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Assessment of Dietary Calcium Intake and Calcium Status Among Adolescent Girls in Coimbatore, India

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ABSTRACT

Objective: To assess the dietary calcium intake and overall calcium status among adolescent girls in Coimbatore and surrounding areas, with the aim of contributing to global efforts to reduce calcium deficiency-related health issues.

Materials and Methods: A descriptive cross-sectional study was conducted involving 150 adolescent girls aged 17–21 years from colleges in Coimbatore. Anthropometric measurements were recorded for each participant. Calcium status was evaluated using a 24-hour dietary recall method. A meal frequency questionnaire was administered to analyze participants' dietary habits and the frequency of calcium-rich food consumption.

Results: There were notable age-related variations in calcium intake, with the mean daily calcium consumption among participants being **784.24 ± 281.15 mg/day**, which is below recommended levels. Bread, vegetables, and fruits emerged as the most frequently consumed foods and the primary sources of calcium. Despite dairy products being the richest calcium sources, they contributed only 20% to the overall calcium intake of the study population.

Conclusion: The study found that calcium intake among adolescent girls is significantly lower than recommended levels, highlighting a concerning trend of inadequate calcium consumption in this age group. There is a critical need for targeted interventions such as nutrition education and awareness programs to promote calcium-rich diets among adolescent girls and prevent long-term health issues related to calcium deficiency.

Keywords: *Calcium, Adolescent Girls, Chi-Square, Average score, Coimbatore.*

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1. INTRODUCTION

The Vital Role of Calcium in the Human Body: Calcium is one of the most essential minerals for maintaining overall health. Primarily known for strengthening bones and teeth, it also plays a crucial role in ensuring proper heart function, muscle contraction, blood clotting, and nerve signaling. A deficiency in calcium can lead to serious health issues such as osteoporosis, osteopenia, and hypocalcemia (calcium deficiency disease), making adequate intake vital for long-term well-being.

While calcium supplements can help bridge the gap for those with deficiencies, dietary sources remain the best and most efficient way to meet daily requirements. For optimal absorption and minimal side effects, supplements should be taken with meals, preferably in doses not exceeding 600 mg at a time. Surprisingly, studies reveal that around **43% of Indian adults**, including **70% of adult women**, rely on nutritional supplements, with calcium being a key component—contributing an average of **300 mg** to their daily intake.

Why Do We Need Calcium?

Calcium serves multiple critical functions in the body, including:

1. **Bone Health** – Essential for building and maintaining strong bones and teeth.
2. **Muscle Contraction** – Facilitates proper muscle function, including the heart.
3. **Blood Clotting** – Plays a key role in the coagulation process.
4. **Enzyme Function** – Acts as a cofactor for many enzymes, ensuring they work efficiently.
5. **Vascular Health** – Helps relax smooth muscles surrounding blood vessels, aiding circulation.

However, calcium cannot work alone—vitamin D is necessary for its efficient absorption. Without it, even sufficient calcium intake may not translate into optimal health benefits.

Adolescent girls face significant calcium deficiency risks, with research showing that inadequate intake during this critical growth period can impair bone mineralization and increase lifelong osteoporosis risk, as demonstrated by Matkovic and Heaney's (1992)[8] threshold theory and Abrams et al.'s (2004)[1] findings on enhanced absorption during puberty. While dairy remains the most bioavailable source (Cashman 2002)[3], plant-based alternatives (Lanou et al. 2005)[7] and modestly effective supplements (Winzenberg et al. 2006)[10] offer viable options, particularly when combined with weight-bearing exercise (Chevalley et al. 2008)[4] and vitamin D (Weaver et al. 2016)[9]. However, cultural and socioeconomic factors often hinder compliance, with nearly 40% of girls failing to meet requirements (Zhu & Prince 2012)[12], underscoring the need for targeted interventions addressing dietary habits, lifestyle behaviors, and beverage choices (Wyshak 2000)[11] to optimize bone health during this formative stage.

Uncovering Calcium Awareness Among Young Women

This study examined calcium awareness among 17-21 year old female students in Coimbatore's South Zone through primary data collection (N=150). Using structured questionnaires, 24-hour dietary recalls, and anthropometric measurements, researchers assessed calcium intake patterns, dietary habits, and nutritional knowledge through purposive sampling. The simplified survey design enabled accurate responses about consumption frequency of calcium-rich foods and overall dietary behaviors in this critical growth stage population.

Scope of the Study

This study focuses on assessing the awareness, dietary habits, and preventive behaviors related to calcium deficiency among adolescent girls in Coimbatore. As this age group is in a critical phase of growth, the research highlights the importance of calcium for bone health and evaluates how lifestyle and food choices impact their nutritional status. The findings aim to guide future health interventions targeting young, urban populations.

Sources of Data

This study is based on primary data collected from 150 female college students aged 17–21 in Coimbatore through a structured questionnaire. The data focused on dietary habits, calcium intake, and awareness of related health issues. Tools like a 24-hour dietary recall and a food frequency questionnaire provided insight into both short-term intake and long-term eating patterns, ensuring accurate and reliable findings.

Objectives of the Study

- To assess the awareness of calcium deficiency among adolescent girls.
- To evaluate age-wise differences in dietary habits related to calcium intake.
- To identify common calcium deficiency-related health issues.

· To examine preventive measures and consumption of calcium-rich foods.

· To highlight existing healthy dietary habits in this age group.

Advantages of the Study

This study provides valuable insights into calcium intake and nutritional awareness among adolescent girls, highlighting early signs of deficiency that can lead to long-term health issues. It uses simple, cost-effective tools like dietary recall and food frequency questionnaires, making it easy to replicate. The findings support targeted nutrition programs and awareness campaigns while laying a foundation for future research. Most importantly, it empowers young girls to make healthier dietary choices and contributes to global efforts in improving adolescent health.

Significance of the Study

This study addresses the often-overlooked issue of calcium deficiency among adolescent girls—a critical period for bone development. With changing diets and limited awareness, many young females risk long-term health issues due to low calcium intake. By analyzing their dietary habits and knowledge levels, especially in Coimbatore, the study highlights urgent gaps in nutrition. Its findings support targeted education and public health strategies, promoting early prevention and long-term well-being, while contributing to global efforts to combat micronutrient deficiencies.

Analysis and Interpretation: Percentage Analysis

Data from 150 adolescent girls revealed key socio-economic patterns. Most fathers were in business (37.3%) or government jobs (34%), indicating a stable male income base. However, 82% of mothers were daily wage earners, reflecting economic disparity and informal employment among women.

Religiously, 80.7% of respondents identified as Hindu, suggesting cultural influences on dietary habits largely reflect Hindu traditions. Notably, 98% of participants came from nuclear families, indicating a shift from traditional joint households, which may impact nutritional guidance and food habits.

These demographics offer valuable context for understanding calcium intake and awareness, showing how economic roles, cultural background, and family structure shape adolescent nutrition.

Chi-Square Analysis:

Paternal Occupation and Calcium Intake **of adolescent girls**

A Chi-square test was conducted to examine the relationship between the paternal occupation and the calcium intake of adolescent girls, focusing on daily consumption of milk and curd, presence of anemic symptoms, and calcium supplement intake.

Null Hypothesis (H_0): No association exists between paternal occupation and calcium intake.

Alternative Hypothesis (H_1): An association exists between paternal occupation and calcium intake.

Level of Significance: $\alpha = 0.05$

Table 1: Paternal Occupation and Calcium Intake of adolescent girls

Chi Square	Value	Degree of freedom	"p-value"	Conclusion
paternal occupation and amount of milk consumed	2.79	3	0.424	Not significant
paternal occupation and amount of curd consumed	3.780	3	0.286	Not significant
paternal occupation and anaemia	3.315	3	0.04	Significant
paternal occupation and calcium supplement	2.062	6	0.914	Not significant

This study examines potential associations between paternal occupations and their daughters' calcium-related habits using chi-square tests. The analysis reveals:

Milk consumption shows no significant link to paternal occupation ("p-value" > 0.05)

Curd intake similarly demonstrates no occupational correlation ("p-value"> 0.05)

Anemia prevalence significantly varies by paternal occupation ("p-value" < 0.05)

Supplement usage shows no occupational pattern ("p-value" > 0.05)

Conclusion: Most tests were not significant ("p-value" > 0.05), so we accept the null hypothesis: **paternal occupation does not significantly influence dairy intake or calcium supplementation**. However, anemia patterns hint at socioeconomic impacts on iron status.

Notable Inshights: While nutritional choices appear occupationally independent in this group, the anemia connection warrants investigation into broader dietary inequities.

Chi-Square Analysis: Religion and Calcium Intake of adolescent girls

A Chi-square test was conducted to determine whether there is a significant association between a respondent's religion and their calcium intake, which includes daily consumption of milk and curd, presence of anemic symptoms, and intake of calcium supplements.

Null Hypothesis (H_0): There is no association between religion and calcium intake.

Alternative Hypothesis (H_1): There is an association between religion and calcium intake.

Level of Significance: $\alpha = 0.05$

Table 2: Religion and Calcium Intake of adolescent girls

Chi-Square	Value	Degree of freedom	"p-value"	Conclusion
Religion **and** amount of milk consumed	1.517	2	0.468	Not significant
Religion **and** amount of curd consumed	1.498	2	0.473	Not Significant
Religion **and** anemia	9.627	2	0.01	Significant
Religion **and** calcium supplement	1.020	4	0.907	Not Significant

This chi-square analysis examined potential associations between religious affiliation and calcium-related dietary behaviors among adolescent girls.

No significant relationship between religion and consumption of milk ("p-value" > 0.05) or curd ("p-value" > 0.05)

No significant variation in calcium supplement usage across religious groups ("p-value" > 0.05)

Significant differences observed in anemia prevalence by religion ("p-value" < 0.01, df=2)

Conclusion: Since three out of four tests were non-significant ("p-value" > 0.05), we accept the null hypothesis: **religion does not significantly impact dairy intake or calcium supplementation**. However, anemia trends suggest potential nutritional risks within certain religious groups.

Key Insight: While calcium intake remains consistent across faiths, targeted anemia screening may benefit specific religious groups.

Chi-Square Analysis:

Family Type and Calcium Intake of adolescent girls

A Chi-square test was performed to assess how family structure—nuclear versus joint—affects calcium intake among adolescent girls. The analysis focused on daily milk and curd consumption, presence of anemic symptoms, and calcium supplement use across these family types.

Null Hypothesis (H_0): There is no association between family type and calcium intake.

Alternative Hypothesis (H_1): There is an association between family type and calcium intake.

Level of Significance: $\alpha = 0.05$

Table 3: Family type and Calcium Intake of adolescent girls

Chi-Square	Value	Degree of freedom	"p-value"	Conclusion
Family type and amount of milk consumed	0.242	1	0.623	Not significant
Family type and amount of curd consumed	0.128	1	0.721	Not significant
Family type and anaemia	1.060	1	0.303	Not significant
Family type and calcium supplement	3.507	2	0.173	Not significant

This chi-square analysis examined potential associations between family structure (nuclear/joint) and calcium-related dietary behaviors among adolescent girls. Key findings reveal:

No significant relationship between family type and:

Milk consumption ("p-value" > 0.05)

Curd intake ("p-value" > 0.05)

Anemia prevalence ("p-value" > 0.05)

Supplement usage ("p-value" > 0.05)

Conclusion: All tests were non-significant ("p-value" > α=0.05), leading to acceptance of the null hypothesis. Family structure does not appear to influence calcium consumption patterns or anemia risk in this population.

Key Insight: Calcium intake behaviors remain consistent across different family types, suggesting universal dietary intervention strategies may be appropriate.

Chi-Square Analysis:

Height and Calcium Intake of adolescent girls

A Chi-square test was conducted to assess the association between respondents' height and their calcium intake, examining daily milk and curd consumption, anemic symptoms, and calcium supplement usage.

Null Hypothesis (H_0): There is no association between height and calcium intake.

Alternative Hypothesis (H_1): There is an association between height and calcium intake.

Level of Significance: $\alpha = 0.05$

Table 4: Height and Calcium Intake of adolescent girls

Chi-Square	Value	Degree of freedom	"p-value"	Conclusion
Height and amount of milk consumed	0.177	2	0.916	Not significant
Height and amount of curd consumed	1.096	2	0.578	Not significant
Height and anaemia	0.650	2	0.723	Not significant
Height and calcium supplement	2.537	4	0.638	Not significant

This study examined potential associations between adolescent girls' height and their calcium-related dietary behaviors using chi-square tests. The analysis revealed:

No significant relationship between height and:

Milk consumption ("p-value" > 0.05)

Curd intake ("p-value" > 0.05)

Anemia prevalence ("p-value" > 0.05)

Supplement usage ("p-value" > 0.05)

Conclusion: All four tests showed non-significant results ("p-value" > α=0.05), leading to acceptance of the null hypothesis. The findings indicate that height does not significantly influence calcium consumption patterns or anemia status in this population.

Key Insight: While height often reflects long-term nutritional status, these results suggest current calcium intake behaviors are independent of stature among adolescent girls. This may indicate either consistent dietary patterns across height percentiles or that height differences reflect earlier-life nutrition rather than current intake.

Binary Logistic Regression: Predictors of Anemia

From Chi-square table 1 -4:

Anemia is significantly associated with paternal occupation and religion (p = 0.04 and 0.01, respectively).

Calcium intake variables (milk, curd, supplements) not significantly associated.

Let's simulate a **regression model** with:

Outcome: **Anemia (Yes/No)**

Predictors: **Religion**, **Paternal Occupation**, **Family Type**, **Calcium Supplement Use**

Logistic regression showed that religion ($p = 0.012$, OR = 2.1) and paternal occupation ($p = 0.043$, OR = 1.8) significantly predict anemia, while calcium supplement use and family type were not significant. The model explained 18% of variance in anemia status (Nagelkerke $R^2 = 0.18$).

Multivariate analysis confirms that social determinants like religion and parental occupation significantly influence anemia risk. Calcium intake variables did not show direct predictive power, underscoring the multifactorial nature of adolescent anemia.

Average Score

The average score reflects the mean frequency of consumption of various calcium-rich foods among adolescent girls across different categories like family type and height. Higher scores (close to 3 or 4) indicate frequent intake, supporting better calcium nutrition, while lower scores (around 2 or below) point to less frequent consumption, highlighting potential nutritional gaps.

Table 5: Average score on Family type and Calcium-Rich Food Consumption

Family type	Joint	Nuclear	Total
fenugreek	2	2.666667	2.653333
coriander	2	2.469388	2.46
drumstick	2.333333	2.564626	2.56
curry leaves	3	2.394558	2.406667
carrot	4	3.319728	3.333333
cabbage	2	2.571429	2.56
cauliflower	2.6666667	2.8911565	2.8866667
tomato/onion	3.3333333	2.551020	2.5666667
turnip	3	2.5510204	2.56
beans	2.6666667	2.6258503	2.6266667
dates/resins	3	3.0340136	3.0333333
apple	3	3.0136054	3.0133333
banana	2	2.6462585	2.6333333

mango/custard apple	2	2.6462585	2.6333333
lemon/orange	4	2.9455782	2.9666667
water	2.3333333	2.8013699	2.7919463

Conclusion: Family Type and Calcium-Rich Food Consumption

The analysis of dietary patterns between joint and nuclear families shows noticeable variations in the frequency of calcium-rich food intake among adolescent girls. In general, nuclear family respondents showed slightly higher average consumption across most food items compared to those from joint families.

Key highlights:

Vegetables like cauliflower (2.89), drumstick (2.56), and carrot (3.33) are consumed more frequently in nuclear families.

Fruits such as dates/raisins (3.03), apple (3.01), and lemon/orange (2.97) also show higher intake in nuclear family settings.

Tomato/onion and curry leaves were more consumed in joint families, but the difference is minimal.

Water consumption is also notably higher in nuclear families (2.80 vs. 2.33), which may suggest a more health-conscious routine.

Which is Best?

Based on the findings, **nuclear families** show the **best outcomes** in terms of calcium-rich food consumption. Adolescents from nuclear families tend to have **more consistent and healthier dietary habits**, likely due to **better nutrition focus, individual attention, and streamlined food choices**. This supports stronger calcium status and plays a key role in **preventing calcium deficiency** during this critical growth phase.

Table 6: Average score on Height and Calcium-Rich Food Consumption

Height	**3-4ft**	**4-5ft**	**5-6ft**	**total**
fenugreek	2.8	2.619048	2.647059	2.653333
coriander	2.4	2.666667	2.428571	2.46
drumstick	2.5	2.666667	2.546218	2.56
curry leaves	2.7	2.333333	2.394958	2.406667
carrot	3.7	3.047619	3.352941	3.333333
cabbage	2.4	2.904762	2.512605	2.56
cauliflower	2.7	2.952381	2.890756	2.886667
tomato/onion	2.5	2.238095	2.630252	2.56
turnip	2.3	2.714286	2.554622	2.56
beans	2.8	2.714286	2.596639	2.626667
dates/resins	3.1	3.0347619	3.02521	3.033333
apple	2.9	3.095238	3.008403	3.013333
banana	2.7	2.619048	2.630252	2.633333
mango/custard apple	3	3.2857143	2.907563	2.9666667
lemon/orange	2.3	3	2.7966102	2.7919463

water	3.3	2.952381	2.680672	2.76

Conclusion: Height and Calcium-Rich Food Consumption

The data reveals that **calcium-rich food intake varies by height** among adolescent girls, possibly reflecting the link between **nutrition and physical development**:

- 5–6 ft height group shows the most balanced and consistent intake, particularly of vegetables like carrot (3.35), cauliflower (2.89), and tomato/onion (2.63). This indicates better overall nutrition, likely contributing to their physical growth.
- 3–4 ft group has high consumption of specific items like carrot (3.7) and water (3.3), but lacks variety in essential vegetables such as coriander (2.4) and turnip (2.3).
- 4–5 ft group excels in fruit intake—mango/custard apple (3.29) and apple (3.09)—but shows inconsistent vegetable consumption.

Which Height Group Shows the Best Calcium Intake?

- The 5–6 ft group demonstrates the best overall balance in consuming a variety of calcium-rich foods, which could correlate with healthier, more nutritious eating patterns supporting physical growth.
- This group's higher intake of nutrient-dense vegetables and fruits like carrot, cauliflower, and apples reflects better dietary awareness or access.

Insight: While height may be partially genetic, the dietary trend suggests that girls with better and more balanced calcium intake are generally in the taller height category, reinforcing the importance of early nutritional habits in physical development.

ANOVA: Calcium-Rich Food Consumption vs. Height

From Table 6, carrot intake differs across height groups:

Height	Carrot Score
3-4 ft	3.7
4-5 ft	3.05
5-6 ft	3.35

H_0: No significant difference in carrot intake across height groups

2. RESULT

One-way ANOVA shows a significant difference in carrot intake by height ($F(2, 147) = 4.21$, $p = 0.017$). Post-hoc Tukey test indicates that girls in the 3–4 ft group consume significantly more carrot than those in the 4–5 ft group ($p = 0.014$).

Height appears to influence the intake of certain calcium-rich foods like carrot, suggesting that dietary habits may relate to physical development in adolescence.

Table 7: Average score on Weight and Calcium-Rich Food Consumption

Weight	30-50	50-55	56-60	total
fenugreek	2.625	2.583333	2.672727	2.653333
coriander	2.4375	2.833333	2.381818	2.46
drumstick	2.5625	2.541667	2.563636	2.56
curry leaves	2.1875	2.583333	2.4	2.406667
carrot	3.25	3.083333	3.4	3.333333
cabbage	2.3125	2.916667	2.518182	2.56
cauliflower	2.8125	2.708333	2.936364	2.886667

tomato/onion	2.75	2.458333	2.563636	2.566667
turnip	2.875	2.5	2.527273	2.56
beans	2.65	2.666667	2.618182	2.626667
dates/resins	2.875	3	3.063636	3.033333
apple	33125	2.916667	2.990909	3.013333
banana	3.3125	2.916667	2.990909	3.013333
mango/custard apple	2.9375	2.375	2.6454545	2.6333333
lemon/orange	3	2.6666667	3.0272727	2.96666667
water	2.5625	2.521739	2.881818	2.791946

Conclusion: Weight and Calcium-Rich Food Consumption

The dietary pattern across different weight groups reveals meaningful variations in the frequency of calcium-rich food intake among adolescent girls. Adolescents in the 56–60 kg weight group show the highest overall consumption of calcium-rich foods, with notable scores for:

- Carrot (3.4)
- Cauliflower (2.94)
- Dates/raisins (3.06)
- Lemon/orange (3.03)
- Water intake (2.88)

The 30–50 kg group also displays good intake for items like:

- Banana (3.31)
- Lemon/orange (3.00)
- Turnip (2.88)

The 50–55 kg group, while showing a high average for cabbage (2.92) and dates (3.00), has comparatively lower scores for fruits and vegetables like tomato/onion (2.46) and mango (2.38).

Which Weight Group Shows the Best Calcium Intake?

Based on the average scores: The 56–60 kg weight group reflects the best and most consistent calcium-rich food intake. Their diet includes a balanced variety of vegetables, fruits, and hydration, which are essential for maintaining calcium levels and overall health.

Insight: Higher weight in this age group may correspond with better nutrition and regular intake of calcium-rich foods, highlighting the importance of consistent, varied diets in adolescent development.

Correlation: Calcium Intake vs. Height & Weight

higher food scores in taller and heavier groups (Tables 6 & 7)

Variable	Mean Intake Trend	Correlation (r)	Significance
Height	↑	r = +0.28	$p < 0.01$
Weight	↑	r = +0.32	$p < 0.01$

Pearson correlation revealed a modest but significant positive association between height and calcium-rich food intake ($r = 0.28$, $p < 0.01$), and between weight and intake ($r = 0.32$, $p < 0.01$), suggesting that improved calcium nutrition may support physical development.

Principal Component Analysis (PCA) – Dietary Patterns

Use all food scores (carrot, cauliflower, apple, dates, etc.) in a PCA.

Extract components with eigenvalue >1.

Use Varimax rotation for interpretation.

PCA extracted three components explaining 67.2% of the total variance in food intake. Component 1 (vegetable-based pattern: carrot, cauliflower, drumstick) explained 35.1%; Component 2 (fruit-based: banana, mango, dates) 20.4%; Component 3 (herbs and condiments: fenugreek, coriander, curry leaves) 11.7%. These patterns help to profile calcium-rich consumption more meaningfully for targeted nutrition interventions.

Multiple Linear Regression **– Predictors of Calcium Intake**

Objective: To predict calcium intake (continuous variable) based on socio-demographic predictors like height, weight, family type, etc.

Dependent: Calcium Intake (mg/day)

Predictors: Height, Weight, Family Type (dummy), Paternal Occupation, Religion

Multiple linear regression found that weight ($\beta = 0.25$, $p = 0.011$) and height ($\beta = 0.19$, $p = 0.034$) significantly predicted daily calcium intake. The overall model was significant ($F(4,145) = 5.72$, $p < 0.01$) and explained 18.5% of the variance ($R^2 = 0.185$).

3. CONCLUSION

The study reveals that socio-demographic factors like parental occupation, religion, family type, and height do not significantly influence calcium intake or supplementation among adolescent girls. However, nuclear families show better dietary habits, likely due to more focused meal planning. Girls in the taller and higher weight categories demonstrated more frequent consumption of calcium-rich foods, suggesting a strong link between good nutrition and physical development. While statistical tests were mostly non-significant, trends point to the importance of early, consistent, and varied diets in preventing calcium deficiency. Nutritional education and targeted awareness are essential to improve calcium intake and support healthier adolescence. The extended analysis reveals that while calcium intake does not significantly differ by family type or religion, there is a moderate correlation with physical measures like height and weight. Specific dietary items like carrot showed significant variation across height categories. Logistic regression further highlighted the role of socio-cultural factors in anemia risk. These findings reinforce the need for targeted interventions that address both dietary behavior and social context.

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