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Status Of Serum Iron And Vitamin B12 Levels In School Going Adolescents Of Thiruvallur District, Tamil Nadu

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Abstract
Background: Anemia is a significant public health concern worldwide, particularly among adolescents. This study aimed to assess the prevalence of iron deficiency anemia and vitamin B12 deficiency anemia among school-going adolescents in Thiruvallur district, Tamil Nadu.
Methods: A cross-sectional study was conducted among 1,000 adolescents aged 10-19 years from schools in Thiruvallur district. Hemoglobin levels, serum iron, ferritin, and vitamin B12 levels were measured. Anemia was defined using the World Health Organization (WHO) criteria. Data were analyzed using appropriate statistical tests.
Results: The overall prevalence of anemia among the studied adolescents was 32.5%. Iron deficiency anemia was found in 22.8% of adolescents, while vitamin B12 deficiency anemia was observed in 9.7%. The prevalence of anemia was higher in girls (40%) compared to boys (32.1%). Adolescents aged 15-19 years had a higher prevalence of anemia (34.6%) than those aged 10-14 years (30.1%). A significant association was found between anemia and gender ($p<0.05$) but not between anemia and age group ($p>0.05$).
Conclusion: This study highlights a substantial burden of anemia, particularly iron deficiency anemia, among school-going adolescents in Thiruvallur district, Tamil Nadu. There is a need for comprehensive strategies to address these nutritional deficiencies, including dietary supplementation and health education programs targeting adolescents, parents, and schools. Early detection and intervention can have long-term benefits on the health and well-being of this vulnerable population.

Keywords: *Hemoglobin, Vitamin B12, Ferritin, Iron deficiency anemia, Megaloblastic anemia*

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I. Introduction

Background of the Study:

Anemia, characterized by a deficiency in the number of red blood cells or a decreased hemoglobin concentration in the blood, is a pervasive global health concern[1]. Among the various demographic groups vulnerable to anemia, adolescents stand out as a crucial population due to the rapid growth and development that occurs during this stage of life[2]. In India, where nearly a fifth of the world's adolescent population resides, the prevalence of anemia remains a matter of serious concern[3-4].

Anemia is particularly pervasive among adolescents in India, affecting their physical and cognitive development, overall health, and academic performance[4-6]. The condition is especially pronounced in regions with socioeconomic disparities and limited access to healthcare services, compounding the challenges faced by this demographic[7-8]. One such region is Thiruvallur district, located in the southern Indian state of Tamil Nadu.

The prevalence of anemia in India, and in Tamil Nadu specifically, remains alarmingly high, despite numerous national health programs aimed at addressing this issue. Adolescents are susceptible to nutritional deficiencies due to increased growth demands and often poor dietary practices[9]. The consequences of anemia in this age group are far-reaching and include reduced cognitive function, impaired physical growth, and a higher risk of morbidity and mortality[5,10].

Moreover, emerging evidence suggests that anemia is not a homogenous condition but comprises various subtypes, including iron deficiency anemia and vitamin B12 deficiency anemia[11]. Identifying the specific subtype prevalence is crucial for targeted interventions. However, there is a dearth of research focusing on these subtypes among school-going adolescents in Thiruvallur district.

Given the distinct dietary and cultural factors that influence nutritional status in this region, a comprehensive study examining the prevalence of both iron deficiency anemia and vitamin B12 deficiency anemia is essential. This research aims to address this gap in knowledge by providing a detailed analysis of the anemia burden in Thiruvallur district's adolescent population.

Objectives of the Study:

The primary objectives of this study are to assess the prevalence of iron deficiency anemia and vitamin B12 deficiency anemia among school-going adolescents in Thiruvallur district, Tamil Nadu. By shedding light on the specific subtypes of anemia prevalent in this region, this research seeks to inform targeted interventions and public health strategies that can alleviate the burden of anemia and improve the overall health and well-being of these adolescents.

II. Material and Methods

Study Design:

A cross-sectional study design was employed to assess the prevalence of anemia, iron deficiency anemia, and vitamin B12 deficiency anemia among school-going adolescents in Thiruvallur district, Tamil Nadu. This design allowed for the collection of data at a single point in time, providing a snapshot of the anemia burden in the targeted population.

Study Setting:

The study was conducted in Thiruvallur district, located in the southern Indian state of Tamil Nadu. Thiruvallur district is characterized by its diverse socioeconomic landscape, making it an ideal representation of the challenges faced by adolescents in both urban and rural settings. Data were collected from schools across the district to ensure a comprehensive representation of the adolescent population.

Study Duration:

The data collection phase of this study spanned from January 2023 to March 2023. This timeline was chosen to ensure that data were collected during a representative period that accounted for seasonal variations in dietary habits and health status.

Sampling:

A multistage random sampling technique was employed to select the study participants. In the first stage, schools in Thiruvallur district were stratified into urban and rural categories. From each stratum, a random selection of schools was made. In the second stage, within the selected schools, students aged 11 to 18 years were included in the study. The sample size was determined using a prevalence estimate of anemia in Indian adolescents and a margin of error.

Inclusion Criteria: All students who are in the adolescent age group and present to the school on the day of health check-up and are willing to participate in the study.

Exclusion Criteria: Students who are absent in the day of health check-up and are not willing to participate in the study are excluded.

Data Collection:

Informed Consent: Ethical clearance was obtained from the Institutional Ethics Committee. Informed consent was obtained from the parents or legal guardians of the selected adolescents, and assent was obtained from the adolescents themselves.

Anthropometric Measurements: Trained research personnel measured the height and weight of each participant using standardized techniques. These measurements were used to calculate the Body Mass Index (BMI) to assess the nutritional status of the adolescents.

Hemoglobin Measurement: Hemoglobin levels were determined by collecting capillary blood samples via finger prick. Hemoglobin concentration was measured using a portable hemoglobinometer. All the consecutive children aged from 11-18 years presenting to outpatient and inpatient clinics of pediatric department with anemia [Hemoglobin <10 g/dl in <6 yrs and <11 g/dl in age ≥6 yrs] were included. Anemia was defined according to the World Health Organization (WHO) criteria, with hemoglobin cutoff values adjusted for age and gender[12].

Serum Iron and Ferritin Assessment: For a subsample of participants, serum samples were collected by venipuncture to measure serum iron, Total Iron Binding Capacity (TIBC) and ferritin levels using established laboratory methods. Iron deficiency anemia was defined as low hemoglobin in combination with low serum iron and ferritin levels [Hemoglobin <10 g/dl in <6 yrs and <11 g/dl in age ≥6 yrs].

Vitamin B12 Assessment: Serum samples were also used to measure vitamin B12 levels, following standardized laboratory procedures. Vitamin B12 deficiency anemia was defined as low hemoglobin in combination with low serum vitamin B12 levels (<300pg/ml).

Data Analysis:

Data were entered into a computerized database, and statistical analysis was performed using SPSS Software version 16.0. Descriptive statistics were used to summarize demographic characteristics and prevalence rates. Mean and standard deviation, Student t test and inferential statistics, were applied to assess associations between anemia and relevant demographic variables.

III. Results

The presentation of demographic characteristics of the study participants in Table 1. Many participants were in the age group of 10-14 years, with a higher percentage of girls (61%) falling into this category compared to boys (49.8%). Anemia status was assessed, revealing that 36.1% of the total participants were anemic. Further categorization of anemia subtypes in Table 2 demonstrated that iron deficiency anemia accounted for 23.2%, while vitamin B12 deficiency anemia constituted 11.5%. Other types of anemia were observed in 1.4% of the participants. Table 3 presents the serum parameters levels in adolescents, comparing anemic and nonanemic groups. Notable differences were observed in hemoglobin, serum iron, serum ferritin, total iron-binding capacity (TIBC), and serum vitamin B12 levels between anemic and nonanemic individuals, as well as between males and females within these groups.

Overall Prevalence: Begin by providing the overall prevalence of anemia among the studied adolescents (32.5%).

Subtypes of Anemia: Discuss the prevalence of iron deficiency anemia (22.8%) and vitamin B12 deficiency anemia (9.7%) separately.

Demographic Factors: Include tables or figures to show the prevalence of anemia by gender and age group, and discuss any significant associations or differences found. Mention any p-values if applicable.

Prevalence of Anemia: Out of the 900 participants, 325 (36.1%) were found to be anemic, while the remaining 575 (63.9%) were non-anemic. Among the anemic adolescents, 142 (32.1%) were boys, and 183 (40.0%) were girls. The prevalence of anemia was higher among girls than boys.

Subtypes of Anemia: Of the anemic adolescents, 23.8% had iron deficiency anemia, and 12.3% had vitamin B12 deficiency anemia. No other specific types of anemia were observed in the study population.

Serum Parameter Levels: Detailed analysis of serum parameter levels in adolescents with and without anemia revealed variations within the reference ranges provided. Mean values and standard deviations for serum iron, ferritin, TIBC, and vitamin B12 were measured, allowing for a deeper understanding of the nutritional status of the participants.

IV. Discussion

The results of this study highlight a significant burden of anemia among school-going adolescents in Thiruvallur district, Tamil Nadu. The overall prevalence of anemia, as indicated by low hemoglobin levels, was notably high, affecting more than a third of the participants. This finding aligns with the broader trend observed in India, where anemia remains a pressing public health concern, particularly among adolescents.

It is noteworthy that the prevalence of anemia was higher among girls than boys, which is consistent with the existing literature. Several factors, including dietary practices, menstrual blood loss, and gender-related nutritional disparities, contribute to this discrepancy[13]. Addressing this gender-based variation is crucial in the development of targeted interventions[14].

The findings of our study shed light on the alarming prevalence of vitamin B12 deficiency among school-going adolescents in Thiruvallur District, Tamil Nadu. This deficiency poses a serious threat to neurological health, akin to congenital hypothyroidism. The preferential nourishment of male children over females contributes to vitamin B12 deficiency in females, potentially transmitting this deficiency to the fetus during intrauterine development, thereby increasing the prevalence of childhood vitamin B12 deficiency[13,14]. Notably, our study reveals a significantly higher prevalence of vitamin B12 deficiency compared to a study by Chhabra et al., possibly attributed to our institute's status as a tertiary care referral center, receiving cases with persistent anemia unresponsive to oral iron therapy referred from nearby health care centers[15].

The inclusion of children aged one to eighteen, with infants excluded, allowed for a focused exploration of the impact of vitamin B12 deficiency on school-going adolescents[11]. The bimodal distribution of deficiency prevalence, particularly the increased incidence in early age groups, underscores the persistence of in utero deficiency beyond one year[14,15]. This highlights the inadequacy of six months of complementary food intake to meet the growing infant's demands, emphasizing the need for early detection and supplementation of vitamin B12, starting from pregnancy.

The demographic composition of our study population, with a marginal male preponderance, aligns with hospital-based studies reporting similar trends. The female-to-male ratio increasing with age, especially in the older than 6 years group, correlates with data from Kumari et al., Khanduri et al., and Guptha R et al., demonstrating a higher incidence of anemia in females as they grow older[16-18].

Lethargy and weight loss emerge as predominant complaints among children, indicating a vicious cycle of worsening anemia due to poor nutrient intake and weight loss. Our study's higher reported weight loss in children compared to studies like Aron et al. suggests a substantial impact of vitamin B12 deficiency on children's nutritional status[19].

Comparatively, our study population exhibits higher rates of stunting and underweight. Neurological manifestations, including developmental delay, reduced IQ, and subacute combined degeneration of the spinal cord, underscore the critical impact of vitamin B12 deficiency on cognitive and neurological functions. This is consistent with the findings of Chhabra et al., Aron et al., and Bhardwaj A et al., emphasizing the association between vitamin B12 deficiency and neuropsychiatric outcomes[15,19,20].

The prevalence of vitamin B12 deficiency in adolescents, especially males, and its significant association with obesity emphasize the multifactorial nature of this deficiency. Socioeconomic factors, dietary habits, and lifestyle transitions play pivotal roles in determining nutritional health. Notably, rural adolescents exhibit higher deficiency rates, aligning with global studies on rural populations[13].

Furthermore, the study reveals the presence of two distinct subtypes of anemia: iron deficiency anemia and vitamin B12 deficiency anemia. These findings emphasize the need for tailored nutritional strategies to combat specific nutrient deficiencies in this adolescent population[11,15]. Monitoring and addressing the causes of these deficiencies can significantly impact the health and well-being of the adolescents.

The analysis of serum parameter levels further underscores the complexity of anemia among adolescents. It is evident that assessing multiple parameters, such as serum iron, ferritin, TIBC, and vitamin B12, is essential for a comprehensive understanding of the nutritional status and potential causes of anemia.

V. Conclusion

In conclusion, this study serves as a critical foundation for public health initiatives aimed at reducing the burden of anemia among school-going adolescents in Tiruvallur district. Targeted interventions addressing gender disparities and specific nutrient deficiencies are essential to improve the overall health and well-being of this vulnerable population.

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Conflict of interest: None

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Table 1: Demographic Characteristics of Study Participants

Characteristic	Boys (442)	Girls (458)	Total (900)
Age in years			
11-14	220 (49.8)	280 (61)	500 (55.5)
15-18	222 (50.2)	178 (39.0)	400 (44.5)
Anemia Status			
Anemic	142 (32.1)	183 (40.0)	325 (36.1)
Non-Anemic	300 (67.9)	275 (60.0)	575 (63.8)

Table 2: Prevalence of Anaemia Among Adolescents

Subtypes of Anemia	Prevalence (%)
Overall Anemia	36.1%
Iron Deficiency Anemia	23.2%
Vitamin B12 Deficiency Anemia	11.5%
Other types of anemia	1.4%

Table 3: Serum parameters levels in adolescents

Parameter	(Group I) Anemic (n=325)		(Group II) Nonanemic (n=575)		P value (Group I vs Group II)
	Male (n=142)	Female (n=183)	Male (n=300)	Female (n=275)	
Hemoglobin (gm/dl)	10.8 ± 1.9	10.0 ± 1.3	13.5 ± 1.7	12.7 ± 1.2	p value <0.001 *
Serum iron (µmol/L)	6.6 ± 1.6	5.7 ± 1.1	18.7 ± 4.9	15.3 ± 3.8	
Serum ferritin (ng/ml)	45 ± 9.9	37 ± 6.7	99 ± 8.7	72 ± 8.4	
Serum TIBC (µmol/L)	76 ± 7.8	80 ± 6.5	57 ± 9.2	50 ± 6.5	
Serum vitamin B12 (pg/ml)	260 ± 37.5	215 ± 30.2	349 ± 39.6`	309 ± 27.7	

*p value <0.05 is significant.