

ORIGINAL ARTICLE

Assessment of Dietary Intake of Essential Minerals in Children Aged 1-12 Years through Milk Consumption

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ABSTRACT

Objectives: Dietary assessment serves as a tool to identify inadequate micronutrient intakes in children. This study aimed to assess the nutritional intake of five essential minerals, calcium, magnesium, phosphorus, sodium, and potassium (Ca, Mg, P, Na, and K) among children aged 1 to 12 years through milk consumption.

Study Design: It was an experimental study

Place and Duration of study: This study was conducted from June 2023 to November 2023 at the Institute of Biochemistry, University of Sindh, Jamshoro, Sindh, Pakistan.

Material and Methods: A total of (n=30) milk samples in acid-wash plastic-type containers were collected from various dairy farms located in the rural areas of District Jamshoro, Sindh, from June 2023 to November 2023, and the mineral content was determined by using flame atomic absorption spectroscopy (FAAS). Nutritional assessments of minerals for children aged 1-12 years were computed based on the concentrations of Ca, Mg, P, Na, and K in the milk samples, whereas daily milk intake in children was obtained based on a questionnaire.

Results: The results revealed that the concentrations of Ca, Mg, P, Na, and K in the milk samples ranged from 798.09-1598.05, 112.35-267.13, 632.06-1098.11, 251.67-501.13, to 1220.32-1701.09 mg/kg with mean value order $K > Ca > P > Na > Mg$. The daily intake of milk was higher in 1-3-year-old children, followed by 4-8 and 9-12-year-olds. The highest daily intake of essential minerals was found in the order of $1-3 > 4-8 > 9-12$ years. Among the essential minerals, K was the most consumed by children, followed by $Ca > P > Na > Mg$. Furthermore, the regular intake of the selected minerals was observed below their recommended ranges.

Conclusion: From this study, we found that daily milk consumption provides essential minerals to children in the order of $K > Ca > P > Na > Mg$, with the highest intake in the 1-3-year-old group of children. Despite this, the regular intake of all five essential minerals remained below the recommended dietary allowances for children aged 1 to 12 years.

Key Words: Assessment, Milk, Minerals, Daily intake

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INTRODUCTION

Minerals and vitamins play a vital role in the

body's growth and immune functions.^{1,2} Some minerals may act as cofactors for multiple enzymatic processes in the body.^{3,4} Dairy

products, including milk, are regarded as a good source of calcium and other essential minerals. In most European international locations, dairy products and milk are an essential source of dietary minerals, comprising 10 to 20% of everyday dietary intake of minerals and various trace micronutrients. For centuries, milk has been considered a healthy drink because it is high in a range of nutrients. The U.S. Department of Agriculture has suggestions for 2015 to 2020 that propose that Americans should drink "Fat-lose or low-fat dairy, which includes milk, yogurt, cheese, and/or fortified soy drinks. In Pakistan, especially in Sindh, the nutritional status of children is extremely poor. About 40% of children are underweight.^{5,6} Milk and other dairy products are consumed widely by children and also form a significant food source of essential minerals required to promote growth and development, such as calcium, magnesium, potassium, phosphorus, and zinc, which are required to sustain bone health, electrolyte balance, enzyme functions, and metabolic processes.⁷⁻⁹ It has also been established that regular milk intake helps maintain adequate levels of these minerals in the daily diet, which are vital for proper growth and physiological functioning in childhood.

Milk has also been considered a nutrient-dense food, but the mineral composition of milk can differ based on the animal feed, breed, processing procedures, and geographical location.¹⁰ Human milk and dairy nutrient concentrations have been studied and have emphasized the variability of the mineral levels and the need to determine how the use patterns are converted into real intake.¹¹ Although the nutritional value of milk has been acknowledged, there is a dearth of region-specific evidence that measures the actual input of milk consumption to the daily intake of minerals by children and its role in meeting recommended dietary consumption targets.¹² These data are indispensable in terms of the formulation of evidence-based dietary guidelines and providing proper mineral nutrition in children. Thus, the main objective of the current study was to determine the essential mineral intake in children via daily milk consumption in order to evaluate the nutritional requirements and contribution of daily milk intake in the supply of essential minerals for children and to provide evidence on dietary advice in the field of pediatric nutrition.

MATERIAL AND METHODS

Study Design: This was an experimental study.

Study Place and duration of Study: Institute of Biochemistry, University of Sindh, Jamshoro, from June 2023 to November 2023

Ethical Approval: Ethical approval was obtained from the Institutional Bioethical Committee (Ref: No-IOB 325/2023).

Sample size: A total of 60 milk samples were collected from the different dairy farms located in Jamshoro. All of the milk samples were collected in a sterilized container and immediately carried for analysis. For milk consumption data, more than 1200 children were selected and interviewed in the presence of their parents about their daily milk intake.

Mineral analysis from milk: The mineral content in collected milk samples was determined by the dryashing method described by James.¹³ For which 2 mL of each milk sample was burnt to ash by using a muffle furnace at 550°C. The obtained ash was dissolved in 10 mL of 2M HCl, and the final volume was made up to 90 mL with distilled water and filtered. A quantitative analysis of five selected minerals was performed by using FAAS (Flame Atomic Absorption Spectroscopy).

Determination of the daily intake of essential minerals: Subjects selected for this study were 1-12 years old from the sampling areas. In order to determine the daily intake of essential minerals via milk intake, a questionnaire was designed about the age and daily milk intake of children. Based on the daily intake of milk data, we calculated the intake of essential minerals in individual children, and the mean intake of each essential mineral was obtained based on each group.

The following formula was used to calculate the daily intake of essential minerals.

Daily intake (DI) = C essential minerals × Milk intake (Kg/day)

Where

C concentration of each essential mineral in milk (mg/kg)

Statistical analysis: The data were analysed by using SPSS version 16. The values of the

selected parameters were expressed as minimum, maximum, and mean \pm SD.

RESULTS

Concentrations of selected essential minerals in milk:

The concentration of five selected essential minerals in the milk is shown in **fig 1**. From the data, the ranking order of average concentration of essential minerals in milk was K (1529.21 ± 26.65) > Ca (1209.57 ± 47.36) > P (785.75 ± 25.2) > Na (393.05 ± 15.16) > Mg (157.08 ± 8.13). Higher levels of K in milk may be due to the usage of different artificial fertilizers and slurry in feed. A high level of K in raw milk is associated with excessive utilization of fertilizer in crops^{14,15} Calcium is a major element in milk; about 70% of calcium derives from milk and other dairy goods. Several researchers^{14,16-18} had reported that milk calcium is higher in raw milk containing high protein values. Phosphorus is an important component of milk required for important biological functions of the human body.¹⁹ The present values of phosphorus in milk were higher than those reported by.²⁰⁻²¹ Sodium is the major cation of the extracellular fluid of the body. The sodium level of milk in the present study was higher than in the earlier studies of.^{22,23} Magnesium is one of the most important essential minerals required for various biochemical reactions (more than 300 biochemical reactions) in the body. The mean value of magnesium in the present study was in line with its importance.²⁴

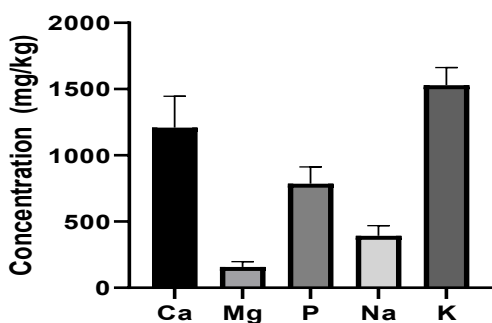


Fig 1: The average concentration of essential minerals in the milk samples (mg/kg)

Daily milk consumption in children: Daily milk consumption in all selected age groups is given in **fig 2**. Data showed that the highest daily milk intake was higher (0.48 ± 0.02 M, 0.439 ± 0.01 F)

in the 1-3 years age group, followed by (0.328 ± 0.01 M, 0.332 ± 0.02 F) 4-8 and (0.284 ± 0.01 M, 0.292 ± 0.01 F) in the 9-12-year age group. Variance in daily milk intake in children may be associated with a dislike of flavour or the use of soft drinks that contain sugar. Number of studies, like²⁴ have reported the good association of milk intake with RDA values of essential minerals.

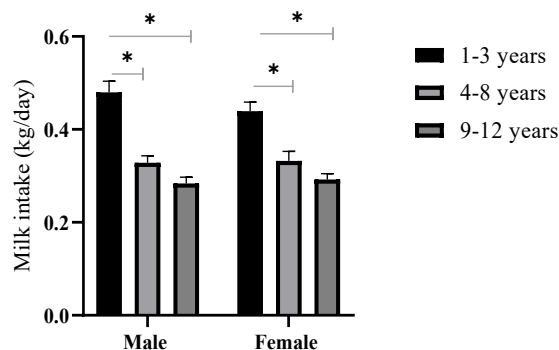


Fig 2: Daily milk consumption by selected age group children

Assessment of essential mineral intake in children:

Assessment of daily intake (DI) of five selected essential minerals (i.e., Ca, Mg, P, Na, and K) in children via daily milk consumption is reported in **table 1**. Among the selected age groups highest daily intake of calcium, 580.59 ± 28.49 mg/day was determined for the 1-3 years age group, while the lowest intake, 343.52 ± 16.23 mg/day for the 9-12 years age group. These reported values of calcium intake in all age groups were lower than the recommended ranges of the Institute of Medicine (IOM, 2011). Number of studies like¹⁴ have reported that daily intake of calcium is far below the recommended ranges of calcium in low- and middle-income countries. The highest daily intake values of magnesium were 75.39 ± 3.7 mg/day in children ranging from 1-3 years, whereas the lowest intake values, 44.61 ± 2.1 mg/day, were noticed in the age group of 9-12 years. Existing values of magnesium daily intake in all age groups were far below their recommended ranges of.²⁵ Low dietary intake of magnesium is associated with several disorders like osteoporosis, cardiovascular and type-2 diabetes.

Phosphorus is one of the essential minerals required for the normal functions of every cell. Regarding phosphorus, inadequate intake was 377.16 ± 18.51 mg/day, found to be higher for children ranging from 1- 3 years old, and the lowest intake was 223.15 ± 10.55 mg/day for children ranging from 9-12 years old. Furthermore, it was pertinent to notice that the daily intake of phosphorus in children was below the recommended ranges of.²⁵

The highest daily intake of sodium was 188.66 ± 9.26 mg/day in children ranging 1-3-year-old, while

the lowest intake, 111.63 ± 5.28 mg/day, was determined in 9-12-year-old children. Compared to the recommended ranges of.²⁵ Sodium intake was found to be far below in all age groups.

Among all age groups, the highest daily intake of potassium, 734.06 ± 36.02 mg/day, was for children ranging 1-3 years old, and the lowest intake value was 434.29 ± 19.26 mg/day in 9–12-year-old children. Lower intake values of potassium were determined in all age groups compared to their recommended ranges.²⁵

Table 1: Showing the summary of the average daily intake of essential minerals for children and their comparison with their reference ranges

Mineral Type	1-3 years group		4-8 years group		9-12 years group	
	Male	Female	Male	Female	Male	Female
Ca						
DI	580.59 ± 156.06	531.40 ± 129.96	397.14 ± 98.58	401.98 ± 135.35	343.52 ± 88.92	353.59 ± 83.42
Reference Range	700	700	1000	1000	1300	1300
Mg						
DI	75.39 ± 20.27	69.01 ± 16.88	51.58 ± 12.81	52.21 ± 17.56	44.61 ± 11.55	45.92 ± 10.83
Reference Range	170	170	230	230	350	250
P						
DI	377.16 ± 101.38	345.20 ± 84.42	257.99 ± 64.04	261.12 ± 87.93	223.15 ± 57.76	229.69 ± 54.19
Reference Range	460	460	500	500	1250	1250
Na						
DI	188.66 ± 50.71	172.68 ± 42.23	129.05 ± 32.03	130.62 ± 43.98	111.63 ± 28.85	114.90 ± 27.12
Reference Range	1000	1000	1200	1200	1500	1500
K						
DI	734.02 ± 197.31	671.83 ± 164.31	502.09 ± 124.63	508.21 ± 171.12	434.29 ± 112.42	447.03 ± 105.46
Reference Range	3000	3000	3800	3800	4500	4500

Reference ranges by the Institute of Medicine (IOM, 2011)

DISCUSSION

The current research examined the intake of the chosen essential minerals (calcium, magnesium, phosphorus, sodium, and potassium) among children aged 1 to 12 years using milk as the source of analysis and established that milk has a significant intake of these minerals, especially in the early years of life. The maximum intake of all the measured minerals was found in the children in the age group of 1-3 years, and the lowest intake was found in the age group of 9-12 years. These results reveal age disparities in the trends of milk consumption and nutritional consequences at the critical periods of growth and development.

The increased mineral dietary patterns among children in the age group of 1-3 years can be explained by the central position of milk in the diet of toddlers, as it is a common source of primary foods in their diet at the time of the transition from breastfeeding or formula feeding to solid foods. At this age, milk is usually taken in relatively copious amounts and offers minerals in highly bioavailable forms, especially calcium and phosphorus, which are vital in the growth of skeletal structures during the early stages. Recent diet studies have recorded comparable results, and they reported that dairy foods contribute significantly to calcium, magnesium, potassium, and phosphorus intake among young children.

Conversely, the reduction in mineral intake based on milk consumption, in older children, especially their age group, 9 years-12 years, may be attributed to the dietary changes, autonomy in food selection, and substitutes in milk with other drinks, including sugar-sweetened beverages. Such a tendency has been recorded in various population-based studies, according to which the decreased intake of milk in late childhood and early adolescence is linked to the decreased overall consumption of major minerals, in particular, calcium and potassium. Such a decrease is nutritionally alarming because late childhood is the time when minerals are highly needed, because bones continue to grow, and the close of the bone mass acquisition stage is approaching.

Generally, the results of this research support the verdict that milk is a useful addition to the diet of children, especially in early childhood. The specified decrease in mineral intake associated with the consumption of milk by older children raises a possible nutritional threat if the alternative sources of minerals are not properly included in the diet. These findings explain the necessity of continuing to use age-appropriate milk intake or similarly nutritionally balanced milk alternatives in balanced children's diets. Future studies need to be conducted to evaluate the total dietary mineral intake of all food sources and determine how to promote sufficient mineral nutrition to older children as milk intake decreases.

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Author's Contribution

AWG: Designed the study, supervised the research, and reviewed the final manuscript.

BRS: Data collection, performed statistical analysis, prepared the figures and tables, and drafted the manuscript.

All the authors have approved the final manuscript draft and accept the responsibility of research integrity.