Physiol. Res. 47: 35–40, 1998

Calciuria, Magnesiuria and Creatininuria – Relation to Age

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Received July 1, 1997
Accepted October 1, 1997

Summary

We assessed the concentration of calcium, magnesium and creatinine in 2715 samples of the first morning urine. The investigation comprised the following age groups: children one, two, four, six, ten and thirteen years old, and groups of adults aged 18–35, 36–49, 50–65, 66–75, 76–85 and 86–93 years. The choice was made by random selection of participants of both sexes from diverse regions of the Czech Republic. We found the age to have a marked influence on the value of calcium, magnesium and creatinine, including urinary concentration ratios of calcium/creatinine and magnesium/creatinine. The urinary calcium concentration was low both in the early and advanced age groups, while it reached peak values in subjects 18–35 years old. The urinary magnesium concentration was also age-dependent, with a maximum in children aged 4 years, and a subsequent decline with advancing age. The value of the ratio urinary calcium/creatinine and urinary magnesium/creatinine was highest in the youngest age group (1–4 years).

Key words
Calcium – Magnesium – Creatinine – Urine – Age – Humans

Introduction

The calcium and magnesium content in the organism is the result of the balance between their intake and excretion, predominantly by urine. The principal regulatory mechanism for homeostasis of magnesaemia is renal excretion. In a recent paper (Šimečková *et al.* 1996), we reported on the age relation of urinary magnesium concentrations, which, in our investigated group consisting of subjects 6–65 years old, was gradually declining with advancing age from the sixth year of age onwards, while calciuria did not change significantly during the whole period under investigation. In the present study, we extended the set so as to include children aged 1, 2 and 4 years, and seniors aged 66–93 years, and we also supplemented the basic groups (6–65 years old probands). We assessed calcium, magnesium and creatinine concentrations in the first morning urine. The latter as the basic parameter of glomerular filtration and protein metabolism. For this reason, many authors express the urinary excretion of investigated compounds in terms of creatinine concentration.

Material and Methods

Altogether, 2715 urinary samples were measured. The investigated group consisted of children one to thirteen years old, and of adults aged 18–93 years. The participants of both sexes were randomly selected from diverse regions of the Czech Republic, excluding diabetic patients. Since our last study (Šimečková *et al.* 1996) did not find any significant differences between men and women, we did not differentiate between genders in the individual age groups of the present study.

PHYSIOLOGICAL RESEARCH *ISSN 0862-8408*

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The calcium concentration was assessed in the morning urinary sample, after an overnight fast, by the Merckotest (photometric assessment according to Young), magnesium by the Merckotest (photometric estimation by Bohuon's method) using a Merck Vitalab Eclipse apparatus. The methods were verified in 600 urinary samples by calcium and magnesium assay using the emission spectrometry method with the spectrometer ICP-OES model OPTIMA 3000 DV from Perkin Elmer. The results of both methods were in agreement. The creatinine concentration was determined by the Merckotest (photometric estimation by Helger's method).

Statistics

Statistical analysis was carried out using the Statgraphic plus 7.0 programme. We used the following statistical methods: descriptive statistics, two sample analysis and ANOVA (one way analysis of variance).

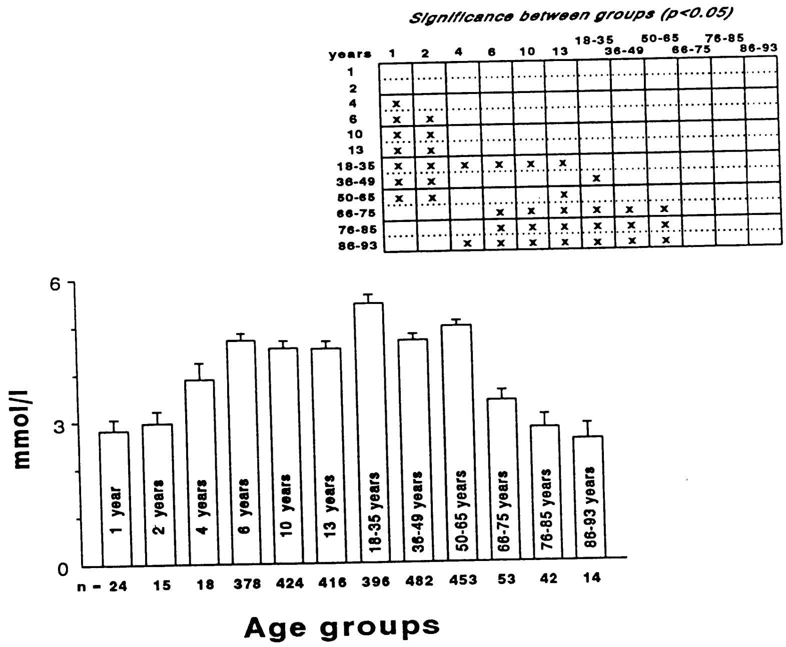

Fig. 1. *Age-related concentrations of calcium (mmol/l) in the urine (means ± S.E.M.).*

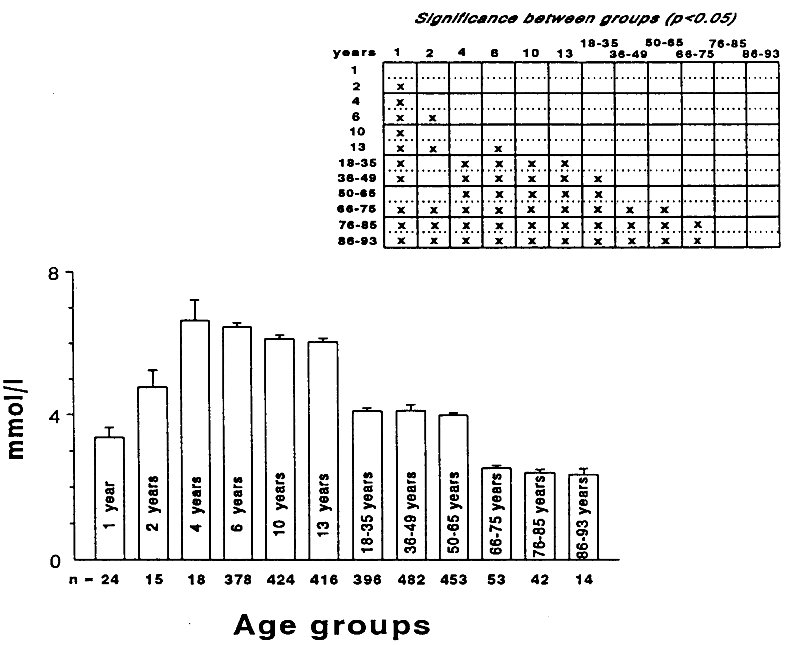

Fig. 2. *Age-related concentrations of magnesium (mmol/l) in the urine (means ± S.E.M.).*

Results

The urinary calcium concentration is obviously age-dependent (Fig. 1), the highest values (5.44 mmol/l) occur in the age group 18–35 years, and they decline both with decreasing age (it significantly differs from all children groups), and with advancing age (significantly when compared with values of subjects over 65 years of age).

The highest value of urinary magnesium concentration (Fig. 2) was recorded in 4-year-old children (6.64 mmol/l). From this age the urinary magnesium concentration declines to 2.35 mmol/l in the group of seniors aged 86–93 years (a significant concentration decline when compared with values in all groups of adults, and also with the group of children aged 1 and 2 years).

The urinary creatinine concentration (Fig. 3) increased from low values in one-year-old children (2.47 mmol/l) up to 15.53 mmol/l in the group of persons aged 18–35 years. These value significantly differ from those recorded in all groups of children, as well as in all groups of adults over 35 years of age. The highest ratios of urinary calcium/creatinine and magnesium/creatinine were found in one- and 2-year-old children. With advancing age, the values of these ratios decline, but in the adult groups these changes are not statistically significant (Figs 4 and 5).

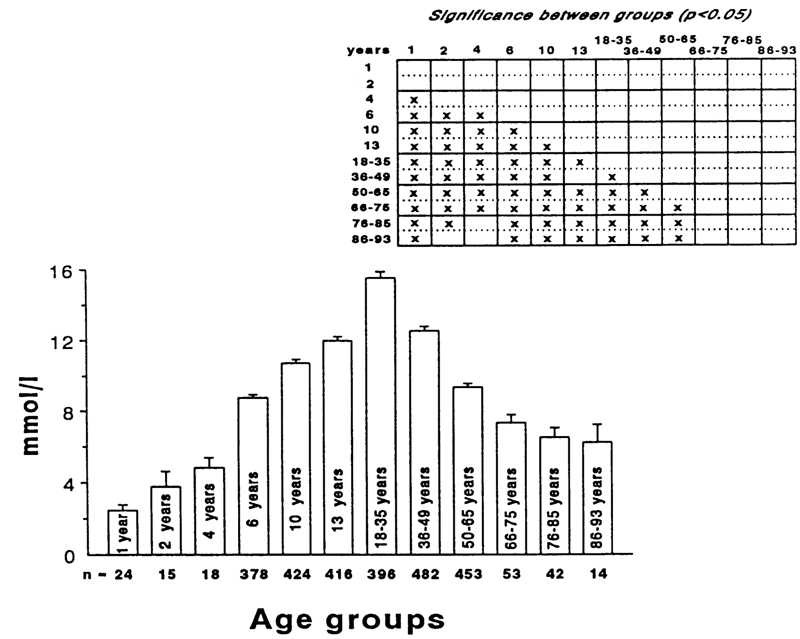

Fig. 3. *Age-related concentrations of creatinine (mmol/l) in the urine (means ± S.E.M.).*

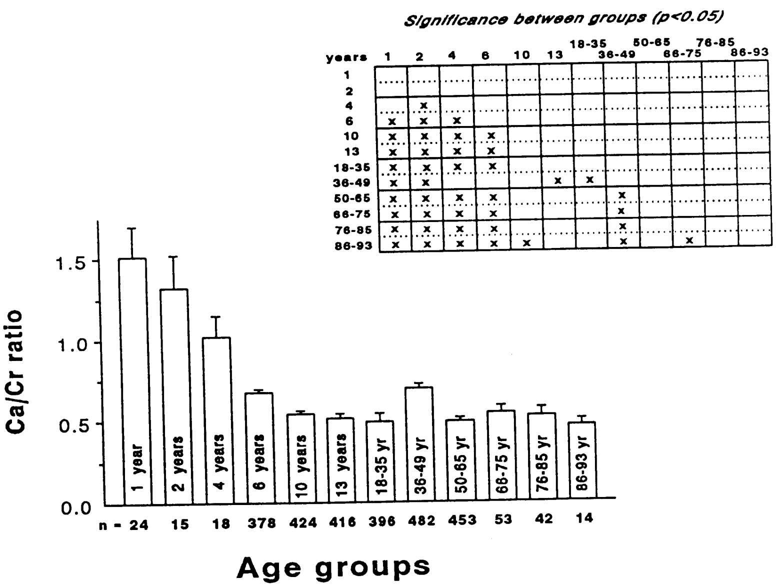

Fig. 4. *Age-related urinary calcium/creatinine ratios (means ± S.E.M.).*

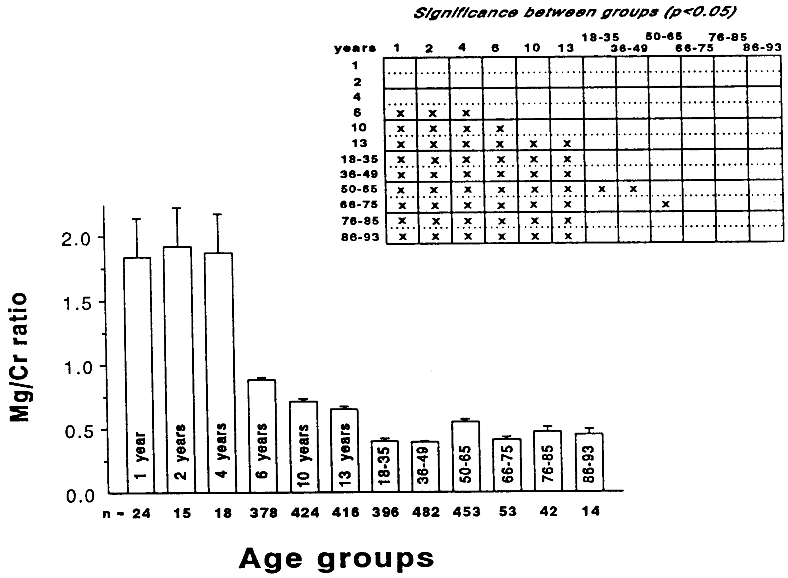

Fig. 5. *Age-related urinary magnesium/creatinine ratios (means ± S.E.M.)*

Discussion

Magnesium ions play pivotal role in the transfer, storage and utilization of energy. Magnesium is a required cofactor in hundreds of enzyme systems intervening in the metabolic pathways of glycides, lipids, proteins and nucleic acids. The intracellular level of free magnesium ion regulates intermediary metabolism of DNA and RNA synthesis and structure, cell growth, reproduction, and membrane structure. Magnesium serves numerous physiological roles which control e.g. neuronal activity, cardiac excitability, muscle contraction, blood pressure and neuromuscular transmission.

The urinary calcium and magnesium concentrations are influenced by several factors. It depends on the content of these ions in food, on the efficiency of intestinal absorption and on the state of renal function. Their excretion is also dependent on body stores of calcium and magnesium, which are modified by growth, aging or various diseases (Speich and Bousquet 1991, Ducreux and Messing 1990). The participation of hormones in these processes is generally known, mainly in regard to calcium.

Our results suggest that the concentration of calcium, magnesium and creatinine in the morning urine is significantly age-dependent. In a previous study (Šimečková *et al.* 1996), we estimated urinary calcium concentrations in a group of subjects from 6 to 65 years of age and we concluded that these values did not significantly change with age. After we had extended our set to include also children 1, 2 and 4 years old, and seniors from 66 to 93 years, we found that particularly these younger children and the senior groups have urinary calcium levels which are significantly lower. The reduced urinary calcium levels in children are obviously the result of enhanced calcium utilization during growth and deposition into bones. In adults, the daily intake of 15–30 mmol calcium in the food, leads to urinary calcium excretion of about 4 mmol/day (Lemann 1993). Our age groups from 6 to 65 years correspond to this. The reduction of urinary calcium concentration in the age groups from 66 to 93 years obviously resulted from the decreased body calcium store, declined absorption lack of vitamins D), decreased renal function, altered dietary habits and altered food intake, and from taking various medicines.

The magnesium content in the serum does not change significantly with age (Leman 1993; Kant *et al.* 1989). However, the urinary magnesium concentration is age-dependent. In our proband set ranging from 1 to 93 years, the highest urinary magnesium concentration is recorded in children aged 4 years, and from this age it declines with age. Independently of age, about 96 % of filtered magnesium is reabsorbed in renal tubules, and this applies both to children and adults (Rude *et al.* 1980). Only sucklings are capable of reabsorbing more than 98 % of the filtered magnesium (Ariceta *et al.* 1995). The lower value of the urinary magnesium concentration in children about one-year-old may result from this phenomenon caused by the rapid growth of body mass in this early stage of life. In adult persons, the urinary magnesium concentration declines with age due to several factors, which evoke primary magnesium depletion mainly in old persons. First of all, there is an insufficient magnesium content in the food (Durlach *et al.* 1993). In the course of several past decades the magnesium content in food gradually declined in industrialized countries from 500 mg/day in 1900 to 175–248 mg/day in 1987–1992 (Altura *et al.* 1996). The food sources should contain approximately

300 mg magnesium/day. Vegetables, beans, nuts, soyabeans, green leafy vegetables are rich in magnesium. Intestinal absorption is one of factors affecting magnesium homeostasis. Children absorb 65–75 % magnesium from food (Alfrey 1992), while adult males only 21 % and females 27 % (Lakshmann *et al.* 1984). Intestinal absorption of magnesium obviously declines with advancing age, and this is one of the reasons for its depletion in old age (Durlach *et al.* 1993). The principal regulatory mechanism of the homeostasis of magnesaemia is renal excretion; as distinct from calcium, where several hormones regulate its metabolism (parathormone, calcitonin, derivatives of vitamins D), no specific hormonal regulatory mechanisms for magnesium in the organism are known (Durlach 1988, Rude 1993). The renal exchange of magnesium in humans depends on a filtration-reabsorption process. During magnesium depletion, this ion is retained by the kidney and its excretion decreases. After magnesium administration, the excess is rapidly excreted into the urine (Rude 1993, Ariceta *et al.* 1996). In our set of probands, the reduced urinary magnesium concentration with advancing age testifies to the economizing of this ion during its depletion.

The increase of urinary calcium/creatinine and magnesium/creatinine ratios in children aged 1–4 years depends mainly on the decreased creatinine concentration in this age period. The creatinine excretion in the first year of life is small (10 mg/kg), in children it rises to 14 mg/kg, and in adults it is about 20 mg/kg (Sargent *et al.* 1993). This is in agreement with our findings. The values of these urinary concentration ratios in morning urinary samples are identical with the mean values in cumulative urinary samples per 24 hours (Ariceta *et al.* 1996).

In conclusion, one can also consider advancing age as a risk period due to the lack of magnesium. The consequences of this state in clinical practice are well known (ischaemic heart disease, atherosclerosis, arterial hypertension, congestive heart failure, diabetes, eclampsia etc.) (Rude 1993, Durlach *et al.* 1993, Altura *et al.* 1993). According to the opinion of Durlach *et al.* (1993), the primary magnesium deficiency is caused by insufficient magnesium intake. The latter can be improved by magnesium supplementation. The factors that have been discussed here, and that have been demonstrated in elderly persons participate in the state of magnesium depletion among elderly persons. Food intake decreases, intestinal absorption is reduced, the magnesium body stores are depleted, renal function is impaired, and there are complex drug-mineral interactions also involved. From our results, it seems to be important to monitor magnesium status in elderly people and to supplement magnesium if necessary (Speich and Bosquet 1991).

Acknowledgements
This research was supported by grants 2734-3 and 3413-3 of Internal Agency of the Ministry of Health of the Czech Republic.

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Reprint requests

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