"DIETARY MICRONUTRIENT INADEQUACIES AND KNOWLEDGE DEFICIENCIES AMONG WOMEN AGED 20-40 YEARS IN MODERN INDIA"

Dr. Deepak Sitaramji Laddhad[1*], Prof. Dr. Rohini B. Pawar (Kulkarni)[2], Dr. Kirti Jamdar[3], Ms. Sushmita Sudhakar Sardar[4]

[1*]Director, Laddhad Hospital, Buldhana Maharashtra, President, Vision Buldhana Educational and Welfare Society, Buldhana Maharashtra, India
[2]Principal ,Vision College of Nursing, Yelgaon Buldana, Maharashtra, India.
[3]Assistant Professor, Leelabai Thackersey, College of Nursing, SNDT Women's University, Churchgate, Mumbai, Maharashtra, India
[4]Clinical Instructor, Vision College of Nursing, Yelgaon Buldana, Maharashtra, India.

Abstract
Background: Micronutrients, including vitamins and minerals, are required by the body in small quantities but play vital roles in various biochemical processes such as enzymatic reactions, gene transcription, and protection against oxidative stress (Brown et al., 2021). Deficiencies in these essential nutrients can lead to life-threatening conditions (Camaschella, 2019). Micronutrient deficiencies, often termed "hidden hunger," continue to pose significant public health challenges, particularly in low- and middle-income countries like India. Despite growing awareness, deficiencies in iron, vitamin D, calcium, and vitamin B12 remain prevalent across various age groups, especially among women and adolescents. Many of these deficiency-related conditions are preventable through dietary awareness, the promotion of a healthy and balanced diet, education, and early detection—facilitated by the use of technological and scientific advancements (World Health Organization).
Methods: This was an explorative study, used evaluative approach and conducted at Buldhanarural district of Maharashtra amongst 30 Women byusing simple random samplingmethod during the period of June 2025 to July 2025. Demographic characteristics, anthropometric measurements, blood cossllected for Hemoglobin, Calcium, Vitamin B12, Vitamin D, folate. Pretest and posttest knowledge regarding micronutrients were assessed through 30 questions. Structured teaching programme was provided after pretest data collection.
Results: Majority of the women 22 (73.33%) had Hemoglobin >12gm%, 7 (23.33%) had Mild anemia, 01(3.33%) had moderate anemia.1 (3.33%) had Vitamin D deficiency, 21(70%) had insufficient level of Vitamin D, and 2(6.66%) had folate deficiency.Majority (36.67%) of the womenwere between 36-45 years were, 56.66% were graduate and 53.14%, 50% of them were working in private sector and had 5 to 10 thousand income per month. All of them were from Buldhana-a rural district of the Maharashtra,80% are married 63.33% belong to joint family having 3 to 6 members in their family. Many of them were vegetarian, taking 2 home cook meals in the day, 46.67% of women consuming micronutrients rich food regularly.Majority of them don't have past medical history, history of anaemia or taking medication. In pre-test, women had 15.93 knowledge score and in post-test it was 23.73 knowledge score, so the mean difference was 7.80 score, which was large and statistically significant, knowledge score.
Conclusion: This study concluded that Prevalence of Micronutrient deficiency was low. Waist circumference and BMI of women is more than normal and Vitamin B12 is less in women who had inadequate knowledge regarding micronutrients, also structured teaching program was significantly effective in improving their knowledge regarding micronutrients. Statically significant was found association between vegetarian diet, income, private job and the prevalence of micronutrient deficiencies.

Keywords: Micronutrients, vitamins, minerals, life-threatening and Deficiencies

INTRODUCTION

Micronutrients, including vitamins and minerals, are required by the body in small quantities but play vital roles in various biochemical processes such as enzymatic reactions, gene transcription, and protection against oxidative stress (Brown et al., 2021). Deficiencies in these essential nutrients can lead to life-threatening conditions (Camaschella, 2019). Inadequate intake of micronutrients such as iron, calcium, zinc, vitamin A, vitamin B12, folate, and iodine often results in micronutrient deficiencies, which are considered a common form of malnutrition.

Each micronutrient plays a crucial role in maintaining overall health and preventing disease. For instance, deficiencies in iron and vitamin B12 can lead to anemia, cognitive impairments, and complications during pregnancy (Camaschella, 2019). Calcium is essential for strong bones and teeth, and also plays an important role in blood clotting, muscle contraction, nerve transmission, and

hormone secretion. In women, calcium deficiency can cause osteoporosis and premenstrual cramps. Folate deficiency during early pregnancy can result in stillbirths and neural tube defects.

Women of reproductive age, particularly those who are pregnant or lactating, have increased nutritional requirements and are therefore at a higher risk of developing micronutrient deficiencies. These deficiencies often go undiagnosed due to the lack of specific clinical symptoms (Cena & Calder, 2020).

In India, especially among low- to middle-income populations, deficiencies of iron, vitamin A, and vitamin B12 are highly prevalent. The main cause is inadequate dietary intake. Although animal-based foods are rich sources of iron, vitamin B12, and protein, less than 2% of women in Maharashtra report regular consumption of non-vegetarian food. While a well-balanced vegetarian diet can meet micronutrient needs, such diets are often unaffordable for many.

Background

Micronutrient deficiencies, often termed "hidden hunger," continue to pose significant public health challenges, particularly in low- and middle-income countries like India. Despite growing awareness, deficiencies in iron, vitamin D, calcium, and vitamin B12 remain prevalent across various age groups, especially among women and adolescents.

Inadequate intake of micronutrients and the resulting deficiencies represent a major global public health concern. According to research findings, over 5 billion people worldwide do not consume sufficient amounts of essential micronutrients. For instance, 68% of the global population lacks adequate iodine intake, 67% are deficient in vitamin E, and 66% in calcium (Food and Agriculture Organization). Women, particularly, show higher rates of inadequate intake of iodine, vitamin B12, and iron.

Micronutrient deficiencies are especially prevalent among pregnant women, primarily due to poor dietary intake and low consumption frequency of foods rich in essential nutrients. These deficiencies can have severe consequences for both the mother and the newborn, including complications during pregnancy, poor fetal development, and increased risk of maternal and infant mortality (Pathak et al., 2004).

Need of the Study

More than 2 billion people worldwide are affected by micronutrient malnutrition. While severe micronutrient deficiency disorders are more commonly reported in low- and middle-income countries, people in developed nations are also affected by various nutritional problems (Passarelli et al., 2024). Contributing factors include lack of awareness and knowledge, unhealthy lifestyles, poverty, and limited access to nutritious, micronutrient-rich foods.

Many of these deficiency-related conditions are preventable through dietary awareness, the promotion of a healthy and balanced diet, education, and early detection—facilitated by the use of technological and scientific advancements (World Health Organization). A study by Kaur et al. (2018) reported that iron deficiency anemia is highly prevalent among adolescent girls in rural India, with over 60% of the sample showing hemoglobin levels below the normal range. The study emphasized the role of nutrition education and iron supplementation in reducing the prevalence.

Kapil (2019) highlighted the widespread prevalence of vitamin A and D deficiencies in India and pointed out that these deficiencies persist even among urban populations with access to fortified foods, indicating gaps in awareness and behavior regarding nutrient intake.

In a community-based intervention study, Singh et al. (2020) conducted a nutrition education program targeting mothers of under-5 children. Post-intervention data showed a significant improvement in dietary practices and knowledge scores, suggesting the effectiveness of structured teaching interventions.

A systematic review by Bhandari et al. (2021) evaluated school-based nutrition interventions and concluded that education coupled with fortified food distribution significantly improved

micronutrient status among adolescents. However, it noted a lack of follow-up studies to assess long-term behavior change.

Gupta & Mishra (2022) emphasized the need for baseline assessment before interventions. Their study showed that only 40% of participants had basic awareness about micronutrients, and post-intervention tests showed a marked improvement in both knowledge and dietary choices.

RESEARCH METHODOLOGY:
Objectives
1. To assess the prevalence of micronutrient deficiencies among women aged 20–45 years.
2. To evaluate the existing knowledge of women (20–45 years) regarding micronutrient deficiencies.
3. To assess the dietary habits of women in the target age group.
4. To develop a treatment and teaching plan on the prevention and management of micronutrient deficiencies.
5. To implement and evaluate the effectiveness of the teaching plan.
6. To determine the association between nutritional status, socioeconomic status, and the prevalence of micronutrient deficiencies.

Study Design:
The investigator employed a survey-based evaluative research design to assess the prevalence of micronutrient deficiencies—specifically calcium, vitamin D3, vitamin B12, iron, and folate—among women aged 20 to 45 years in the Buldhana district of Maharashtra, India.

Study Area:
The study was conducted in selected rural regions of the Buldhana district, located in the state of Maharashtra, India.

Study Population:
The target population comprised women aged 20–45 years who were permanent residents of rural areas in the Buldhana district.

Inclusion Criteria:
- Women aged between 20 to 45 years.
- Women who are willing to provide informed consent and participate in the study.
- Women who are not currently taking any form of micronutrient supplements.

Exclusion Criteria:
- Women diagnosed with chronic conditions such as malabsorption syndromes.
- Women currently taking micronutrient supplements.
- Women with physical or mental disabilities that may interfere with participation in the study.

Study Duration:
The duration of the study wasthree months from May 2025 to July 2025.

Sample Size:
The study included a total of 30 women meeting the inclusion criteria.

Sampling Method:
A probability sampling technique was employed, specifically simple random sampling, to select participants from the eligible population.

Study Limitations:
Sample Size: A sample size of 30 may not provide the generalizability needed for broader conclusions.
Geographic Limitation: Since the study is focused on a specific district (Buldhana), it may not represent micronutrient deficiencies and knowledge levels in other regions.
Data Collection Bias: Self-reporting and recall bias may impact the accuracy of dietary and knowledge assessments.

Teaching Plan Components:
1. Introduction to Micronutrients.
2. Micronutrient Deficiencies
3. Micronutrient-Rich Foods
4. Barriers to Micronutrient Intake
5. Supplements and Fortified Foods
6. Promoting Healthy Eating Habits

Tool Description
Section I: Demographic and Health Profile
- Socio-demographic data (age, education, occupation, income, Geographic location (urban/rural)
- Dietary patterns (Frequency of consuming micronutrient-rich foods, Common food habits and cultural preferences that may impact micronutrient intake)
- Health status (Current health conditions, History of anemia or other micronutrient deficiencies)
- Anthropometric Measurements (Height and weight for BMI calculation)

Section II: Biochemical Assessment
Blood samples will be collected to evaluate levels of key micronutrients, including calcium, vitamin D3, vitamin B12, iron, and folate.

Grading of Anemia:
Anemia severity will be classified based on hemoglobin levels as follows:
- **Normal:** >12 g/dL
- **Mild Anemia:** 10–12 g/dL
- **Moderate Anemia:** 7–10 g/dL
- **Severe Anemia:** <7 g/dL

Section III: Knowledge Assessment
A set of multiple-choice questions (MCQs) was used to assess participants' knowledge regarding micronutrient deficiencies. Pre-Intervention and Post-Intervention knowledge assessment have been done.

Ethical Considerations:
Strict ethical protocols were followed throughout the study. Informed consent has been obtained from each participant prior to data collection. The confidentiality and anonymity of the participants were maintained, and all procedures have conducted in accordance with ethical research standards.

RESULT:
- The majority of the women, 22 (73.33%), had hemoglobin levels >12 gm/dl, indicating no anemia; 7 (23.33%) had mild anemia (10–12 gm/dl), and 1 (3.33%) had moderate anemia (7–10 gm/dl). Regarding Vitamin D levels, 1 (3.33%) woman was found to have a deficiency, while 21 (70%) had insufficient levels. In terms of folate status, 2 (6.66%) women showed a deficiency.

- Notably, none of the participants were found to have a deficiency in Vitamin B12 or serum calcium.
- Before the intervention, 43.33% of the women demonstrated an inadequate level of knowledge, whereas 56.66% had a moderate level of knowledge regarding micronutrient health.
- Dietary patterns revealed that 60% of the women were vegetarian, typically consuming two home-cooked meals per day. A total of 46.67% reported regular consumption of micronutrient-rich foods. Additionally, 26.66% were non-vegetarian, and the remaining 13.34% followed either a vegan or eggetarian diet.
- In the post-test phase, 30.00% of participants achieved a moderate level of knowledge, while 70.00% demonstrated an adequate level. A paired Student's t-test was employed to assess the effectiveness of the intervention. The mean knowledge score increased from 15.93 in the pre-test to 23.73 in the post-test, reflecting a mean difference of 7.80, which was statistically significant, indicating a substantial improvement in knowledge.
- The association between the prevalence of micronutrient deficiencies and socioeconomic status was analyzed using the Chi-square test. A highly significant association was observed between the prevalence of anemia and socioeconomic variables such as educational level, occupation, and monthly income ($p = 0.01$, $\chi^2 = 14.58$). Women with secondary education, those who were homemakers, and those with a monthly income below 5,000 were more likely to exhibit mild anemia.
- Furthermore, a significant association was identified between Vitamin D deficiency and the age groups 36–40 and 40–45 years ($p = 0.05$, $\chi^2 = 8.52$), as well as with monthly income less than ₹5,000 ($p = 0.01$, $\chi^2 = 11.36$), suggesting that both age and economic status are influential factors in the prevalence of Vitamin D deficiency among the study population.

Table 01: Prevalence of Anemia. Calcium, Vitamin D, B12 and Folate

Prevalence of Anemia		
Hemoglobin	**n**	**%**
Normal:>12 g/dL	22	73.33%
Mild Anemia: 10–12 g/dL	7	23.33%
Moderate Anemia: 7–10 g/dL	1	3.33%
Severe Anemia:<7 g/dL	0	0.00%
Prevalence of Calcium Deficiency Normal Range-8.4 -10.2 mg/dl		
Serum Calcium	**n**	**%**
Calcium Deficiency	0	0.00%
Prevalence of Vitamin D Deficiency / Insufficiency		
Vitamin D	**n**	**%**
<10 ng/dl- Deficiency	01	**3.33%**
10 to 30 ng/dl- Insufficiency	21	**70%**
Prevalence of Vitamin B12 Deficiency		
Vitamin B12	**n**	**%**
<100 pg/ml	0	0.00%
Prevalence of Vit B9/ Folate Deficiency		
Vit B9/ Folate	**n**	**%**
<2- deficiency	02	**6.66%**

Table 02: Micronutrient values

Micronutrient	Mean	Standard Deviation
Hb gm/dl	12.66	1.25
Calcium mg/dl	9.57	.64

| Vitamin D ng/dl	23.69	8.55
Vitamin B12 pg/ml	274.83	132.50
Folate (VitaminB9) ng/dl	7.39	3.37

Table03 :Comparison of Pre-test And Post-test level of knowledge score

Level of score	Pretest		Posttest		Extended McNemar's test
	n	%	n	%	
Inadequate	13	43.33%	0	0.00%	χ2=11.14 P=0.01**(S)
Moderate	17	56.66%	9	30.00%	
Adequate	0	0.00%	21	70.00%	
Total	30	100.00%	30	100.00%	

***very high significance at p<0.001

Table 03 shows that before the intervention, 43.33% of the women had an inadequate level of knowledge, 56.66% had a moderate level, and none had an adequate level of knowledge. In the post-test, no participant had an inadequate level of knowledge; 30.00% had a moderate level, and 70.00% had an adequate level of knowledge.

Fig 1: Simple bar diagram with 2 standard error bar compares the people knowledge score between pre-test and post-test score
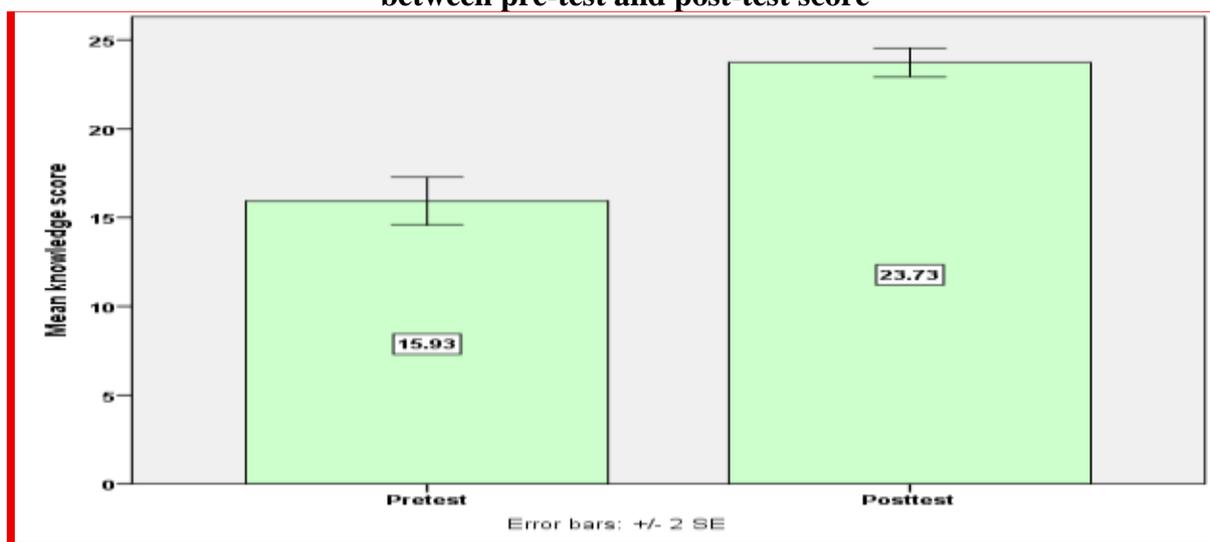
DISCUSSION:

Let S., (2024) reported prevalence of anemia in women in reproductive age were rise from 53% to 57%, It was found that women of Scheduled Tribe, poor, breast feeding and consuming fish occasionally were suffering from anemia. In present study 23.33% women in age group of 18-45 had Mild anemia 3.33% had moderate anemia. there is highly significant (p value 0.01, chi square value is 14.58) association found between prevalence of anaemia and socioeconomic status-educational level, occupation, monthly income. Women with secondary education, homemaker and having monthly income less than 5 thousand had mild anaemia. (Let S., 2024)

Sundarakumar et al. (2021) has done similar study in women, the study shown that low vitamin Dlevel (<30 ng/ml)were reported in 75.7% women, vitamin D deficiency (<20 ng/ml) was 39.1%, B12 deficiency (<200 pg/ml) 42.3& and folic acid deficiency (<3 ng/ml) was seen in 11.1% women. Low vitamin D (94.3%) and folic acid deficiency (21.8%)were noted in women aged ≥75 years. In present study 3.33% women hadvitamin D deficiency and 70% had insufficient level of vitamin D,

6.66% had folate deficiency and no one had Vitamin B12 and serum calcium deficiency. Women in age-36 to 40 and 40 to 45 yrs had reported vitamin deficiency. (Sundarakumar et al. 2021)

Shah SA (2023), supported present study, the study was done in 18-45 years working women and finding revealed that 58.3% had a normal hemoglobin level, 56% had mild anemia,23.33% history of anemia.Overall, the prevalence of anemia was 41.7%. Present study was done in women aged 18 to 45yrs, 73% were working women, out of 30women 73.33% had Hemoglobin >12gm/dl, 7 (23.33%) had Mild anemia (10-12gm/dl), 01(3.33%) had moderate anemia (7-10gm/dl).26.66% was overall prevalence of anemia in women. (Shah SA, 2023)

Qiu Y, Ding C (2021) conducted similar study. the result of the study was nutritional knowledge The mean score of women was 65.1 ± 11.8, and the awareness rate was 20.9% (95% CI: 19.6−22.3%). Significant differences ($p < 0.001$) had seen in the knowledge levels among different dimensions. Food safety dimension received highest scores (80.13), 72.05 was gained by diet–diseases dimension and 60.95 found in nutrient contents dimension. In present study 43.33% of them had inadequate level of knowledge score regarding micronutrients, 56.66% women had moderate level of score. There is significant difference ($p < 0.001$) seen in pre-test and post-test knowledge score especially in Micronutrients & their Sources domain, of women, statistical difference tested by using student paired t-test. (Qiu Y, Ding C,2021)

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