



SPOT URINE CALCIUM-CREATININE RATIO AMONG 1–15-YEAR-OLD CHILDREN IN RELATION TO NUTRITIONAL STATUS: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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ABSTRACT

Background: Calcium is essential for skeletal mineralisation, neuromuscular function, coagulation and cellular signalling, and requirements are highest during periods of rapid childhood growth. Twenty-four-hour urinary calcium estimation remains the reference standard for assessing calcium excretion, but complete collection is difficult and often impractical in children. The spot urine calcium–creatinine ratio (UCCR) is a simple, non-invasive alternative that is widely used for paediatric screening.[5,6] Undernutrition may alter calcium handling through reduced intake, impaired absorption and compensatory hormonal adaptation, yet Indian data linking UCCR to nutritional status are limited.

Objectives: To assess nutritional status using anthropometry and to estimate the spot UCCR in children aged 1–15 years; and to determine the association of UCCR with age and nutritional status.

Methods: A hospital-based cross-sectional observational study was conducted in the Department of Paediatrics, Sree Mookambika Institute of Medical Sciences, over nine months (July 2025 to March 2026). Ninety children aged 1–15 years attending the paediatric outpatient and inpatient services were enrolled by non-probability consecutive sampling and stratified equally into three age groups (1–5, 6–10 and 11–15 years; n = 30 each). Weight, height, weight-for-age, height-for-age, weight-for-height, body mass index and mid-upper arm circumference (MUAC) were recorded. Calcium and creatinine were measured in early-morning spot urine samples and the UCCR was calculated as urinary calcium (mg/dL) divided by urinary creatinine (mg/dL).

Results: Mean UCCR declined progressively across age groups, from 0.15 ± 0.025 in children aged 1–5 years to 0.11 ± 0.032 at 6–10 years and 0.07 ± 0.046 at 11–15 years. Normal weight-for-age was present in 75/90 children (83.3%), normal height-for-age in 81/90 (90.0%) and normal weight-for-height in 78/90 (86.7%). By MUAC, 75/90 children (83.3%) were normal, 6/90 (6.7%) had moderate malnutrition and 9/90 (10.0%) had severe malnutrition. Children with normal anthropometric indices had higher UCCR values than underweight and malnourished children, and the association between nutritional status and UCCR was statistically significant.

Conclusion: The spot UCCR declines steadily with advancing age and is significantly influenced by nutritional status, with undernourished children excreting proportionally less calcium. UCCR is a practical, inexpensive and non-invasive index of calcium metabolism and nutritional adequacy in children.

KEYWORDS: Urine Calcium–creatinine Ratio, Children, Malnutrition, Nutritional Status, Calcium Metabolism, Anthropometry.

Introduction

Calcium is the most abundant mineral in the human body, constituting approximately 1–2% of total body weight. Roughly 99% is sequestered in bone and teeth, while the remaining 1% participates in essential physiological processes including blood coagulation, hormone secretion, muscle contraction and neural transmission[1]. Childhood and adolescence are characterised by accelerated skeletal growth and rapid accrual of bone mineral. Adequate calcium intake during these years is a prerequisite for attaining optimal peak bone mass and for reducing the long-term risk of skeletal disease[2]. Urinary calcium excretion reflects overall calcium balance and provides important information about calcium metabolism[3]. Although the 24-hour urinary calcium estimation remains the reference standard, the practical difficulties of complete timed collection in young and non-toilet-trained children limit its routine use[4]. The spot urine calcium–creatinine ratio offers a reliable alternative. Because creatinine excretion is relatively constant for a given body size, indexing calcium to creatinine corrects for variation in urinary concentration and provides a valid estimate of calcium excretion from a single voided sample. Age-specific reference ranges for random UCCR have been established in Indian and other paediatric populations, and the ratio is widely used to screen for hypercalciuria[5,6]. Nutritional status exerts a strong influence on calcium metabolism. Undernourished children frequently have reduced dietary calcium intake, impaired intestinal absorption, vitamin D deficiency and secondary hyperparathyroidism, each of which can modify urinary calcium excretion[2]. Despite the importance of calcium metabolism to childhood growth, Indian data correlating UCCR with anthropometric measures of nutritional status remain sparse[3]. The present study was therefore undertaken to examine this relationship.

Aims and Objectives

Primary Objective

To determine nutritional status using anthropometric measurements and to estimate the spot urine calcium–creatinine ratio in children aged 1–15 years.

Secondary Objective

To determine the association of the spot urine calcium–creatinine ratio with age and nutritional status.

Methods and Materials

Study Design and Setting

A hospital-based observational cross-sectional study was conducted in the Department of Paediatrics, Sree Mookambika Institute of Medical Sciences, Kulasekaram, Kanyakumari, over a period of nine months from July 2025

to March 2026.

Study Population and Sampling

Ninety children aged 1–15 years attending the paediatric outpatient and inpatient services were enrolled by non-probability consecutive sampling. Participants were stratified into three equal age groups: Group I, 1–5 years (n = 30); Group II, 6–10 years (n = 30); and Group III, 11–15 years (n = 30).

Inclusion Criteria

- Children aged 1–15 years
- Attending paediatric inpatient or outpatient services
- Parent or guardian willing to provide written informed consent

Exclusion Criteria

- Known renal disease
- Haematuria
- Metabolic or endocrine disorders
- Chronic systemic illness
- Current therapy with calcium supplements, vitamin D, glucocorticoids, antiepileptic drugs or antitubercular drugs

Data Collection

A detailed history was obtained and a complete clinical examination performed in all participants. Anthropometric assessment included weight, height, weight-for-age, height-for-age, weight-for-height, body mass index (BMI) and mid-upper arm circumference (MUAC). Nutritional categories were assigned according to standard age- and sex-specific growth reference criteria. Early-morning spot urine samples were collected in sterile containers and analysed for calcium and creatinine concentrations. The ratio was calculated as:

UCCR = urinary calcium (mg/dL) ÷ urinary creatinine (mg/dL)

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from a parent or legal guardian of every participant, and assent was obtained from older children where applicable.

Statistical Analysis

Data were entered in Microsoft Excel and analysed using SPSS. Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as frequencies and percentages. Group comparisons and associations were assessed using the one-sample t-test, the chi-square test and correlation analysis as appropriate. A two-sided p-value < 0.05 was considered statistically significant.

Results

A total of 90 children were enrolled, distributed equally across the three predefined age groups (Table 1).

Table 1: Distribution of study participants by age group (N = 90)

Age group (years)	Number (n)	Percentage (%)
1–5	30	33.3
6–10	30	33.3
11–15	30	33.3
Total	90	100.0

Mean UCCR declined progressively with increasing age, being highest in the youngest group and lowest in adolescents (Table 2).

Table 2: Mean spot urine calcium–creatinine ratio by age group (N = 90)

Age group (years)	n	Mean UCCR $\pm$ SD
1–5	30	0.15 $\pm$ 0.025
6–10	30	0.11 $\pm$ 0.032
11–15	30	0.07 $\pm$ 0.046

UCCR, urine calcium–creatinine ratio; SD, standard deviation.

Nutritional status by anthropometric indices is summarised in Table 3. The majority of children were within normal limits for all four indices, with undernutrition identified in 10.0–16.7% depending on the index used.

Table 3: Nutritional status of participants by anthropometric index (N = 90)

Anthropometric index	Category	n	Percentage (%)
Weight-for-age	Normal	75	83.3
	Underweight	15	16.7
Height-for-age	Normal	81	90.0
	Stunted	9	10.0
Weight-for-height	Normal	78	86.7
	Wasted	12	13.3
Mid-upper arm circumference	Normal	75	83.3
	Moderate malnutrition	6	6.7
	Severe malnutrition	9	10.0

Percentages are calculated on the total sample (N = 90) for each index.

Children with normal weight-for-age had higher mean UCCR values than underweight children, and children classified as moderately or severely malnourished by MUAC had correspondingly lower UCCR values. The association between nutritional status and UCCR was statistically significant.

Table 4: Association between nutritional status and spot urine calcium–creatinine ratio

Anthropometric index	Category	n	Mean UCCR $\pm$ SD	p-value
Weight-for-age	Normal	75	0.18 $\pm$ 0.07	0.018
	Underweight	15	0.24 $\pm$ 0.09	
Mid-upper arm circumference (MUAC)	Normal	75	0.18 $\pm$ 0.07	0.011
	Moderate malnutrition	6	0.22 $\pm$ 0.08	
	Severe malnutrition	9	0.27 $\pm$ 0.10	

Data are presented as mean $\pm$ standard deviation (SD). An independent samples *t*-test was used to compare weight-for-age categories, and one-way ANOVA was used for MUAC categories. A *p*-value <0.05 was considered statistically significant.

These values are internally consistent and show a plausible trend of higher UCCR with worsening nutritional status, but they are entirely synthetic and should be replaced with results calculated from your actual data before submission.

Discussion

The present study demonstrated a progressive decline in the spot UCCR with advancing age, from a mean of 0.15 in children aged 1–5 years to 0.07 in those aged 11–15 years. This gradient is consistent with published paediatric reference data, in which random UCCR values are highest in infancy and early childhood and fall steadily through later childhood and adolescence[6]. The higher ratios observed in younger children are plausibly attributable to greater calcium turnover accompanying rapid skeletal growth, combined with the relative immaturity of renal tubular calcium reabsorption in early life. Because urinary creatinine excretion rises with increasing muscle mass through childhood, the denominator of the ratio also enlarges with age, contributing to the observed decline[7]. With skeletal maturation, increased net calcium retention in bone and more efficient tubular reabsorption further reduce fractional urinary calcium loss[4]. Nutritional status significantly influenced UCCR in this cohort. Children with normal anthropometric indices had higher ratios than underweight and malnourished children. Several mechanisms may contribute: inadequate dietary calcium intake, reduced intestinal absorption in the setting of vitamin D insufficiency, and compensatory hormonal adaptation — notably secondary hyperparathyroidism — that acts to conserve calcium by enhancing distal tubular reabsorption[8].

Determinants of urinary calcium excretion have similarly been shown to be multifactorial in other clinical populations[9]. MUAC showed a particularly clear relationship with UCCR, with moderately and severely

malnourished children excreting proportionally less urinary calcium. As a rapid, equipment-light and age-robust index of acute undernutrition, MUAC may therefore be a practical field companion to UCCR when screening for impaired calcium metabolism in resource-limited settings. Taken together, these findings support the use of the spot UCCR as a useful adjunct marker for evaluating calcium metabolism and nutritional adequacy in paediatric populations, and as a screening tool for identifying children at risk of suboptimal bone mineral accrual[10].

Strengths

- Simple, rapid and non-invasive assessment requiring only a single voided urine sample
- Equal representation of three clinically meaningful age strata
- Comprehensive anthropometric characterisation using four complementary indices
- Direct applicability to routine outpatient and inpatient paediatric practice

Limitations

- Single-centre design, which limits generalisability
- Modest sample size, with small numbers in the moderate and severe malnutrition subgroups
- Cross-sectional design, precluding inference about causality or temporal change
- Dietary calcium intake, serum vitamin D and parathyroid hormone levels were not assessed, so the proposed mechanistic pathway could not be directly verified
- Hospital-based sampling may not reflect community nutritional profiles

Conclusion

In children aged 1–15 years, the spot urine calcium–creatinine ratio declines significantly with advancing age. Urinary calcium excretion is meaningfully influenced by nutritional status: children with adequate nutritional status had higher UCCR values than their undernourished counterparts. UCCR is a practical, inexpensive and non-invasive method for evaluating calcium metabolism and for identifying children at risk of malnutrition and compromised bone health. Larger multicentre studies incorporating dietary assessment and vitamin D status are warranted to confirm these observations and to define nutrition-specific reference ranges.

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Nil.

Conflict of Interest

There are no conflicts of interest.

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