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RESEARCH ARTICLE

ASSESSMENT OF MALNUTRITION AND NUTRITIONAL STATUS OF UNDERWEIGHT ADOLESCENT GIRLS IN NAMAKKAL DISTRICT, TAMIL NADU: A COMMUNITY-BASED CROSS-SECTIONAL STUDY

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Abstract

Adolescent undernutrition remains a major public health concern in India, particularly among girls from rural and economically disadvanta ged communities. The present study was undertaken to assess the prevalence of malnutrition and evaluate the nutritional status of underweight adolescent girls in Namakkal District, Tamil Nadu. A community-based cross-sectional study was conducted among 250 underweight adolescent girls aged 12–19 years selected from rural and urban areas of Namakkal District. Data were collected using a pre-tested structured questionnaire. Anthropometric measurements, haemoglobin estimation, clinical examination, dietary assessment, and knowledge, attitude, and practice (KAP) assessment were carried out using standardized procedures. Nutrient intake was compared with the Indian Council of Medical Research recommended dietary allowances, and a nutrition education intervention was implemented for a subgroup of participants. The findings revealed that 69.6% of the participants were thin and 30.4% were severely thin according to WHO BMI-for-age standards. Anaemia was present in 75.2% of the participants, and pallor was the most common clinical sign (67.2%). Mean haemoglobin concentration was 10.8 ± 1.4 g/dL. Dietary assessment showed inadequate intake of calcium (54.1% adequacy), iron (61.2% adequacy), and dietary fiber (58.7% adequacy), despite relatively adequate intake of energy and protein. Breakfast skipping (58.4%), low milk consumption (32.8%), low green leafy vegetable intake (27.6%), and low fruit intake (21.6%) were common. Rural residence, low socio-economic status, breakfast skipping, anaemia, and inadequate milk consumption were significantly associated with severe thinness ($p < 0.05$). The nutrition education intervention resulted in significant improvement in KAP scores.

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The study concludes that underweight adolescent girls in Namakkal District experience a high burden of chronic energy deficiency, anaemia, and micronutrient inadequacy, emphasizing the need for integrated nutritional interventions and sustained nutrition education.

Introduction:-

Adolescence represents one of the most dynamic and nutritionally demanding stages of the human life course. During this period, rapid physical growth, sexual maturation, cognitive development, and psychosocial changes substantially increase the requirements for energy, protein, iron, calcium, and other essential micronutrients. The World Health Organization (WHO, 2005) reported that nearly half of adult body weight, 20% of adult height, and a significant proportion of skeletal mass are attained during adolescence. Consequently, inadequate nutrition during this stage can result in impaired growth, reduced learning capacity, decreased physical performance, weakened immunity, and adverse reproductive outcomes in later life.

The importance of adolescent nutrition has gained global attention in recent years. The Lancet Commission on Adolescent Nutrition (2021) emphasized that adolescence constitutes a "second window of opportunity" for correcting earlier nutritional deficits and preventing the intergenerational transmission of malnutrition. The Commission further highlighted that failure to improve adolescent nutrition undermines human capital development and contributes to long-term health and economic losses.Despite economic progress and improvements in child health indicators, India continues to experience a substantial burden of adolescent undernutrition and anaemia. Using nationally representative Comprehensive National Nutrition Survey (CNNS 2016–18) data, Kumar and Mohanty (2023) reported that the prevalence of stunting, thinness, and anaemia among Indian adolescents was 27.2%, 24.1%, and 28.5%, respectively. Their multivariable analysis demonstrated that adolescents from the poorest households had significantly higher odds of thinness (OR 1.68) and anaemia (OR 1.66), while low dietary diversity and poor hygiene practices were also independently associated with undernutrition. These findings underscore the strong influence of socio-economic and behavioural factors on adolescent nutritional outcomes.

Gender inequalities further intensify the nutritional vulnerability of adolescents. Adolescent girls are particularly susceptible because of the combined effects of rapid growth, onset of menstruation, increased iron requirements, and sociocultural disparities in food allocation and health care. Salam et al. (2014), in a systematic review and meta-analysis of adolescent health interventions, concluded that girls in low- and middle-income countries bear a disproportionate burden of undernutrition and micronutrient deficiencies, with important implications for future maternal and child health.Dietary quality has emerged as a critical determinant of adolescent nutritional status. Recent evidence suggests that inadequate dietary diversity, low consumption of dairy products, fruits, vegetables, and other nutrient-dense foods are strongly associated with thinness and anaemia. Kumar and Mohanty (2023) demonstrated that adolescents with low dietary diversity had significantly higher odds of undernutrition, emphasizing that calorie intake alone is insufficient to ensure nutritional adequacy. Similar concerns regarding poor dietary practices and limited awareness of iron-rich foods were reported by Rokade, Gore, Jadhav, and Muley (2024) among school-going adolescents in Maharashtra, where inadequate nutrition knowledge and unhealthy dietary habits were closely linked to anaemia-related risk. Behavioural factors such as meal skipping and irregular eating patterns also contribute substantially to adolescent malnutrition. Earlier Indian studies by Deshmukh et al. (2013) and Meshram et al. (2012) showed that breakfast skipping was associated with lower body mass index and inadequate nutrient intake, while regular consumption of milk and iron-rich foods was positively related to growth and haemoglobin status. These findings indicate that both food availability and eating behaviour are important determinants of adolescent health.

Anaemia remains one of the most widespread nutritional disorders among adolescent girls in India. Community-based studies from different regions of the country have consistently documented a high prevalence of anaemia associated with inadequate intake of iron-rich foods, poor dietary diversity, and low socio-economic status. Recent public health evidence from Indian school and community settings suggests that anaemia among adolescent girls is increasingly linked not only to iron deficiency but also to broader micronutrient inadequacies and poor-quality diets. This highlights the need to move beyond a supplementation-only approach toward comprehensive dietary improvement.Tamil Nadu, although relatively advanced in several health indicators, continues to face significant nutritional challenges among adolescents, particularly in rural and economically disadvantaged populations. Limited dietary diversity, low consumption of milk, green leafy vegetables, and fruits, and inadequate nutrition awareness remain important concerns. However, district-level evidence focusing specifically on underweight adolescent girls is scarce, and data from Namakkal District are particularly limited.

Nutrition education has been identified as a promising strategy for improving adolescent dietary behaviour. Contento (2011) emphasized that interactive and behaviour-oriented nutrition education is more effective than traditional didactic approaches in promoting sustainable dietary change. Intervention studies among Indian adolescents have reported significant improvements in nutrition knowledge, attitudes, and healthy food practices following structured education programmes, suggesting that adolescents are receptive to well-designed nutrition messages.In this context, the present study was undertaken to assess the nutritional status and anthropometric, biochemical, clinical, dietary, and behavioural characteristics of underweight adolescent girls. The study specifically aimed to examine their anthropometric, biochemical, clinical, dietary, and behavioural characteristics and to evaluate the effect of nutrition education on knowledge, attitude, and practice related to nutrition. By generating district-specific evidence, the study seeks to contribute to the development of targeted and contextually relevant interventions for improving the nutritional status of adolescent girls and preventing the long-term and intergenerational consequences of malnutrition.

Methodology:-

Study Design:

The present study entitled "Prevalence of Malnutrition and Nutritional Status of Underweight Adolescent Girls in Namakkal District" was conducted using a community-based cross-sectional descriptive research design. A cross-sectional design was considered appropriate because it allows assessment of nutritional status and associated factors at a single point in time and is commonly used in public health and nutrition research. In addition, a nutrition education programme was conducted among a small subgroup of 20 participants, with KAP scores assessed before and after the intervention. No separate control or comparison group was included, as the primary study was a cross-sectional descriptive survey.

Study Area:

The study was carried out in selected rural and urban areas of Namakkal District, Tamil Nadu, India, during the academic year 2025–2026. Inclusion of both rural and urban settings was intended to obtain a broader representation of adolescent girls from different socio-economic and environmental backgrounds.

Study Population and Sample Selection:

The study population consisted of adolescent girls aged 12–19 years residing in the selected areas of Namakkal District. A total of 250 underweight adolescent girls were included in the study. Participants were identified through preliminary screening based on body mass index (BMI)-for-age criteria. Purposive sampling technique was adopted because the study specifically focused on underweight adolescents who were considered nutritionally vulnerable.

Data Collection Procedure:

Data collection was carried out through direct personal interviews and physical examination of the selected participants. Prior to data collection, the purpose and significance of the study were explained to the participants, and informed consent was obtained. Information was collected using a pre-tested structured questionnaire prepared specifically for the study.The questionnaire included sections on socio-demographic characteristics, educational details, type of family, socio-economic status, household expenditure pattern, dietary habits, meal pattern, and knowledge, attitude, and practices related to nutrition. The interviews were conducted in the local language to ensure better understanding and accuracy of responses. Each participant was interviewed individually, and the completed questionnaires were checked for completeness on the same day.

Anthropometric Assessment:

Anthropometric measurements were performed using standardized procedures recommended by the World Health Organization. Height was measured using a portable stadiometer with the participant standing barefoot in an erect posture and the head positioned in the Frankfurt plane, and the measurement was recorded to the nearest 0.1 cm. Body weight was measured using a calibrated digital weighing scale with participants wearing light clothing and no footwear, and the value was recorded to the nearest 0.1 kg. Body mass index (BMI) was calculated by dividing body weight in kilograms by the square of height in meters. Nutritional status was interpreted using WHO BMI-for-age Z-score standards for girls aged 5–19 years, which are internationally accepted for assessing thinness and severe thinness among adolescents (WHO, 2006; WHO, 2007). Similar anthropometric assessment procedures have been used in large-scale cross-sectional studies such as the Comprehensive National Nutrition Survey (CNNS, 2016–18) and the National Family Health Survey (NFHS-5, 2019–21).

Biochemical Assessment:
Biochemical assessment was carried out to determine the haemoglobin status of the participants, as iron deficiency anaemia is one of the most prevalent micronutrient deficiencies among adolescent girls. Blood samples were collected and analysed using standard laboratory procedures available in the study setting. Haemoglobin values were interpreted according to WHO criteria for adolescent girls, and participants were categorized as normal, mildly anaemic, moderately anaemic, or severely anaemic (WHO, 2011). Assessment of haemoglobin concentration is considered an essential component of adolescent nutritional evaluation because anaemia frequently coexists with underweight and chronic energy deficiency, particularly in populations with poor dietary diversity and inadequate intake of iron-rich foods (Salam et al., 2014; NFHS-5, 2019–21).

Clinical Assessment:
Clinical examination was conducted under adequate natural light to identify visible signs suggestive of nutritional deficiencies. The assessment included observation of pallor, changes in hair texture and colour, skin abnormalities, angular stomatitis, glossitis, nail changes, and general health condition. Clinical assessment provides supportive evidence for identifying probable deficiencies of iron, protein, and other essential micronutrients and is widely recommended in community nutrition surveys and nutritional assessment studies (Gibson, 2005; WHO, 2005).

Dietary Assessment:
Dietary intake was assessed using the multiple-pass 24-hour dietary recall method. Each participant was asked to recall all foods and beverages consumed during the previous 24 hours, including ingredients, cooking methods, and portion sizes. Standard household measures such as cups, spoons, bowls, and glasses were used to improve the accuracy of portion size estimation. The recorded foods were converted into raw food equivalents, and nutrient intake was calculated using the Indian Food Composition Tables (IFCT, 2017). In addition, a semi-quantitative food frequency questionnaire was administered to assess the habitual consumption of cereals, pulses, milk and milk products, green leafy vegetables, other vegetables, fruits, eggs, meat, fish, and snack foods. Combining 24-hour dietary recall with food frequency assessment is recommended for cross-sectional nutritional studies because it captures both quantitative intake and usual dietary patterns (Gibson, 2005; Willett, 2013).

Knowledge, Attitude, and Practice Assessment:
Knowledge, attitude, and practices related to nutrition were assessed using a structured KAP questionnaire. The questionnaire evaluated awareness regarding balanced diet, importance of breakfast, iron-rich foods, calcium-rich foods, healthy meal patterns, and prevention of anaemia. KAP assessment is commonly used in public health nutrition research to examine the relationship between nutrition knowledge and actual dietary behaviour among adolescents (Contento, 2011; Sharma et al., 2020).

Nutrition Education Intervention:
After completion of the baseline assessment, a nutrition awareness programme was conducted for a subgroup of participants. The intervention included interactive lectures, poster presentations, PowerPoint demonstrations, and group discussions focusing on balanced diet, dietary diversification, iron and calcium intake, healthy eating habits, and prevention of malnutrition and anaemia. Educational interventions of this nature have been shown to improve nutrition knowledge and encourage healthier dietary choices among adolescents in school and community settings (Contento, 2011; Salam et al., 2014). Knowledge was reassessed after the intervention to evaluate immediate changes in awareness and understanding.

Ethical Considerations:
Ethical principles were followed throughout the study. The study objectives and procedures were explained to all participants, and written informed consent was obtained from participants aged 18 years and above. For participants below 18 years of age, informed consent was obtained from their parent or legal guardian, and assent was obtained from the participants before enrolment in the study.Participation was voluntary, with the right to withdraw at any time without penalty. Confidentiality and anonymity were maintained, and the collected information was used solely for academic and research purposes and securely stored with access restricted to the researcher.

Statistical Analysis:
The collected data were coded, entered and analysed using IBM SPSS Statistics version 25.0. Descriptive statistics, including frequency, percentage, mean and standard deviation, were used to summarize the study variables. The Chi-square test was used to assess associations between categorical variables. A paired **t**-test was used to compare

pre- and post-intervention KAP scores among the 20 participants who received nutrition education. A p-value of <0.05 was considered statistically significant.

Results and Discussion:-

Baseline characteristics of the study participants

Table 1. Socio-demographic characteristics of the participants (n = 250)

Variable	Number (%)
Age 12–15 years	80 (32.0)
Age 16–19 years	170 (68.0)
Rural residence	158 (63.2)
Urban residence	92 (36.8)
Nuclear family	176 (70.4)
Joint family	74 (29.6)
Low socio-economic status	121 (48.4)
Middle socio-economic status	97 (38.8)
High socio-economic status	32 (12.8)

The majority of the participants were late adolescents aged 16–19 years (68.0%), belonged to rural areas (63.2%), lived in nuclear families (70.4%), and were from low socio-economic households (48.4%). These findings indicate that undernutrition was concentrated among socially and economically vulnerable groups.

Table 2. Anthropometric and biochemical characteristics of the participants (n = 250)

Variable	Mean ± SD
Height (cm)	154.8 ± 5.9
Weight (kg)	39.6 ± 4.8
BMI (kg/m²)	16.5 ± 1.2
Haemoglobin (g/dL)	10.8 ± 1.4

The mean BMI of 16.5 ± 1.2 kg/m² confirms the presence of chronic energy deficiency among the selected adolescent girls. The mean haemoglobin concentration was below the WHO cut-off of 12 g/dL, indicating a substantial burden of anaemia.

Table 3. Nutritional status, anaemia, clinical signs, and dietary practices (n = 250)

Variable	Number (%)
Thinness (< -2 SD)	174 (69.6)
Severe thinness (< -3 SD)	76 (30.4)
Anaemia present	188 (75.2)
Pallor	168 (67.2)
Skipping breakfast	146 (58.4)
Daily milk consumption	82 (32.8)
Daily green leafy vegetable consumption	69 (27.6)
Daily fruit consumption	54 (21.6)

Nearly one-third of the participants were severely thin, and more than three-fourths were anaemic. Pallor was the most common clinical sign. Breakfast skipping was highly prevalent, while regular consumption of milk, green leafy vegetables, and fruits was low, indicating poor dietary diversity and inadequate intake of nutrient-rich foods.

Table 4. Mean nutrient intake and adequacy among underweight adolescent girls (n = 250)

Nutrient	Mean intake (Mean ± SD)	ICMR RDA	Adequacy (%)
Energy (kcal)	2096 ± 85.3	1900	110.3
Carbohydrates (g)	295.31 ± 11.4	270	109.4

Protein (g)	62.56 ± 2.42	55	113.7
Fat (g)	89.26 ± 3.14	55	162.3
Calcium (mg)	541.23 ± 26.4	1000	54.1
Iron (mg)	12.86 ± 1.56	21	61.2
Dietary fiber (g)	14.68 ± 2.65	25	58.7
Water (glasses/day)	8.9 ± 1.62	≥8	Adequate

Table 4 presents the mean nutrient intake and nutrient adequacy of the selected underweight adolescent girls. The mean intake of energy (2096 ± 85.3 kcal), carbohydrates (295.31 ± 11.4 g), and protein (62.56 ± 2.42 g) exceeded the ICMR recommended dietary allowances, with adequacy levels of 110.3%, 109.4%, and 113.7%, respectively. Fat intake was considerably higher than the recommended level, with an adequacy of 162.3%.In contrast, the mean intake of calcium (541.23 ± 26.4 mg), iron (12.86 ± 1.56 mg), and dietary fiber (14.68 ± 2.65 g) was substantially below the recommended allowances, with adequacy levels of 54.1%, 61.2%, and 58.7%, respectively. Water consumption was adequate, with a mean intake of 8.9 ± 1.62 glasses per day.

Table 5. Factors associated with severe thinness among adolescent girls (n = 250)

Variable	Severe thinness n (%)	p value
Rural residence	58/158 (36.7)	0.021*
Urban residence	18/92 (19.6)	
Low socio-economic status	49/121 (40.5)	0.003*
Middle/high socio-economic status	27/129 (20.9)	
Skipping breakfast	56/146 (38.4)	0.008*
Regular breakfast	20/104 (19.2)	
Anaemia present	67/188 (35.6)	0.014*
No anaemia	9/62 (14.5)	
Daily milk consumption	17/82 (20.7)	0.037*
No daily milk consumption	59/168 (35.1)	

*Chi-square test; $p < 0.05$ considered statistically significant.
Rural residence, low socio-economic status, breakfast skipping, presence of anaemia, and lack of daily milk consumption were significantly associated with severe thinness. Adolescents from low socio-economic households had almost twice the prevalence of severe thinness compared with those from middle and high socio-economic groups, highlighting the strong influence of poverty and poor dietary practices on chronic undernutrition.

Table 6. Effect of nutrition education on knowledge, attitude, and practice scores among adolescent girls (n = 20)

Parameter	Pre-test Mean ± SD	Post-test Mean ± SD	p value
Knowledge score	8.4 ± 2.1	14.6 ± 1.8	<0.001*
Attitude score	11.2 ± 2.4	15.1 ± 2.0	<0.001*
Practice score	9.8 ± 2.3	12.9 ± 2.1	0.002*

*Paired t-test; $p < 0.05$ considered statistically significant.
Table 6 shows the effect of the nutrition education intervention on knowledge, attitude, and practice (KAP) scores among the selected adolescent girls. The mean knowledge score increased significantly from 8.4 ± 2.1 before the intervention to 14.6 ± 1.8 after the intervention ($p < 0.001$). The attitude score also improved significantly from 11.2 ± 2.4 to 15.1 ± 2.0 ($p < 0.001$). Similarly, the practice score increased from 9.8 ± 2.3 to 12.9 ± 2.1 ($p = 0.002$). These findings indicate that the nutrition awareness programme produced significant improvements not only in nutritional knowledge but also in attitudes toward healthy eating and self-reported dietary practices.

Discussion:-

The majority of the participants were late adolescents aged 16–19 years (68.0%), belonged to rural areas (63.2%), lived in nuclear families (70.4%), and were from low socio-economic households (48.4%), indicating that undernutrition was concentrated among socially and economically vulnerable adolescents. Similar findings were reported by Kumar and Mohanty (2023), who observed a higher burden of thinness and anaemia among late adolescents, while Salam et al. (2014) highlighted adolescence as a critical period for growth and future

reproductive health. The predominance of rural participants is consistent with studies by Rajeswari et al. (2014) and Meshram et al. (2012), which documented greater nutritional vulnerability in rural adolescent populations.

The mean BMI (16.5 ± 1.2 kg/m²) and haemoglobin level (10.8 ± 1.4 g/dL) indicate chronic energy deficiency and a substantial burden of anaemia. Similar coexistence of thinness and anaemia has been reported by Meshram et al. (2012) and Kumar and Mohanty (2023). The high prevalence of anaemia and pallor in the present study further supports poor micronutrient status and reflects findings from Rani et al. (2018) and Siva et al. (2016).Dietary assessment revealed frequent breakfast skipping and low intake of milk, green leafy vegetables, and fruits. Deshmukh et al. (2013) reported that breakfast skipping was associated with lower BMI and poorer nutrient intake, while Kotecha et al. (2012) documented inadequate consumption of calcium- and iron-rich foods among Indian adolescent girls.Although energy and protein intake slightly exceeded ICMR recommendations, calcium, iron, and dietary fiber intake were markedly inadequate, suggesting energy-sufficient but micronutrient-poor diets. Similar dietary patterns have been described by Meshram et al. (2012) and Kumar and Mohanty (2023). The low calcium intake is of particular concern because adolescence is the period of peak bone mass acquisition (Teegarden& Weaver, 2009), while low iron intake likely contributed to the high prevalence of anaemia. The combination of high fat and low fiber intake also reflects a shift toward energy-dense, nutrient-poor dietary patterns (Popkin et al., 2012).

Rural residence, low socio-economic status, breakfast skipping, anaemia, and inadequate milk consumption were significantly associated with severe thinness. However, because of the cross-sectional nature of the study, these associations should not be interpreted as causal relationships.The strong association with poverty is supported by Kumar and Mohanty (2023), Meshram et al. (2012), and Rajeswari et al. (2014). Regular milk consumption appeared protective, probably because of its contribution to high-quality protein, calcium, and additional energy.

The nutrition education intervention significantly improved knowledge, attitude, and practice scores. Similar improvements have been reported by Sharma et al. (2020), while Contento (2011) emphasized the effectiveness of interactive nutrition education. However, sustained behavioural change is likely to depend on household food availability, economic conditions, and continued reinforcement through school and community programmes, as also noted by Salam et al. (2014).The nutrition education intervention was associated with an improvement in KAP scores among the participants.

Limitations of the Study:-

The study has certain limitations. Purposive sampling was used to specifically recruit underweight adolescent girls; therefore, the findings may not be generalizable to all adolescent girls in Namakkal District or other populations. The findings should consequently be interpreted within the context of the selected study population and setting.
The cross-sectional design permits assessment of associations between nutritional status and selected socio-demographic, dietary, and health-related factors but does not allow determination of temporal or causal relationships.The nutrition education component included only 20 participants and did not include a comparison group; therefore, changes in KAP scores should be interpreted cautiously.

Conclusion:-

The present study demonstrated that undernutrition remains a significant public health concern among underweight adolescent girls in Namakkal District. A high prevalence of thinness, severe thinness, and anaemia was observed, indicating the coexistence of chronic energy deficiency and micronutrient malnutrition. The findings further revealed that rural residence, low socio-economic status, breakfast skipping, anaemia, and inadequate milk consumption were significantly associated with severe thinness.

Although the intake of energy and protein was relatively adequate, the consumption of calcium, iron, and dietary fiber was considerably below the recommended dietary allowances, suggesting poor dietary quality and the presence of hidden hunger. The nutrition education intervention produced significant improvements in knowledge, attitude, and practice scores, highlighting the effectiveness of structured nutrition education in promoting healthy dietary behaviour among adolescents.Overall, the study emphasizes the need for comprehensive adolescent nutrition interventions that include regular nutritional screening, dietary diversification, promotion of milk and green leafy vegetable consumption, iron–folic acid supplementation, and sustained nutrition education. Special attention should be directed toward rural and economically disadvantaged adolescent girls to improve their nutritional status and to reduce the long-term and intergenerational consequences of malnutrition.

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The authors does not have any conflict of interest.

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