12.

Overall, the results showed that independent variables: socioeconomic status, and "Dominant Breastfeeding" history independently and as multivariable model had a significant association with Vitamin B12 deficiency.

DISCUSSION

The present study evaluated the prevalence of Vitamin B12 deficiency among malnourished children. Out of 91 malnourished children, 42 had Vitamin B12 deficiency. The prevalence of Vitamin B12 deficiency among malnourished children is quite high which goes to show that intake of the proper diet containing a combination of essential micronutrients is essential for keeping normal Vitamin B12 levels. Malnutrition is a strong risk factor for deficiency of micronutrients like Vitamin B12, folate, and Iron and my study proved that Vitamin B12 level is likely

Table 3: Coefficients and statistical significance of socioeconomic status and feeding practices.

Variable	Coefficients	Standard Error	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
Intercept	-14.707	37.337	0.695	-88.905	59.492
Breastfeeding	44.515	19.384	0.024	5.994	83.037
Socioeconomic	60.089	12.732	<0.001	34.787	85.390

to be low among malnourished children as prevalence is quite high. My study shows the high prevalence of Vitamin B12 deficiency among malnourished children and it reflects the inadequate intake and poor absorption of micronutrients among children in Pakistan.

The role of gender in the prevalence of Vitamin B12 deficiency was negligible in results as the proportion of Male and Female children in the malnourished sample population (44 Males, 47 Females) and those with Vitamin B12 deficiency were almost equal (19 Males, 23 Female). This is due to the reason that malnutrition prevails equally among children of either gender due to risk factors of socioeconomic status and inadequate dietary intake by mothers in the vegetarian population.

The prevalence of Vitamin B12 deficiency in the age group less than 18 months is 19% (8 Vitamin B12 deficient children in the 6-15 Months age group). Due to dominant breastfeeding history, lack of complimentary food, and inadequate intake of animal-derived food by mothers of lactating children, the prevalence of Vitamin B12 deficiency is high. Moreover, the age group of 36 months to 60 months had a prevalence of 55%. This age group is vulnerable to Vitamin B12 deficiency due to the extensive requirement of micronutrients in growing age, but children don't have quality food due to low socioeconomic status or vegetarian diet preference.

The mean weight of 9.31 kg and MUAC of 10.1cm lies on the low side as compared to normal children of age group 6 to 60 months of age. Since the sample population was malnourished, the children included in the study had weights less than the Z-score minus 3SD of WHO recommended criteria of Weight for Height. The height statistics of children with a mean of 90.74cm lie in the normal range according to weight. The low weight and MUAC of less than 11.5cm are indicative of insufficient growth as compared to age due to malnutrition.

The mean Vitamin B12 level among children with Vitamin B12 deficiency is 99.46pg/ml which is much less than the mean value of 299.99pg/ml for normal/healthy children. Thus, 42 children with Vitamin B12 deficiency had a mean Vitamin B12 level of 99.46pg/ml which indicates poor growth due to various factors like inadequate diet intake, poor socioeconomic status, malabsorption, lack of food supplementation, *etc.*

Stratification of the population concerning feeding history showed that two-thirds (67%) of the malnourished children had a "Dominant Breastfeeding" history, while around one-third (33%) had food supplementation in addition to breastfeeding. Thus, dominant breastfeeding history is a leading cause of malnourishment and hence, Vitamin B12 deficiency. Most of the mothers of children belonging to low socioeconomic status are themselves deficient in essential micronutrients reflected in terms of malnourishment in their children and also deficiency of Vitamin B12 and folate acid.

Stratification of population of malnourished children according to socioeconomic status showed that almost 60% belonged to low socioeconomic status, while 27.47% belonged to Medium socioeconomic status, and only 13.2% had High socioeconomic status. Thus, socioeconomic status has a profound impact on the malnourishment of children. Children of low socioeconomic status are unable to purchase high-quality nutritious food containing the right combination of essential micronutrients.

Having discussed the situation of Vitamin B12 deficiency among children, it is important to explore the underlying factors. Among various reasons discussed in the literature, Vitamin B12 deficiency could occur due to malabsorption disorders like chronic pancreatitis, Crohn's disease, bacterial infection in the small intestine, worm infestation, and surgical resection of the terminal ileum. Juvenile Pernicious anemia is also a common cause of Vitamin B12 deficiency in children [13]. The children suffering from micronutrient deficiency due to malnutrition may be Vitamin B12 and/or folic acid deficient [14, 15]. Moreover, Pancytopenia may occur due to severe prolonged deficiency of Vitamin B12 and/or folic acid deficiency. The bone marrow examinations of 15-25% patients of with this disease were found to have megaloblastic anemia as well [16, 17]. Healthcare professionals must check Vitamin B12 and folic acid levels among children suffering from Pancytopenia and low reticulocyte count. Moreover, proper intervention measures to reduce the symptoms must be taken. Diagnosis should include the root cause of micronutrient deficiencies like malnutrition, malabsorption, and giardiasis.

The results of the present study are comparable with those of Yaikhomba *et al.* [18] as they analyzed the prevalence of Iron, folate, and Vitamin B12 in malnourished children. They found the prevalence of Vitamin B12 deficiency as 34% which is slightly less than the measured value of 46%. They conducted a study on a sample of 50 children in India that provides similar sort of cultural and socioeconomic conditions as Pakistan.

Goyal *et al.* [19] conducted a study to determine cobalamin and folate status in malnourished children. They found the prevalence of Vitamin B12 deficiency to be 37.5% which is close to my measured prevalence of 46%. They also found that the majority of Vitamin B12 deficient children lie in the low socioeconomic group (26 out of 30) as compared to 34 out of 42 in my case.

The present study has some limitations, Firstly, serum Vitamin B12 levels are a less sensitive indicator of Vitamin B12 deficiency as compared to holo-transcobalamin and metabolites in the form of methylmalonic acid and homocysteine. Secondly, the study comprised a sample from Karachi, Pakistan. Most of them belonged to the low socioeconomic group that doesn't evaluate representative prevalence of Vitamin B12 deficiency

among middle and high economic groups. Although the prevalence of malnourishment is likely to be low in middle and high socioeconomic groups, this study cannot be generalized for all socioeconomic groups. Thirdly, the small sample size limits the generalizability of results to larger populations and rural areas of Pakistan.

CONCLUSION

This study evaluated Vitamin B12 deficiency among 91 malnourished children, finding a prevalence of 46%. Children aged 36-60 months (55%) were most affected. Regression analysis showed significant associations between Vitamin B12 deficiency, low socioeconomic status, and dominant breastfeeding history. A multivariable model confirmed these as strong contributors. These findings highlight the need for governmental intervention and stakeholder collaboration to improve dietary standards for mothers and children from low socioeconomic backgrounds in Pakistan, addressing the high prevalence of Vitamin B12 deficiency in this vulnerable population.

CONSENT FOR PUBLICATION

Written informed consent was taken from the parents/ guardians of all the participants.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Declared none.

AUTHORS' CONTRIBUTION

MA and FA performed data collection, analysis, and manuscript writing.

REFERENCES

1. Green R, Allen LH, Bjørke-Monsen AL, Brito A, Guéant JL, Miller JW, *et al*. Vitamin B12 deficiency. Nat Rev Dis Prim 2017; 3: 1-20. DOI: https://doi.org/10.1038/nrdp.2017.40
2. Rasmussen SA, Fernhoff PM, Scanlon KS. Vitamin B12 deficiency in children and adolescents. J Pediatr 2001; 138: 10-7. DOI: https://doi.org/10.1067/mpd.2001.112160
3. Molina V, Medici M, Taranto MP, de Valdez GF. Effects of maternal vitamin B12 deficiency from end of gestation to weaning on the growth and haematological and immunological parameters in mouse dams and offspring. Arch Anim Nutr 2008; 62: 162-8. DOI: https://doi.org/10.1080/17450390801892567
4. Green R, Miller J. Handbook of vitamins. CRC Press Baton Raton, FL; 2007.
5. Goyal S, Tiwari K, Meena P, Malviya S, Mohd A. Cobalamin and folate status in malnourished children. Int J Contemp Pediatr 2017; 4: 1480-4. DOI: https://doi.org/10.18203/2349-3291.ijcp20172690
6. Allen L, King J, Lönnerdal B. Nutrient regulation during pregnancy, lactation, and infant growth. Vol. 352. Springer Science & Business Media 2013.
7. 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(9890): 427-51. DOI: https://doi.org/10.1016/S0140-6736(13)60937-X
8. Meshram II, Arlappa N, Balakrishna N, Rao KM, Laxmaiah A, Brahmam GNV. Trends in the prevalence of undernutrition, nutrient and food intake and predictors of undernutrition among under five year tribal children in India. Asia Pac J Clin Nutr 2012; 21: 568.
9. Müller O, Krawinkel M. Malnutrition and health in developing countries. CMAJ 2005; 173: 279-86. DOI: https://doi.org/10.1503/cmaj.050342
10. Asim M, Nawaz Y. Child malnutrition in Pakistan: evidence from literature. Children 2018; 5: 60. DOI: https://doi.org/10.3390/children5050060
11. Clark SF. Iron deficiency anemia. Nutr Clin Pract 2008; 23: 128-41.
12. Auerbach M, Ballard H. Clinical use of intravenous iron: administration, efficacy, and safety. Hematol 2010, Am Soc Hematol Educ Progr B 2010; 2010: 338-47. DOI: https://doi.org/10.1182/asheducation-2010.1.338
13. Crary SE, Hall K, Buchanan GR. Intravenous iron sucrose for children with iron deficiency failing to respond to oral iron therapy. Pediatr Blood Cancer 2011; 56: 615-9. DOI: https://doi.org/10.1002/pbc.22930
14. Lerner NB. Megaloblastic anemia. In: Kliegman RM, Stanton BMD, Eds. Nelson's Textbook of Pediatrics. 20th ed. Philadelphoa Elsevier 2016; 2319-21.
15. Kakepoto GN, Iqbal MP, Iqbal SP. Megaloblastic anaemia in a hospital-based population. Med Sci Res 2000; 28: 45-8.
16. Hashim H, Tahir F. Frequency of vitamin B12 and folic acid deficiencies among patients of megaloblastic anemia. Ann pakinst Med Sci 2006; 2: 192-4.
17. Khan A, Aqeel M, Khan TA, Munir A. Pattern of hematological diseases in hospitalized paeditric patients based on bone marrow examination. J Postgrad Med Inst 2008; 22(3): 196-200.
18. Yaikhomba T, Poswal L, Goyal S. Assessment of iron, folate and vitamin B12 status in severe acute malnutrition. Indian J Pediatr 2015; 82: 511-4. DOI: https://doi.org/10.1007/s12098-014-1600-7
19. Goyal S, Tiwari K, Meena P, Malviya S, Mohd A. Cobalamin and folate status in malnourished children. Int J Contemp Pediatr 2017; 4: 1480-4.