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Urinary Magnesium, Calcium, and Phosphorus to Creatinine Ratios of Healthy Elementary School Lebanese Children

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Abstract Urinary magnesium (Mg), calcium (Ca), and phosphorus (P) excretions are known to vary greatly between populations due to dietary habits, physical activity, mineral content of water, climate, genetics, and race. Thus, it is essential to determine the normal values in each population in order to assess the status as well as to diagnose any possible abnormality of metabolisms especially hypercalciuria. A study was conducted to determine urinary Mg/creatinine (Cr), Ca/Cr, and P/Cr ratios of healthy Lebanese elementary schoolchildren. Using a multi-stage cluster sampling at district, school, and class levels, a sample of 1403 children (781 boys and 622 girls), from 26 different schools, was selected. Non-fasting morning urine samples and anthropometric data were collected and analyzed. The mean Mg/Cr, Ca/Cr, and P/Cr ratios were 0.122 ± 0.075 mg/mg (0.568 ± 0.348 mM/mM), 0.084 ± 0.101 mg/mg (0.237 ± 0.286 mM/mM), and 0.692 ± 0.417 mg/mg (2.527 ± 1.524 mM/mM), respectively, with no significant difference between boys and girls (P = 0.706, 0.161, and 0.604; respectively). The 95th percentile of Mg/Cr, Ca/Cr, and P/Cr ratios fluctuated with age, showing a sharp decrease in Ca/Cr and P/Cr at the age of 10. The mean Mg/Cr, Ca/Cr, and P/Cr ratios were comparable to those of similar age groups in other populations. The 95th percentiles of Mg/Cr, Ca/Cr, and P/Cr ratios were 0.26 mg/mg (1.23 mM/mM), 0.27 mg/mg (0.76 mM/mM), and 1.48 mg/mg (5.40 mM/mM), respectively. These values can be used as cutoffs to detect abnormalities in these three minerals' metabolisms among healthy Lebanese children.

Keywords Urinary Mg/Cr ratio · Ca/Cr ratio · P/Cr ratio · Reference values · Children · Lebanon

Introduction

The optimal growth and development of children are shaped by several factors including adequate nutrition and mineral intake particularly of magnesium (Mg), calcium (Ca), and phosphorus (P). The status of these minerals is known to be controlled by dietary and metabolic factors that affect their urinary excretion. Accordingly, the urinary excretion of Mg, Ca, and P is a good marker that reflects the status and a reliable indicator that highlights the presence of metabolic abnormalities.

In general, 24-h urine collection during schooldays is impractical and, therefore, the use of spot urine samples is often employed to assess urinary excretion of minerals. The measurement of solute/Cr ratios using spot urine samples is extensively performed in children [1–7] due to its usefulness, feasibility, and the strong linear relationships between total mineral excretions and mineral/Cr ratio [1, 8–12]. Non-fasting random spot urine samples, when analyzed, showed stronger associations as compared to fasting samples, and therefore, they are adopted for screening purposes [13].

The detection of mineral metabolic disorders requires comparing urinary mineral excretions to normal reference values [1]. While urinary Mg, Ca, and P reference standards for adults are known to range within relatively narrow limits,

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the values for the pediatric population seem to vary widely among different populations according to children's race, country, and age [1–5, 8, 9]. These variations are largely responsible for the absence of defined reference values.

Reference values for Mg, Ca, and P excretion, to the best of our knowledge, have not been determined for Lebanese children. Accordingly, the objective of this study was to determine the reference values for urinary Mg/Cr, Ca/Cr, and P/Cr ratios of healthy 6- to 10-year-old Lebanese children.

Materials and Methods

This work is part of a wider project that focused on determining urinary mineral concentration in Lebanese elementary schoolchildren.

Study Population

A cross-sectional study was carried out between March 2013 and January 2014. A total of 1403 (781 boys and 622 girls) healthy elementary students (6 to 10 years old) were randomly selected from 26 schools, using a multi-stage cluster sampling procedure. School-based sampling was used as the average enrollment rate in Lebanese elementary children which was 96 % in 2012, according to World Bank data. The study protocol was approved by the Institutional Review Board of the American University of Beirut, and recruitment was coordinated with the Ministry of Education and Higher Education. In brief, the number of schools required per district was calculated proportional to total number of schools per district and within districts; schools were selected using simple random selection from a comprehensive school listing. Parents who provided consent were asked to fill a health questionnaire and children having chronic or acute illness or receiving any medical treatments were excluded from the study. Children of consenting parents were asked to sign an assent form. In a follow-up visit, height and weight of children were measured using standard procedures and non-fasting urine samples were collected between 9:00 a.m. and 1:00 p.m. and aliquots were stored at −20 °C until analyzed.

Analysis of Minerals

Urine samples were defrosted and acidified with dilute hydrochloric acid (HCl) to prevent mineral precipitation [8] that may affect the accuracy of the results. In brief, 75 μl of HCl solution (36 M of HCl:H_2O in 1:5(*v*/*v*)) was added to 5 ml of urine to bring pH of the specimens between 3 and 4. Mg, Ca, and P were determined by the absorbance of the colored complex with formazan, the colorimetric reactions with Arsenazo III dye, and the ammonium molybdate, respectively, and Cr was measured by the two-point rate procedure, all using VITROS 350 analyzer (Ortho Clinical Diagnostics, Johnson and Johnson, Buckinghamshire, United Kingdom).

Internal Control

Pooled urine specimens were used as internal control (IC) to determine within and between run coefficients of variance (CV). Three measurements of Mg, Ca, P, and Cr of the QC sample were carried out after every 30 sample determinations, having a minimum average of 3 QC per run. The between-runs CV of Mg, Ca, P, and Cr were 5.1, 5.5, 2.4, and 3.8 %, respectively, while the within-runs CV were 2.24, 0.73, 1.33, and 1.77 %.

Cr excretions in mg/kg/day (mM/kg/day) were calculated using the equation of Remer et al. [14].

Statistical Analysis

Statistical analysis was performed using SPSS 21 (IBM SPSS). Statistical significance was set at a P value <0.05. Results are presented as means ± standard deviation (SD) for quantitative variables and percent for categorical variables. Data were stratified by sex and/or by five age groups (6–6.9, 7–7.9, 8–8.9, 9–9.9, and 10–10.9). Two-sample independent t test was used to identify differences by sex and one-way ANOVA to evaluate differences among age groups, and means were separated by Fisher's test when F values were significant. The Anderson-Darling test for normality revealed that the Mg/Cr, Ca/Cr, and P/Cr ratios did not follow Gaussian distribution and were skewed to the right. Despite deviation from normality assumption, parametric tests were used, given that these tests are acceptable under condition of large sample size.

Six subjects were excluded due to insufficient urine volume and other two subjects (outliers) were excluded based on the Anderson-Darling normality test.

Results

The study involved 1395 children, 777 boys and 618 girls (with a boy/girl ratio of 1.3/1) aged from 6 to 10 years. Body weight was similar between boys and girls, while height was marginally significant (P = 0.049), with the girls being 1 cm taller on average. There was no significant difference in BMI (P = 0.714) (Table 1). The average Cr excretion was 16.988 ± 2.145 mg/kg/day (0.150 ± 0.019 mM/kg/day); boys and girls had similar means (P = 0.109) (Table 2) and the excretion was found to increase with age (P < 0.001) (Table 3).

No significant differences were detected in mean Mg/Cr, Ca/Cr, and P/Cr ratios between boys and girls (Table 2). These ratios showed a slight decrease with age, but this decrease

Table 1 Anthropometric measurements of the sample population

	Total (1395)	Boys (778)	Girls (617)	*P* value
Weight (kg)	28.31 ± 7.88	28.12 ± 7.73	28.56 ± 8.06	0.299
Height (cm)	127.1 ± 9.7	126.6 ± 9.4	127.7 ± 10.1	0.049*
BMI (kg/m^2)	17.25 ± 2.75	17.28 ± 2.81	17.22 ± 2.67	0.710

All values are reported as mean ± SD. The number presented between brackets is the sample size. Significance is set at $P < 0.05$

only reached statistical significance with P/Cr ($P = 0.172$ for Mg/Cr; $P = 0.373$ for Ca/Cr; $P < 0.001$ for P/Cr; Table 3).

The mean Ca/P ratio was 0.146 ± 0.190 mg/mg (0.113 ± 0.147 mM/mM) and did not exhibit sex-related ($P = 0.366$; Table 2) and age-related ($P = 0.382$; Table 3) differences.

Since mineral to Cr ratios did not differ between boys and girls, no further analyses were reported according to sex.

Percentile analysis showed that the 50th percentile of Mg/Cr ratio was 0.11 mg/mg (0.50 mM/mM); it slightly declined from 0.12 mg/mg (0.56 mM/mM) at the age of 6–6.9 to reach 0.10 mg/mg (0.47 mM/mM) at the age of 10–10.9. The 95th percentile was 0.26 mg/mg (1.21 mM/mM) and showed minor variations between the different age groups with the highest value of 0.28 mg/mg (1.3 mM/mM) for the age of 7–8.9 and the lowest value of 0.25 mg/mg (1.16 mM/mM) for the age of 9–10.9 (Fig. 1).

The 50th percentile of Ca/Cr ratio was around 0.05 mg/mg (0.14 mM/mM) and exhibited slight variations with age, while the upper limit (95th percentile) was 0.27 mg/mg (0.76 mM/mM) and ranged from 0.23 mg/mg (0.65 mM/mM) to 0.31 mg/mg (0.87 mM/mM) across age groups (Fig. 2).

Moreover, the 50th percentile of P/Cr ratio was 0.60 mg/mg (0.31 mM/mM) and decreased slightly with age from 0.67 mg/mg (2.58 mM/mM) to 0.48 mg/mg (1.84 mM/mM). The 95th percentile of all age groups was 1.48 mg/mg (5.69 mM/mM), and this was almost stable across the different age groups, except for a drop to 1.22 mg/mg (4.69 mM/mM) in the oldest age group (Fig. 3).

Discussion

The mean Cr excretion was similar to other populations, and it was shown to increase with age in line with the findings of Remer et al. [14].

Urinary excretion of Mg, Ca, and P is known to decrease with age especially in the first few years of life [4] and after the age of 10 [1, 2, 4, 15] due to an increased rate of mineral retention as a result of growth spurt [16]. Thus, our selected age group falls within the range of minimally affected age, and this was the rationale behind the choice of this particular age range.

Our results showed that mean Mg/Cr ratio of Lebanese elementary schoolchildren (0.122 ± 0.075 mg/mg or 0.568 ± 0.348 mM/mM) was higher than that of Iranian (7–10 years old) (0.035 ± 0.015 mg/mg) [1] and Taiwanese (7–10 year olds) (0.027 ± 0.015 mg/mg; measured on fasting urine samples) [2]. However, the observed ratio was lower than the values reported for 1–15-year-old British (0.21 ± 0.1 mg/mg) [17] and 3–14-year-old Americans (0.161 ± 0.011 mg/mg) [18], possibly due to the wider age brackets of the surveyed children since higher values are reported in the first few years of life [1, 4]. Mean Ca/Cr ratio of Lebanese children (0.084 ± 0.101 mg/mg or 0.237 ± 0.286 mM/mM) was fairly close to that of American Caucasians [19], Turkish [20], and German [14] children with averages of 0.08 mg/mg, 0.092 ± 0.123 mg/mg, and 0.272 ± 0.21 mmol/mmol (0.096 ± 0.074 mg/mg), respectively. The mean Ca/Cr ratio was 15 to 30 % lower than that of Korean (0.10 ± 0.09 mg/mg) [21], Argentinian (0.103 + 0.076 mg/mg) [3], and Thai (0.12 ± 0.12 mg/mg) [7] children and almost twice as those of African-American (0.04 mg/mg) [19], Iranian (0.039 ± 0.044 mg/mg) [1], Swedish (0.043 ± 0.346 mg/mg) [5], and Taiwanese (0.055 ± 0.044 mg/mg) [2] children. Additionally, the mean P/Cr ratio (0.692 ± 0.417 mg/mg or 2.660 ± 1.603 mM/mM) of Lebanese children was higher than that of Iranian [1] and Taiwanese [2] children of comparable age range and close to that of children living in Florida (0.72 ± 0.08 mg/mg) [22].

Table 2 Magnesium to creatinine (Mg/Cr), calcium to creatinine (Ca/Cr), phosphorus to creatinine (P/Cr), and calcium to phosphorus (Ca/P) ratios of elementary Lebanese schoolchildren

Urinary excretion	Total (1395)		Boys (778)		Girls (617)		*P* value
	mg/kg/day	mM/kg/day	mg/kg/day	mM/kg/day	mg/kg/day	mM/kg/day	
Cr	16.988 ± 2.145	0.150 ± 0.019	16.910 ± 2.170	0.150 ± 0.019	17.088 ± 2.112	0.151 ± 0.019	0.109
Mg/Cr	0.122 ± 0.075	0.568 ± 0.348	0.121 ± 0.075	0.565 ± 0.347	0.123 ± 0.075	0.572 ± 0.350	0.706
Ca/Cr	0.084 ± 0.101	0.237 ± 0.286	0.087 ± 0.112	0.246 ± 0.316	0.080 ± 0.086	0.225 ± 0.243	0.161
P/Cr	0.692 ± 0.417	2.660 ± 1.603	0.687 ± 0.412	2.640 ± 1.584	0.698 ± 0.424	2.683 ± 1.630	0.604
Ca/P	0.146 ± 0.190	0.113 ± 0.147	0.150 ± 0.197	0.116 ± 0.152	0.141 ± 0.181	0.109 ± 0.140	0.366

All values are reported as mean ± SD. The number between brackets is the sample size. Significance is set at $P < 0.05$ for the difference between boys and girls. Significance is set at $P < 0.05$ for the difference between boys and girls

Table 3 Age-related differences of Mg/Cr, Ca/Cr, P/Cr, and Ca/P ratios of elementary Lebanese schoolchildren

Age Years	Sample *n*	Mg/Cr mg/mg	Ca/Cr	P/Cr	Ca/P	Cr mg/kg/d
		mM/mM				mM/kg/d
6–6.9	325	0.126 ± 0.074	0.091 ± 0.122	0.759 ± 0.410[a]	0.141 ± 0.185	16.499 ± 1.736[a]
		0.589 ± 0.346	0.257 ± 0.345	2.917 ± 1.576	0.109 ± 0.143	0.146 ± 0.015
7–7.9	347	0.125 ± 0.079	0.083 ± 0.103	0.708 ± 0.400[a]	0.133 ± 0.175	16.676 ± 1.925[a]
		0.583 ± 0.366	0.233 ± 0.291	2.721 ± 1.537	0.103 ± 0.135	0.147 ± 0.017
8–8.9	301	0.122 ± 0.077	0.087 ± 0.091	0.730 ± 0.454[ab]	0.147 ± 0.188	17.212 ± 2.092[b]
		0.568 ± 0.360	0.246 ± 0.256	2.806 ± 1.745	0.114 ± 0.145	0.152 ± 0.0185
9–9.9	214	0.120 ± 0.070	0.078 ± 0.090	0.642 ± 0.435[b]	0.159 ± 0.209	17.377 ± 2.277[b]
		0.561 ± 0.328	0.220 ± 0.254	2.468 ± 1.672	0.123 ± 0.162	0.154 ± 0.020
10–10.9	208	0.111 ± 0.069	0.075 ± 0.087	0.556 ± 0.345[c]	0.161 ± 0.207	17.559 ± 2.711[b]
		0.517 ± 0.320	0.212 ± 0.246	2.137 ± 1.326	0.124 ± 0.160	0.155 ± 0.024
Total	1395	0.122 ± 0.075	0.084 ± 0.101	0.692 ± 0.417	0.146 ± 0.190	16.988 ± 2.145
		0.568 ± 0.348	0.237 ± 0.286	2.660 ± 1.603	0.113 ± 0.147	0.150 ± 0.019
P value		0.172	0.373	<0.001	0.382	<0.001

All values are reported as mean ± SD. One-way ANOVA was used to study differences in Ca and P excretion among age groups. Significance is set at $P < 0.05$. Subgroup analysis is performed using Fisher method. Categories not sharing the same letter are significantly different

The different values in the aforementioned populations can be related to varied dietary patterns and behaviors with, for example, the high phytate intake [23] of Iranians which is known to inhibit the absorption of minerals. Additionally, the low ratio in Taiwanese children [2] might be related to their low intake of dairy products [24] which are good food sources of Ca and P.

In line with other findings, similar values were found for boys and girls regarding urinary Mg/Cr [2, 4], Ca/Cr [1, 6, 7, 20, 21], and P/Cr ratios [1, 2, 4]. This similarity could be directly related to the pre-pubertal age range of the selected sample.

The observed modest decrease of Mg/Cr and Ca/Cr ratios with age, which failed to reach significance ($P > 0.05$), may be attributed, at least in part, to the narrower age bracket of children surveyed in the present work. However, this was not reported by several studies [1, 4, 5], which had different age distributions. The observed decrease in P/Cr ratio with age was in line with other countries including Iran [1], Taiwan [2], Switzerland [4], and Spain [15], using similar age groups, though the magnitude of the decrease is expected to be exacerbated after the age of 10 [1, 2].

The upper limit or the 95th percentile, which reflects the potential existence of metabolic abnormalities, was found to

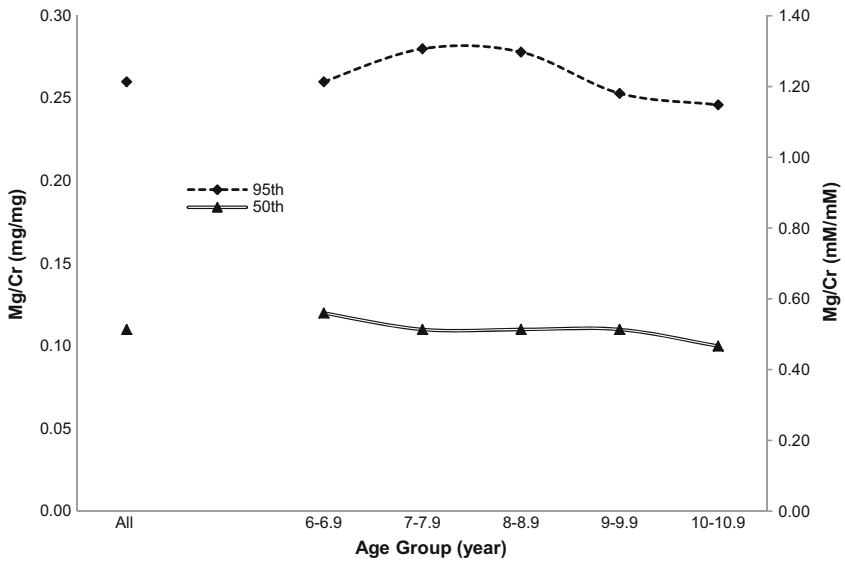

Fig. 1 Reference values for Mg/Cr ratio for elementary Lebanese schoolchildren

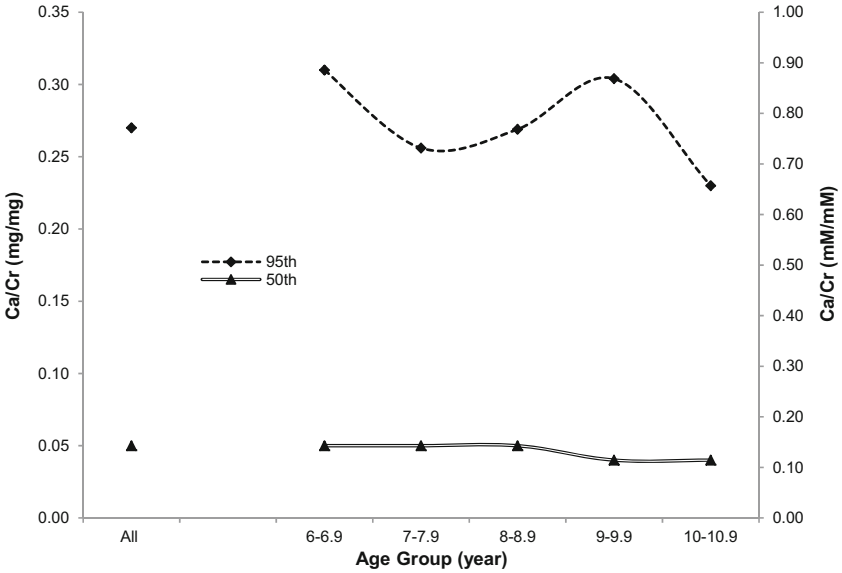

Fig. 2 Reference values for Ca/Cr ratio for elementary Lebanese schoolchildren

be 0.26 mg/mg (1.21 mM/mM) for Mg/Cr, and this fall between the values reported in Spain (0.28 mg/mg) [15] and Switzerland (0.21 mg/mg) [4]. For Ca/Cr ratio, the 95th percentile in our population (0.27 mg/mg or 0.76 mM/mM) was close to other reported values ranging from 0.25 to 0.29 mg/mg [3, 4, 7, 15, 20] and was similar to that obtained by Metz [25] for 5–10-year-old children (0.248 mg/mg) from meta-analysis of 4386 urine samples of children reported in 14 studies. The 95th percentile for Ca/Cr ratio was used by many workers to detect hypercalciuria; Ca/Cr ratios higher than 0.21 mg/mg for fasting [3, 26] or casual [20, 27] samples and 0.27 mg/mg for random non-fasting ones [26] have been suggested in the literature as being indicative of hypercalciuria. Within this framework, the incidence of hypercalciuria among Lebanese children would be estimated at 9.2 and 6.8 % using a cutoff of 0.21 mg/mg [20, 27] and 0.248 mg/mg [25], respectively. The percentages of hypercalciuria among Lebanese children, using different reference values (0.21, 0.248, and 0.27 mg/mg), were within the range of hypercalciuria reported among children of comparable age from different countries [27].

It is plausible that the similarities in ratios between Lebanese and Spanish children may have been brought about by their Mediterranean climate and broadly similar dietary habits. The low ratios reported for Iranian children may be related to the presence of high levels of phytate [23, 28] which is known to inhibit minerals' absorption. The relatively low ratios of Taiwanese children [2] may be linked, at least in part, to the use of fasting urine samples, rather than random spot urine samples.

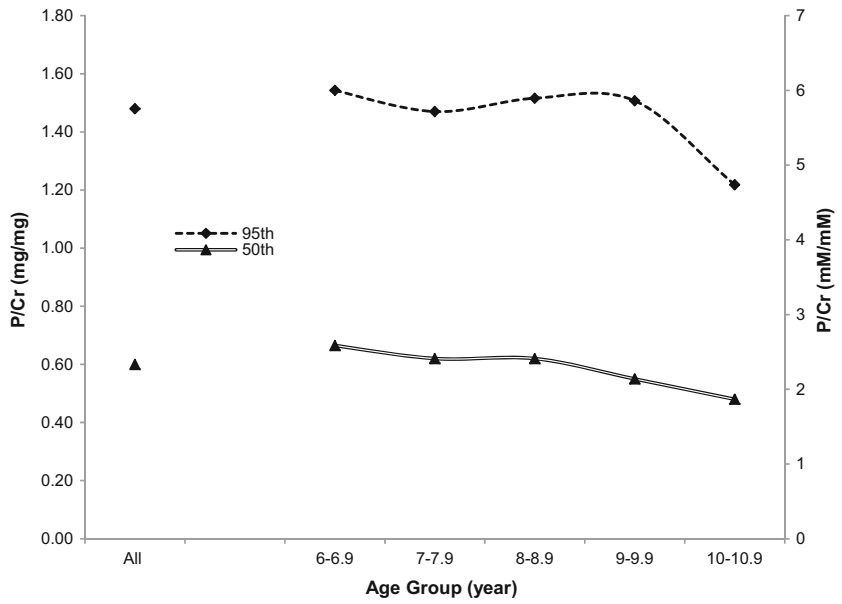

Fig. 3 Reference values for P/Cr ratio for elementary Lebanese schoolchildren

The observed 95th percentile of P/Cr ratio (1.48 mg/mg or 5.69 mM/mM) was lower than that of Spanish [15] and higher than that of Iranian [1], Swiss [4], Taiwanese [2], and Indian [29] children.

Similar to the means, the slight decrease in the 95th percentile after the age 10 is expected to become more pronounced in teenagers [1, 2, 4] due to increased rate of mineral (including Mg) retention and bone deposition especially in children older than 12 [16, 30].

In our population, the inter-individual variability, as reflected by standard deviation (SD), was 120 % of the mean for Ca and 60 % for Mg and P. This seems to be comparable to that of other populations, in which the SD has been reported to vary between 42.8 and 112.8 % [1–3, 5, 17, 21], between 44 and 55 % [1, 2, 17], and between 11.1 and 36.9 % for Ca, Mg, and P, respectively. The similarity of percentage of hypercalciuria with other populations may imply that the inter-individual difference in Ca excretion may have been attributed to varied levels of intake rather than excretion [27].

In brief, the mean Mg/Cr, Ca/Cr, and P/Cr reference values were similar to others. Despite the wide variability around the mean, the rate of hypercalciuria (7 to 8 %), calculated using different cutoffs, was found to be similar to that of other populations [27]. This finding, as well as the skewed to the right distribution, suggests a high rate of low Ca excretion that could be related to several factors including low intake, low absorption, and high reabsorption.

In fact, mineral accretion in this age range is known to be low as compared to older children and adolescents [16, 30]. The relatively low mean Ca intake of 10- to 16-year-old Lebanese students [31] has been attributed to several factors, including low vitamin D status and high phytate intake, which hinder the absorption of Ca. Despite the sunny weather that characterizes the Middle East and North Africa (MENA) region, hypovitaminosis D remains a common health problem in this area [32]. This epidemic does not spare the pediatric population. According to a number of workers [31, 32], a significant proportion of Lebanese students do not meet adequate intakes of vitamin D and suffer from vitamin D insufficiency. To this end, a low vitamin D status inhibits Ca absorption [33] and triggers parathyroid hormone (PTH) secretion which enhances Ca reabsorption and, therefore, reduces its excretion [34]. Moreover, according to the FAO (2011), more than one-third of the energy ingested by the Lebanese comes from cereals, mainly bread which is known to contain significant amounts of phytate due to the short leavening time employed in the preparation of Arabic bread [35]. Phosphate in phytate molecules is unavailable and it inhibits in a pronounced manner the absorption of Ca and Mg [36]. Therefore, it is reasonable to postulate that the observed Ca/P ratio is mainly modulated by decreased excretion of Ca.

In conclusion, a large representative sample of healthy elementary schoolchildren was studied to establish age-related reference values for urinary Mg/Cr, Ca/Cr, and P/Cr which would be important in the diagnosis of abnormalities in Mg, Ca, and P metabolisms among Lebanese children. Our results (means and reference values) were similar to those reported in other countries; however, the wide inter-individual variability may be attributed to different dietary habits and lifestyle patterns within our population.

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Conflict of Interest The authors declare that they have no competing interests.

References

1. Safarinejad MR (2003) Urinary mineral excretion in healthy Iranian children. Pediatr Nephrol 18:140–144
2. Chen LAJ, Chen CH, Chesney RW, Stapleton FB, Roy S (1994) Urinary mineral excretion among normal Taiwanese children. Pediatr Nephrol 8:36–39
3. Alconcher LF, Castro C, Quintana D, Abt N, Moran L, Gonzalez L, Cella M, Torelli M (1997) Urinary calcium excretion in healthy school children. Pediatr Nephrol 11:186–188
4. Matos V, Melle G, Boulat O, Markert M, Bachmann C, Guignard JP (1997) Urinary phosphate/creatinine, calcium/creatinine, and magnesium/creatinine ratios in a healthy pediatric population. J Pediatr 131:252–257
5. Esbjorner E, Jones I (1995) Urinary calcium excretion in Swedish children. Acta Paediatr 84:156–159
6. Sorkhi H, Aahmadi MH (2005) Urinary calcium to creatinin ratio in children. Indian J Pediatr 72:1055–1056
7. Vachvanichsanong P, Lebel L, Moore ES (2000) Urinary calcium excretion in healthy Thai children. Pediatr Nephrol14:847–850
8. Foley KF, Boccuzzi L (2010) Urine calcium: laboratory measurement and clinical utility. Lab Med 41:683–686
9. Reusz GS, Dobos M, Byrd D, Sallay P, Miltényi M, Tulassay T (1995) Urinary calcium and oxalate excretion in children. Pediatr Nephrol 9:39–44
10. Gökçe Ç, Gökçe Ö, Baydinc C, Īlhan N, Alaşehirli E, Özküçük F, Tasci M, Atikeler K., Haika C, Arslan N (1991) Use of random urine samples to estimate total urinary calcium and phosphate excretion. Arch Intern Med 151:1587–1588
11. Nordin B (1959) Assessment of calcium excretion from the urinary calcium/creatinine ratio. Lancet 274:368–371
12. Tang NL, Cran YK, Hui E, Woo J (2000) Application of urine magnesium/creatinine ratio as an indicator for insufficient magnesium intake. Clin Biochem 33:675–678
13. Rath B, Aggarwal MK, Mishra TK, Talukdar B, Murthy NS, Kabi BC (1994) Urinary calcium creatinine ratio and hypercalciuria. Indian Pediatr 31:311–311
14. Remer TA, Neubert C, Maser-Gluth (2002) Anthropometry-based reference values for 24-h urinary creatinine excretion during growth and their use in endocrine and nutritional research. Am J Clin Nutr 75:561–569
15. Sáez-Torres C, Rodrigo D, Grases F, García-Raja AM, Gómez C, Lumbreras J, Frontera G (2014) Urinary excretion of calcium, magnesium, phosphate, citrate, oxalate, and uric acid by healthy schoolchildren using a 12-h collection protocol. Pediatr Nephrol 29:1201–1208

16. Joint, FAO and WHO (2005) Vitamin and mineral requirements in human nutrition
17. Ghazali S, Barratt T (1974) Urinary excretion of calcium and magnesium in children. Arch Dis Child 49:97–101
18. Mirčetić RN, Dodig S, Raos M, Petres B, Cepelak I (2001) Magnesium concentration in plasma, leukocytes and urine of children with intermittent asthma. Clin Chim Acta 312:197–203
19. So NP, Osorio AV, Simon SD, Alon US (2001) Normal urinary calcium/creatinine ratios in African-American and Caucasian children. Pediatr Nephrol 16:133–139
20. Sönmez F, Akcanal B, Altıncık A, Yenisey C (2007) Urinary calcium excretion in healthy Turkish children. Int Urol Nephrol 39:917–922
21. Choi IS, Jung ES, Choi YE, Cho YK., Yang EM, Kim CJ (2013) Random urinary calcium/creatinine ratio for screening hypercalciuria in children with hematuria. Ann Lab Med 33:401–405
22. Malone JI, Lowitt S, Duncan JA, Shah SC, Vargas A, Root AW (1986) Hypercalciuria, hyperphosphaturia, and growth retardation in children with diabetes mellitus. Pediatrics 78:298–304
23. Roohani N, Hurrell R, Wegmueller R, Schulin R (2012) Zinc and phytic acid in major foods consumed by a rural and a suburban population in central Iran. J Food Comp Anal 28:8–15
24. Pan WH, Wu HJ, Yeh CJ, Chuang SY, Chang HY, Yeh NH, Hsieh YT (2011) Diet and health trends in Taiwan: comparison of two nutrition and health surveys from 1993-1996 and 2005-2008. Asia Pac J Clin Nutr 20:238–250
25. Metz MP (2006) Determining urinary calcium/creatinine cut-offs for the paediatric population using published data. Ann Clin Biochem 43:398–401
26. Stapleton FB (1990) Idiopathic hypercalciuria: association with isolated hematuria and risk for urolithiasis in children. The Southwest Pediatric Nephrology Study Group. Kidney Int 37: 807–811
27. Koyun M, Güven AG, Filiz S, Akman S, Akbas H, Baysal YE, Dedeoglu N (2007) Screening for hypercalciuria in schoolchildren: what should be the criteria for diagnosis? Pediatr Nephrol 22:1297–1301
28. Mehrjardi MM, Dehghani A, Jahed Khaniki GR, Shah Hosseini F, Hajimohammadi B, Nazary N (2014) Determination of phytic acid content in different types of bread and dough consumed in Yazd, Iran. Journal of Food Quality and Hazards Control 1:29–31
29. Sweid HA, Bagga A, Vaswani M, Vasudev V, Ahuja RK, Srivastava RN (1997) Urinary excretion of minerals, oxalate, and uric acid in north Indian children. Pediatr Nephrol 11:189–192
30. Theintz G, Buchs B, Rizzoli R, Slosman D, Clavien H, Sizonenko PC, Bonjour JP (1992) Longitudinal monitoring of bone mass accumulation in healthy adolescents: evidence for a marked reduction after 16 years of age at the levels of lumbar spine and femoral neck in female subjects. J Clin Endocrinol Metab 75:1060–1065
31. Salamoun MM, Kizirian AS, Tannous RI, Nabulsi MM, Choucair MK, Deeb ME, El-Hajj Fuleihan GA (2004) Low calcium and vitamin D intake in healthy children and adolescents and their correlates. Eur J Clin Nutr 59:177–184
32. El-Hajj Fuleihan G, Nabulsi M, Choucair M, Salamoun M, Hajj Shahine C, Kizirian A, Tannous R (2001) Hypovitaminosis D in healthy schoolchildren. Pediatrics 107:e53–e60
33. DeLuca HF (2004) Overview of general physiologic features and functions of vitamin D. Am J Clin Nutr 80:1689S–1696S
34. Bouhtiauy I, Lajeunesse D, Brunette M (1991) The mechanism of parathyroid hormone action on calcium reabsorption by the distal tubule. Endocrinology 128:251–258
35. Lopez HW, Krespine V, Guy C, Messager A, Demigne C, Remesy C (2001) Prolonged fermentation of whole wheat sourdough reduces phytate level and increases soluble magnesium. J Agric Food Chem 49:2657–2662
36. Shils ME, Shike M (2006) Modern nutrition in health and disease. Lippincott Williams & Wilkins