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# Knowledge, attitude, and practice toward micronutrients among adolescent girls

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## ABSTRACT

**Introduction:** Micronutrient deficiency is prevalent among adolescents in India. To promote the consumption of foods rich in micronutrients, it is essential to understand knowledge, attitude, and practices (KAP) related to micronutrients. Limited evidence is available on the KAP regarding micronutrient intake among adolescents. Therefore, this study aimed to assess KAP related to micronutrients among adolescents.

**Methods:** The study sample comprised 182 adolescent girls enrolled in grades 8-12 at a private school. Socioeconomic status and KAP were assessed by the revised Kuppuswamy's scale, 2023, and a pre-validated questionnaire, respectively.

**Results:** All participants had poor knowledge, while over half (56.3%) exhibited a moderate attitude, whereas the majority of the participants had poor practice (85.6%) toward micronutrients. The mean KAP scores were 3.21 ± 3.39, 43.93 ± 8.77, and 127.53 ± 38.94, respectively. The highest correct response was 'The optimal time to obtain Vitamin D from Sun Exposure' (43.1%), followed by 'The normal level of hemoglobin' (34.3%). More than fifty percent of the participants (56.9%) believed that it is good to consume a variety of foods every day. About practice items, the consumption of food items rich in micronutrients was lower among participants.

**Conclusion:** The knowledge and practices related to micronutrients were very limited among adolescent girls. Interventions are necessary to enhance awareness of the health benefits associated with adequate micronutrient intake. This work contributes critical baseline data that can guide the development of health policies aimed at improving outcomes for this vulnerable population group.

**Keywords:** Knowledge; attitude; practices; micronutrients; adolescents

## INTRODUCTION

Adequate nutrient intake is essential throughout the life course, particularly during adolescence, to support rapid physiological growth and development and set the groundwork for long-term good health (1). Nutritional quality and quantity consumed during adolescence profoundly impact health and well-being. Poor nutritional status is often associated with self-imposed food restrictions and unhealthy eating behaviors. Along with meal skipping and substituting them with snacks, adolescents are particularly vulnerable to fast foods, restrictive diets, and disordered eating (2-4). These factors represent the serious risks to this age group's nutritional sufficiency and quality of diets.

Inadequate intake of micronutrients and the resulting deficiencies represent one of the major challenges to global public health (5). Adolescents in India are at risk for the "triple burden" of malnutrition, which includes undernutrition, overnutrition, and micronutrient deficiencies in India (6). Key factors contributing to micronutrient deficiencies include limited dietary diversity, predominantly plant-based diets with low mineral bioavailability due to antinutritional factors, a high burden of infections and illnesses, and increased physiological demands during growth (7). Data from the Comprehensive National Nutrition Survey (2016-2018) indicate that zinc and Vitamin B12 deficiencies affect 32% and 31% of adolescents in India, respectively (6). Among adolescents, the prevalence of Vitamin A and Vitamin D deficiencies was 16% and 24%, respectively, while approximately 37% were found to have folate deficiency. A multi-center cross-sectional study by Awasthi et al. (2022) among Indian adolescents reported that the prevalence of calcium, iron, Vitamin D, and Vitamin B12 deficiencies was 59.9%, 49.4%, 39.7%, and 33.4%, respectively (8).

The Government of India has implemented various strategies to combat micronutrient malnutrition, including food fortification, micronutrient supplementation, dietary diversification, and nutrition education initiatives (9,10).

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There is a need for a comprehensive, long-term, and sustainable strategy to effectively address micronutrient deficiencies. Diet diversification is a sustainable approach to providing micronutrients and nutrition education (11,12). To promote dietary diversification and encourage the consumption of micronutrient-rich foods among adolescents, it is essential to understand their knowledge, attitudes, and practices (KAP) related to micronutrients. Such insights are critical for designing and implementing effective interventions to improve micronutrient status. Adolescence is a critical developmental stage during which individuals can be guided to take responsibility for their actions, adopt healthy behaviors, and make informed decisions that benefit both their immediate and long-term health. Therefore, the objective of the present study was to assess the KAP related to micronutrients among adolescent girls.

## METHODS

The present research was part of an intervention study to prevent hidden hunger among adolescent girls. The study was conducted at Mahatma Gandhi Mission Primary and Secondary School, Nerul, Navi Mumbai, a private school. All students belonged to the lower and middle classes. All students enrolled in grades 8-12 at the selected private school were eligible to participate in the study. Of the 220 eligible students, 21 were excluded due to the absence of signed parental consent forms, 7 due to incomplete data, and 10 were absent on the day of the baseline survey. Thus, a total of 182 adolescent girls were included in the study.

All school-going girls between the ages of 13 and 18 who provided their assent to participate in the study were included.

Girls suffering from any chronic disease were excluded from the study. Detailed explanations about the study were given to participants and their parents with the help of an information sheet. After the discussion with them, the information sheet, consent, and assent form were given to them.

Data were collected on participants' age, education, and dietary habits, along with family-related variables, such as household income, and the education and occupation of the head of the family.

Socioeconomic status (SES) was assessed using the Revised Kuppuswamy's Socioeconomic Scale (13). Kuppuswamy's Scale is one of the most commonly used tools for assessing the SES of urban populations in India. It evaluates the primary earning member of a household based on three key parameters: education level, occupation, and monthly income. Since income levels and the cost of living are influenced by inflation, it is crucial to use a regularly updated version of the scale that reflects changes in the Consumer Price Index (CPI). This ensures that socioeconomic classification remains accurate and relevant over time. The cut-off scores in the Kuppuswamy's SES Scale were used to categorize families into different socioeconomic classes based on the total score derived from: education of the head of the family (scored 1-7), occupation of the head of the family (scored 1-10), and monthly family income (scored 1-12, updated based on CPI). The total score (ranging from 3 to 29) classifies the SES into the following five classes: Upper class (26-29), upper-middle Class (16-25), lower-middle Class (11-15), upper-lower class (5-10), lower class (<5).

KAPs were assessed by a 134-item self-designed and validated questionnaire. The development and validation of the questionnaire have been described in detail elsewhere (14). The psychometric properties of the questionnaire were evaluated through assessments of face validity, content validity, and construct validity using exploratory factor analysis with the principal axis method. Internal consistency was determined using Cronbach's alpha ($\alpha > 0.7$), and test-retest reliability was assessed using intraclass correlation coefficients (ICC > 0.7). The instrument demonstrated good internal consistency and acceptable to good test-retest reliability. Item-level content validity indices for clarity and relevance were also found to be satisfactory.

The total raw scores for knowledge (0-63), attitude (21-63), and practice (0-330) were converted into percentages. Scores of 75% and above were classified as good, 51-74% as moderate, and 50% or less as poor for KAP.

Ethical approval for the study was obtained from the Institutional Ethics Committee of MGM Institute of Health Sciences.

Statistical analyses were conducted using the Statistical Package for the Social Sciences for Windows, version 25.0. Continuous variables were summarized as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Pearson's correlation coefficient was used to assess the relationships between knowledge, attitude, and practice scores.

Data can be accessed upon reasonable request.

## RESULTS

The mean age of the participants was 15.04 ± 1.38 years. The majority (65.7%) belonged to the 13-15 years age group. The fifty participants (50.5%) belonged to the nuclear family. Just over half of the participants (55.2%) were from upper lower socioeconomic backgrounds. More than two-thirds of the participants were non-vegetarian, and nearly one-third of them were ovo-vegetarian. The socio-demographic profile and food habits of the participants are shown in Table 1.

All participants had poor knowledge, more than fifty percent of the participants (56.3%) had a moderate attitude, whereas the majority of the participants had poor practice (85.6%) toward micronutrients.

The mean score for knowledge was 3.21 ± 3.39. The highest correct response was "The best time to get Vitamin D from Sun Exposure" (43.1%), followed by "The normal level of hemoglobin" (34.3%). Less than one-fifth of the participants answered correctly about the name of the nutrients (14.9%), micronutrients (13.8%), and micronutrient supplements available in the market (14.4%). A small number of the participants answered correctly about the sources and ways to prevent micronutrient deficiency (5-10%), and an insignificant number of participants responded correctly about the causes and deficiency of micronutrient deficiency (>5%). Knowledge of foods that enhance or inhibit iron absorption was limited among participants (Table 2).

The mean score of attitude items was 43.93 ± 8.77. More than fifty percent (56.3%) of adolescents had uncertainty about micronutrient importance. Nearly one-third of the

**TABLE 1.** Sociodemographic characteristics and food habits of study participants

| Variables | n (%) |
|---|---|
| Age≠ | 15.04±1.38 |
| 13-15 years | 119 (65.7) |
| 16-18 years | 63 (34.3) |
| Religion | |
| Hindu | 161 (88.5) |
| Muslim | 6 (3.3) |
| Christian | 4 (2.2) |
| Others | 11 (6.0) |
| Family Type | |
| Nuclear | 92 (50.5) |
| Joint | 90 (49.5) |
| Education of the participants | |
| 8th | 42 (23.1) |
| 9th | 38 (20.9) |
| 10th | 59 (32.4) |
| 11th | 23 (12.6) |
| 12th | 20 (11) |
| Head of the family | |
| Father | 167 (91.76) |
| Mother | 12 (6.59) |
| Grandparents | 3 (1.64) |
| Education of the head of the family | |
| Up to primary | 25 (13.81) |
| Up to middle school and above | 127 (69.7) |
| Graduation and above | 30 (16.57) |
| Occupation of the head of the family | |
| Unskilled worker (Domestic servant, peon, watchman) | 44 (24.31) |
| Skilled and Semi-skilled worker (Driver, carpenter, factory labourer) | 113 (62.43) |
| Arithmetic skill jobs | 17 (9.39) |
| Professional and Semi professional | 7 (3.87) |
| Socioeconomic class | |
| Lower | 21 (11.5) |
| Upper Lower | 100 (55.2) |
| Lower middle | 48 (26.37) |
| Upper Middle | 13 (7.0) |
| Food Habits | |
| Vegetarian | 33 (18.1) |
| Non-vegetarian | 121 (66.5) |
| Eggetarian | 28 (15.4) |

≠Mean±SD

**TABLE 2.** Responses to knowledge items related to micronutrients among adolescent girls

| S. No. | Knowledge items | Correct answer n (%) |
|---|---|---|
| 1. | Name the nutrients | 27 (14.9) |
| 2. | Name micronutrients | 25 (13.8) |
| 3. | Sources of micronutrients | |
| | a. Vitamin A | 13 (7.2) |
| | b. Vitamin B12 | 9 (5) |
| | c. Vitamin D | 20 (11.1) |
| | d. Folate | 3 (1.7) |
| | e. Vitamin C | 15 (8.3) |
| | f. Calcium | 20 (11.1) |
| | g. Iron | 6 (3.3) |
| | h. Zinc | 2 (1.1) |
| 4. | Symptoms of micronutrient deficiency | |
| | a. Vitamin A | 4 (2.2) |
| | b. Vitamin B12 | 3 (1.7) |
| | c. Vitamin D | 3 (1.7) |
| | d. Folate | 0 |
| | e. Vitamin C | 2 (1.1) |
| | f. Calcium | 6 (3.3) |
| | g. Iron | 0 |
| | h. Zinc | 0 |
| 5. | Causes of micronutrient deficiency | |
| | a. Vitamin A | 2 (1.1) |
| | b. Vitamin B12 | 0 |
| | c. Vitamin D | 3 (1.7) |
| | d. Folate | 0 |
| | e. Vitamin C | 1 (0.6) |
| | f. Calcium | 1 (0.6) |
| | g. Iron | 0 |
| | h. Zinc | 0 |
| 6. | Ways to prevent micronutrient deficiencies | 14 (8.2) |
| 7. | The normal level of hemoglobin | 62 (34.3) |
| 8. | Name the foods that increase iron absorption | 12 (6.6) |
| 9. | Name the foods that decrease iron absorption | 7 (3.9) |
| 10. | Name the vitamin that increases calcium absorption | 12 (6.6) |
| 11. | Name the micronutrient supplements available in the market | 26 (14.4) |
| 12. | The best time to get Vitamin D from Sun Exposure | 78 (43.1) |

participants agreed that they may have a deficiency of nutrients. More than fifty percent of the participants (56.9%) believed that it is good for you to consume a variety of foods every day. Fifty percent of the participants were interested in knowing that micronutrients are good for their health. More than two-fifths of the participants agreed to eat non-vegetarian foods regularly (Table 3).

The mean score of practice items (according to food groups) is mentioned in Table 4. The consumption of food items rich in micronutrients was lower among participants. Except for cereals, pulses, milk, and milk products, the consumption of other foods, of fruits, vegetables, non-vegetarian foods, and nuts was only thirty percent (in comparison to the maximum score).

The practice section also included items related to sunlight exposure, cooking methods, dietary enhancers and inhibitors of micronutrient absorption, and supplementation practices. Less than one-fifth of the participants (16.6%) had ever gone for estimation of micronutrients, and only 6.1% of participants take micronutrient supplements. The majority of them were not aware of deworming tablets, and 86% of them reported not taking them. Iron-based cooking vessels were used in only 34% of participants' households rest of them were not aware of or were not using them. Nearly 5-10% of the participants only had the practice of consuming Vitamin C-rich foods along with their meals. While 31% consumed tea and 41% consumed coffee, along with the meals or immediately after the meals. The exposure to sunlight was usually from 7 am to 11 am for about 15 min among most of the participants (78%). Only 15% of them used sun protection, of which 16%

**TABLE 3.** Responses to attitude statements related to micronutrients among adolescent girls

| Items on attitude | | Agree | Undecided | Disagree |
|---|---|---|---|---|
| | | n (%) | | |
| 1. | Do you think you may have a deficiency of the following nutrients? | | | |
| 1a. | Vitamin A | 53 (29.3) | 83 (45.3) | 46 (25.4) |
| 1b. | Vitamin B12 | 50 (27.6) | 82 (44.8) | 50 (27.6) |
| 1c. | Vitamin D | 58 (32) | 78 (42.5) | 46 (25.4) |
| 1d. | Folate | 48 (26.5) | 87 (47.5) | 47 (26) |
| 1e. | Vitamin C | 50 (27.6) | 85 (46.4) | 47 (26) |
| 1f. | Calcium | 55 (30.4) | 83 (45.3) | 44 (24.3) |
| 1g. | Iron | 52 (28.7) | 83 (45.3) | 47 (26) |
| 1h. | Zinc | 49 (27.1) | 84 (46.4) | 48 (26.5) |
| 2. | Do you think micronutrient deficiency is harmful to health | 78 (43.1) | 58 (31.5) | 46 (25.4) |
| 3. | It is good for you to consume a variety of foods every day | 103 (56.9) | 28 (14.9) | 51 (28.2) |
| 4. | It is not difficult for you to consume different types of food every day | 83 (45.9) | 43 (23.2) | 56 (30.9) |
| 5. | Knowing more about micronutrients is good for your health | 94 (51.9) | 22 (11.6) | 66 (36.5) |
| 6. | Daily, we should eat fruits and vegetables | 94 (51.9) | 7 (3.3) | 81 (44.8) |
| 7. | Daily, we should consume milk and milk products | 91 (50.3) | 27 (14.4) | 64 (35.4) |
| 8. | We should consume meat regularly | 75 (41.4) | 46 (24.9) | 61 (33.7) |
| 9. | We should consume fish regularly | 79 (43.6) | 45 (24.3) | 58 (32) |
| 10. | We should consume eggs and chicken regularly | 76 (42) | 42 (22.7) | 64 (35.4) |
| 11. | Daily, we need to get sun exposure | 93 (51.4) | 14 (7.2) | 75 (41.4) |
| 12. | Personal hygiene is important to prevent micronutrient deficiencies | 98 (54.1) | 26 (13.8) | 58 (32.0) |
| 13. | Nutrition awareness and education are important to prevent and control the nutritional deficiencies | 90 (49.7) | 20 (10.5) | 72 (39.8) |
| 14. | Micronutrient supplementation is important to prevent and control deficiencies | 64 (35.4) | 62 (33.7) | 56 (30.9) |

used a scarf to cover the face, and only 6% used sunscreen lotion but not regularly.

In addition, the Pearson correlation coefficients were calculated to assess the relationships among KAP scores. A positive but statistically insignificant correlation was observed between knowledge and attitude scores (r = 0.115, p = 0.122), as well as between knowledge and practice scores (r = 0.133, p = 0.074) (Table 5).

**TABLE 4.** Mean scores of practice items by food groups among adolescent girls

| Food groups | Mean±SD | Max score |
|---|---|---|
| Cereals | 12.78±5.10 | 30 |
| Pulses | 7.90±2.88 | 12 |
| Milk and milk products | 18.46±8.76 | 42 |
| Leafy vegetables | 17.61±9.06 | 54 |
| Other vegetables | 21.82±8.69 | 54 |
| Fruits | 16.73±10.02 | 48 |
| Non-veg | 8.56±5.81 | 24 |
| Nuts | 23.84±13.26 | 66 |
| Total practice score | 127.53±38.94 | 330 |

SD: Standard deviation

**TABLE 5.** Association between knowledge, attitude, and practice scores

| Scale | Pearson's correlation coefficient (r, *p*-values) | |
|---|---|---|
| | Attitude | Practice |
| Knowledge | 0.115, 0.122 | 0.133, 0.074 |

## DISCUSSION

The study assessed the KAPs toward micronutrients: iron, calcium, zinc, folic acid, and Vitamins A, D, B12, and C using a pre-validated questionnaire among adolescent girls. Most studies have assessed KAP about overall nutrition among adolescents and their parents and teachers (15-19). Very few studies have investigated the KAP of micronutrients among adolescents (20,21).

The present study's findings revealed that most participants had a very poor knowledge regarding all aspects of micronutrients, including their food sources, causes, and symptoms of deficiency. This poor knowledge might be due to the inadequate access to and availability of information on micronutrients. Augustine et al. (2012) have documented higher levels of knowledge about micronutrients among adolescent boys compared to those observed in the present study (21). Similarly, another study conducted among the age group of 14-16-year-old adolescents to assess KAP about micronutrients found that the level of knowledge was higher among them than in the present study (20). This discrepancy may be explained by variations in socio-demographic characteristics, differences in the questionnaire content, and the use of open-ended questions in the present study.

Among micronutrients, iron, calcium, and Vitamin D have been studied for KAP among adolescents (22-26). Extensive research has been carried out on iron (24,25,27-29). In the present study, the majority of adolescents (96%) lacked knowledge about iron-rich foods, a finding consistent with a study conducted in Palestine, where approximately 90% of adolescents showed limited awareness of such foods (29). A study by Latha and Mohan et al. in India reported that the majority of adolescents had greater knowledge about iron-rich foods, which contrasts with the findings of the present study (27). Another study by Wiafe on KAP related to iron found that 31.4% of the participants were aware of the food sources of iron (24). Similarly, the percentage of participants who were aware of foods that enhance iron absorption was lower compared to observations from

previous studies (28). With regards to Vitamin D, a study by Tariq et al estimated that only 9% of participants were able to correctly identify food sources of Vitamin D, and this result concurred with the present study (22).

With regards to the attitude subscale, the majority of them were undecided about their susceptibility to micronutrient deficiency. Furthermore, they had a positive attitude toward the importance of knowing about micronutrients, consuming micronutrient-rich food sources, and sanitary and hygiene practices to prevent micronutrient deficiencies. This positive attitude toward knowing about micronutrients can be beneficial in the planning and implementation of nutrition education interventions.

The results of micronutrient-rich foods consumption-related practices (lower mean scores) showed lower consumption of micronutrient-rich food sources, specifically, fruits, green leafy vegetables, milk products, non-vegetarian foods, and nuts and oilseeds. Similarly, a study conducted to assess the KAP related to Vitamin D showed poor consumption of food-rich Vitamin D among college students (23). The present study found that participants with greater knowledge about food sources of micronutrients also tended to have higher intake of micronutrient-rich foods, although this association was not statistically significant. These findings are consistent with Wiafe et al. (2021), who reported a positive relationship between knowledge of iron-rich food sources and increased consumption of iron-rich foods, including chicken, fresh fish, and dried fish (24). This lower consumption might be due to the lack of knowledge about the importance and benefits of consuming micronutrient-rich foods.

Responses to other micronutrient-related practices showed that most participants had neither undergone any laboratory micronutrient estimation nor taken any micronutrient supplementation. All of them followed good hygiene and sanitary practices. For practices related to improving iron absorption, only very few of the participants were aware of deworming tablets and had taken them in recent times. The consumption of Vitamin C-rich foods alongside meals to enhance iron absorption was notably low. While intake of inhibitors, such as tea or coffee, along with meals was found to be more common. A similarly low consumption of Vitamin C-rich fruits, coupled with higher intake of tea and coffee, was reported in a study by Huong et al. (30). This may be attributed to limited knowledge and awareness about the right practices that can increase nutrient/iron absorption. With regards to sun exposure, the majority of them are exposed for at least 20-30 min of sun exposure every day. This is because many of the girls come to the school on foot, and the physical activity period is usually between 11-12 am, and 4-5 pm based on the school shift timings. Most of the girls do not use sunscreen lotion. They use only a hat or scarf for sun protection, and that too, not regularly. There are research studies also suggesting sunlight exposure to at least 15% of the body surface area, such as the face, hands, and arms, or equivalent area, to prevent a shortfall of Vitamin D, yet accurate recommendations are difficult due to various factors influencing cutaneous synthesis of Vitamin D (31).

Understanding the KAPs is very important for better implementation of nutrition intervention programs and in controlling these micronutrient deficiencies (32). These findings highlight the need for designing and implementing a nutrition education intervention aimed at improving KAP toward micronutrients among adolescent girls.

One of the major strengths of this study is the use of a validated questionnaire to assess KAP regarding micronutrients. There is very limited research that has been done on validated questionnaires that cover micronutrients, a critical concern in developing countries, such as India. Second, unlike most previous studies that focused on a single micronutrient, the present study assessed KAP related to eight different micronutrients collectively.

Certain limitations should be considered when interpreting the findings of this study. The generalizability of the results may be restricted due to the use of purposive sampling and the study being conducted in an urban setting.

## CONCLUSION

This study depicts the lack of knowledge related to micronutrient and their importance among adolescent girls. Nevertheless, the majority of adolescent girls exhibited a positive attitude toward gaining knowledge about micronutrients. There is also a need to improve dietary practices and other associated practices to prevent micronutrient deficiencies. Understanding other important factors, such as dietary habits related to micronutrients, good hygiene and sanitation, and disease prevention measures, is also important in reducing the risks of micronutrient deficiencies. Therefore, intervention programs should comprehensively address all aspects of micronutrients to effectively improve KAP among adolescent girls, which can help not only in preventing micronutrient deficiencies but also in early detection and management of the same.

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## DECLARATION OF INTEREST

Authors declare no conflict of interest.

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