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Low Calcium Intake of Pre-Adolescent Girls from Customary Diets in A Semi-Rural Setting in Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

Calcium is a critical nutrient for adolescent bone development and overall health, yet intake often remains below recommended levels in many populations. **Objectives:** To assess the calcium intake of pre-adolescent girls, their calcium fortified preferences, and perceived barriers to calcium-rich foods to inform targeted nutritional interventions. To assess the calcium intake of adolescent girls, their calcium fortified preferences, and perceived barriers to calcium-rich foods. **Methods:** A descriptive cross-sectional study was conducted, where 78 school girls aged 9-14 years completed FFQ with a focus on foods rich in calcium. The questionnaire also contained questions inquiring about the perceived barriers which could result in low intake/no intake of calcium-dense foods. **Results:** A total of 174 calcium-rich foods and products were available in Charsadda city. Mean intake of calcium (275 ± 52) was well below the RDI. Notable gaps in students' awareness of calcium sources and their importance existed. The top 8 Key barriers that potentially hinder the intake of nutritious foods were identified, including cost, low availability in the school environment, low awareness, inappropriate storage facilities at school, food habits, low nutrition education, food stigma, and junk food pressure. The data highlights a clear preference among students for certain calcium-fortified food types over others. **Conclusions:** Mean calcium intake from foods available to pre-adolescent girls was low, with numerous barriers identified that hinder calcium intake in this age group. Further, pre-adolescent girls preferred a variety of calcium-fortified foods, biscuits and milk on top of the list.

INTRODUCTION

Calcium is a critical micronutrient important for skeletal system development, especially during pre-adolescence, a time characterized by bone growth acceleration and hormonal development [1]. Proper calcium consumption during this window of development is critical in the attainment of peak bone mass and the prevention of osteoporosis, fractures, and other bone diseases in adulthood [2]. Global guidelines, like those of the World Health Organization (WHO) and Institute of Medicine (IOM), recommend that children 9-12 years of age consume 1000 to 1300 mg of calcium each day to maximize growth and

physiological functioning [3]. Nonetheless, there is evidence that calcium consumption in children living in South Asian nations, such as Pakistan, continues to be woefully inadequate, especially in rural and resource-poor populations [4]. This is further compounded by socio-economic limitations [5], restricted dietary variety [6], minimal exposure to dairy or fortified foods [7], and widespread ignorance about nutritional requirements [8]. The outcomes of this research are anticipated to guide specific nutrition interventions and assist with the design of culturally sensitive approaches to enhancing calcium



consumption among school-age girls in comparable contexts. In Pakistan, where the dietary habits are predominantly cereal-based and calcium-containing foods are missing from typical diets, the risk of calcium deficiency is particularly high among young girls. Pre-adolescent females are a group of special concern because poor calcium consumption during this age can result in impaired bone structure, growth delay, and increased risk of persistent nutritional deficiency. Although the seriousness of this problem is so considerable, little evidence supports the availability of calcium-rich foods in the semi-rural regions of Pakistan, especially KP, where socio-cultural and economic obstacles are unique. Information regarding the calcium sources in foods is critical to any nutrition policy development in addressing the common calcium deficiencies [9, 10].

Despite the recognized importance of calcium for bone growth and overall health, evidence regarding the actual intake of calcium-rich foods among pre-adolescent girls in semi-rural Pakistan remains scarce. Existing studies primarily focus on urban populations or do not account for cultural, economic, and school-related barriers affecting dietary choices. This lack of localized data limits the development of targeted interventions to improve calcium intake in vulnerable groups. This study aims to know pre-adolescent girls' daily dietary intake of calcium in a semi-rural area in KP and to ascertain the primary sources of calcium in their traditional diets. Also, to know what foods these girls prefer to eat as a source of calcium and what perceived barriers they have while trying to achieve calcium-rich foods.

METHODS

This descriptive cross-sectional study was carried out in a semi-urban school in Charsadda, targeting students in grades 5 through 9 who were between the ages of 9 and 14 during two survey phases (Jan–Feb and Jun–Jul 2022). 79 of the 120 enrolled students took part with permission from their guardians. Sample size was estimated using the standard formula for a single population proportion with a 70% expected response rate, 5% margin of error, and 95% confidence level [11]. Data were collected in four sections using a self-administered, validated questionnaire that was created with expert input: (1) demographics and familiarity with foods high in calcium; (2) food frequency and 24-hour recall with illustrations; (3) perceived barriers to calcium intake using a 5-point Likert scale; and (4) preferences for fortified foods that are available on the market. BMI-for-age percentiles were determined using CDC growth charts for girls aged 2–19 years. The questionnaire underwent a pilot test for clarity and relevance, and its content validity was established through expert review before data collection. The researcher

explained the survey procedure one day before administration. A full census of eligible girls (ages 9–14, grades 5–9) was conducted at the selected semi-urban school. As the entire target group was surveyed, randomization or stratification was not applicable, ensuring representativeness and reducing selection bias. SPSS version 20.0 was used to analyze the data; descriptive statistics were used, and calcium intake was calculated from reported intakes using national food composition tables that were cross-checked with USDA data. RDAs and mean daily calcium intake were compared; a daily intake of less than 300 mg was deemed critically deficient [3]. Means and SDs on the Likert scale were also computed. No comparison between the season-based data was done as it was beyond the scope of the study.

RESULTS

Mean age was 13.5 (4.56) years. More than half of the girls (56.4%) were from grades 6–8 (Middle school grades). Only 53 of the 174 calcium-rich foods that had previously been identified [12] were recognized by the students, and only 26 of them had been consumed in the previous three months. Although fortified dairy products, such as high-calcium milks and cheeses, were widely known, consumption was found to be modest. Standard UHT and pasteurized milk, yoghurt, and malted beverages were among the frequently consumed dairy products; each serving included 150–200 mg of calcium. Although students were aware of meats and legumes as good sources of calcium, they rarely actually consumed them, particularly when it came to soy milk and red beans. On the other hand, subjects ate more turnip, okra, mint, and radish—vegetables that contain appreciable calcium (Table 1).

Table 1: Number of Food Items and Products Known to and Consumed by Students

Variables	Number of Items Known to the Responders	Number of Items Reports have been Consumed in the Last 3 Months
Meat and Meat Products	13	3
Vegetables	12	8
Dairy and Dairy Products	5	2
Legumes, Nuts, and Seed Products	6	3
Starchy Foods	15	10
Calcium Supplement Tablets	2	0
Total	53	26

The amount of calcium consumed and the calcium sources were recorded. The sample of 78 pre-adolescent girl's students surveyed, no student met the Pakistani Recommended Daily Intake (RDI) for calcium (≥ 800 mg/day). The median calcium intake was 275 ± 52 mg/day, indicating all students had inadequate calcium intake. The main calcium sources were dairy and meat products. Approximately 84% of participants consumed less than

200 mg/day of calcium, indicating a critical deficiency (Table 2).

Table 2: Summary of Daily Calcium Intake

Variables	Value
Mean Calcium Intake (mg/day)	275 ± 52
% Below 200 mg/day	84%
% Below RDA (1000 mg/day)	100%
Most Common Food Sources	Naan, Chapati, Tea, Spinach, Lassi, Mint, Mustard, Rice, Barsnada (Lotus Root), Okra, Turnip, Cabbage, Radish, Garlic

Most calcium in the diet was derived from naan/chapati, tea, egg and spinach (Figure 1).

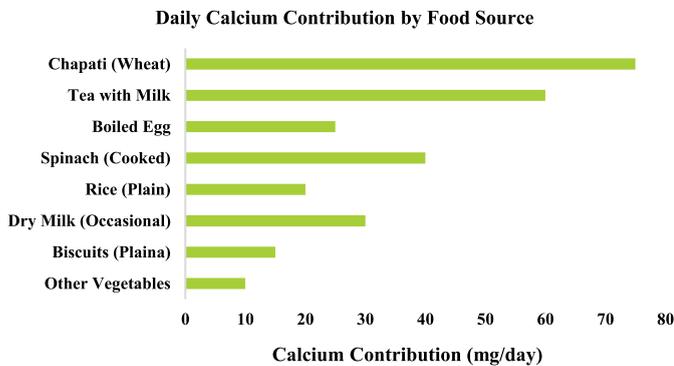


Figure 1: Daily Calcium Contribution by Food Source

Key barriers to the intake of calcium-containing foods were recorded. Using a 5-point Likert scale, the results list the main barriers to schoolgirls consuming enough foods high in calcium. The primary barrier to affordability was the high cost of nutrient-dense foods, which received the highest rating (Mean=4.5). Poor cafeteria diversity, low nutrition knowledge, inadequate food storage, cultural dietary habits, lack of nutrition education, junk food marketing, poor comprehension of food labels, and seasonal produce availability are some of the hurdles that received 4.0. Peer pressure, low staff participation, inadequate outside assistance, and the lack of school nutrition programs were all assessed as moderate hurdles (Mean=3.5). These results demonstrate how access to nutritious foods in semi-urban environments is restricted by both systemic and sociocultural issues (Table 3).

Table 3: Perceived Barriers hindering Calcium Rich Foods Intake

Barriers	Descriptions	Likert Scale Mean ± SD	Median (IQR)
High Cost	Healthy options like fruits, dairy, lean meats, and fortified products are often more expensive.	4.5 ± 1.5	5 (4-5)
Limited Variety in School Canteens	Canteens mostly offer affordable, less nutritious snacks rather than balanced meals.	4 ± 1.0	4 (4-5)

Low Parental Nutrition Awareness	Many parents lack knowledge about balanced diets and the importance of specific nutrients.	4 ± 1.5	4 (3-5)
Inadequate Food Storage Facilities	Lack of refrigeration limits the availability of perishable, nutritious foods like milk and yoghurt.	4.0 ± 1.5	4 (4-5)
Cultural and Traditional Food Habits	Local food preferences may exclude key sources of nutrients like cheese or fortified products.	4.0 ± 1.5	4 (3-5)
Insufficient Nutrition Education	Students are not regularly taught about healthy eating or the importance of specific nutrients.	4.0 ± 1.0	4 (3-5)
Peer Pressure and Food Stigma	Students may avoid healthy food to conform with peers or avoid being labelled "different."	3.5 ± 1.0	4 (3-5)
Marketing of Junk Food	Unhealthy snacks are aggressively advertised to children, influencing their choices.	4.0 ± 1.5	4 (3-5)
Poor Nutrition Label Understanding	Many students cannot interpret labels to assess calcium, iron, or vitamin content in foods.	4.0 ± 1.5	4 (3-5)
Seasonal Availability of Produce	Fruits and vegetables rich in nutrients may not be available year-round.	4.0 ± 1.3	4 (3-4)
Limited Staff Involvement	Teachers and staff often do not monitor or encourage healthy eating during school hours.	3.5 ± 1.4	3 (3-4)
Lack of External Support	Government or NGO-supported nutrition initiatives may be absent or irregular.	3.5 ± 1.3	3 (3-4)
Absence of School Nutrition Programs	Few schools offer consistent programs like fortified meals, milk breaks, or health talks.	3.5 ± 1.3	3 (3-4)

Using a 5-point Likert scale, the study displays the preferences of students for meals supplemented with calcium. Dry milk powder and calcium-fortified biscuits were the most popular products (Mean=4.5), probably because of their familiarity, taste, and ease of use. Breakfast cereals (Mean=2), soy milk, and UHT fortified milk (Mean=2.5) were moderately desired items, perhaps as a result of their lesser cultural acceptance. Malt drinks, juices, snack bars, yoghurt, cheese slices, tofu, chocolate, and noodles were the least popular (Mean=1-1.5) and frequently regarded as strange, expensive, or less appetizing. These findings demonstrate how student preferences are influenced by flavor, cost, and cultural familiarity (Table 4).

Table 4: Students' Preferences for Calcium-Fortified Foods

Calcium-Fortified Food Type	Examples / Notes	Likert Scale Mean ± SD	Median (IQR)
Calcium-Fortified Biscuits	Sweet or savory; often marketed as nutritious snacks	4.5 ± 1.0	5 (4-5)

Calcium-Fortified Dry Milk Powder	Used in drinks or added to recipes; long shelf life	4.5 ± 1.0	5(4-5)
UHT Calcium-Fortified Milk	Regular, low-fat, flavored options available	2.5 ± 1.4	3(2-4)
Calcium-Fortified Soy Milk	Dairy alternative; often flavored and sweetened	2 ± 1.5	2(1-3)
Calcium-Fortified Malt Drinks	Popular among students; often advertised for energy	1.5 ± 1.2	1(1-2)
Calcium-Fortified Fruit Juices	Orange juice and other fortified foods with calcium	1.5 ± 1.3	1(1-2)
Calcium-Fortified Breakfast Cereals	Usually eaten with milk; convenient and palatable	2 ± 1.4	2(1-3)
Calcium-Fortified Snack Bars	Cereal bars or granola with added nutrients	1.5 ± 0.5	1(1-2)
Calcium-Fortified Cheese Slices	Often expensive, but palatable; easy to use in sandwiches	1 ± 0.5	1(1-1)
Fortified Yogurt and Yogurt Drinks	May not be labelled clearly as calcium-rich; needs awareness	1.5 ± 0.5	1(1-2)
Hard Tofu (Calcium-Set)	Traditional and inexpensive, though not always recognized by students	1 ± 0.5	1(1-1)
Calcium-Fortified Chocolate or Sweets	Sometimes marketed as health-enhanced treats	1 ± 0.5	1(1-1)
Fortified Instant Noodles or Soups	Rare but emerging in some markets	1 ± 0.5	1(1-1)

To find out if there were statistically significant variations in students' preference scores for the various kinds of calcium-fortified foods, a one-way ANOVA was performed. At least some groups' mean preference scores differed significantly, according to the study $F(12, 1677) = 24.56, p < 0.001$. Calcium-enriched biscuits and dry milk powder were much more popular ($p < 0.010$) than other products such as fortified cheese slices, tofu, snack bars, and instant noodles, according to post hoc comparisons using the Tukey HSD test. These findings imply that students' acceptance of fortified foods may be influenced by factors such as product form, convenience, and flavor familiarity.

DISCUSSION

The present research identified that despite the fact that numerous calcium-dense foods are present in Charsadda, fewer than one-third of them were identified by students as dietary sources of calcium. Milk, largely used in tea, was the predominant calcium source, presumably for reasons of publicity associating it with bone health and not through nutritional awareness [13, 14]. The students had no idea how much milk one should use to provide daily calcium needs. Cost was the greatest limiting factor: families had to incur 30-60 PKR/day/child on good sources, which is considerable in proportion to the average income (mean: 29,500 PKR/month; range: 24,000-45,000 PKR/month). There were universal misconceptions, e.g., many thought drinking milk with fruits (especially watermelon) was harmful. Intakes of calcium predominantly comprised

chapati, tea and milk, and spinach, which form part of rural diets [15]. But their bioavailability of calcium is low owing to inhibitors such as phytates, oxalates, and tannins [16, 17]. Milk was seldom taken as a single beverage, further restricting proper calcium absorption. Students showed inadequate knowledge of non-dairy sources of calcium, including nuts, seeds, legumes, and fortified foods. This is consistent with other South Asian research estimating poor awareness and consumption levels in adolescents [18, 19]. Such evidence highlights the imperative for school-based nutrition education that is culturally appropriate, access to low-cost fortified foods, and public awareness campaigns [20, 21]. The present research also reports that students preferred fortified biscuits and milk as their food of choice. This preference must be taken into consideration in future clinical trials, policies and programs for school feeding programs. The present research emphasizes the imperative to develop focused interventions to enhance calcium consumption in school-aged girls, suggesting school-level supplementation, fortification of staple foods, increased promotion of affordable calcium foods such as sesame seeds and moringa, and education of parents as main strategies. It is, however, subject to the limitations of being based on self-reported data, having no biochemical validation, being geographically limited, and having no inclusion of contextual influences such as vitamin D status and socioeconomic factors that can influence the generalizability and validity of results.

This study is limited by its reliance on self-reported dietary data, the absence of biochemical validation of calcium status, and the geographic restriction to a single semi-rural school, which may affect generalizability. Future research could incorporate larger, multi-site studies, include biochemical assessments, and explore interventions such as school-based supplementation and culturally tailored nutrition education to effectively enhance calcium intake among pre-adolescent girls.

CONCLUSIONS

Mean calcium intake from foods available to pre-adolescent girls was low, with numerous barriers identified that hinder calcium intake in this age group. Further, pre-adolescent girls preferred a variety of calcium-fortified foods - biscuits and milk on top of the list.

Authors' Contribution

Conceptualization: SS

Methodology: SS, IA

Formal analysis: SS, AA, IA

Writing and Drafting: SS, AA, IA

Review and Editing: SS, AA, IA

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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