The role of the therapeutic team in shaping eating habits and lifestyle in children with dietary calcium deficiency

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Abstract

Purpose: Assessment of the effect of low-calcium diet on bone mineral content in children and adolescents.

Material and methods: The study involved 89 children (49 girls and 40 boys) aged 5-18 years, in whom diseases affecting bony metabolism had been excluded. Children with a history of dietary calcium content below 500 mg/day were recruited. The study group was divided according to age: group I, age 5-9 years (children before puberty); group II, age 9-15 years (early puberty); group III, 15-18 years (late puberty). Dual energy X-ray absorptiometry (DEXA) was used for densitometric measurements. Bone mineral density (BMD) was assessed in the whole skeleton (total BMD), in vertebrae L2-L4 (spine BMD) in g/cm^2 and as Z-score. Concentrations of Ca, Ca^2, P, activity of alkaline phosphatase (AP) and its bony isoenzyme were determined in the serum.

Results: Total bone mass below 5th percentile (according to the norm for age and gender) was found in 56.98% of the children involved in the study. A significant reduction was noted in the spine mineral mass in boys ($p<0.01$) as compared to girls (0.731 ± 0.17 g/cm^2 and 0.835 ± 0.19 g/cm^2, respectively).

The lowest mean Z-score (-1.850) was observed in group III as compared to group I (-1.194) ($p<0.01$) and group II (-1.201) ($p<0.05$). There were statistically significantly positive correlations between total and spine BMD and BMI. The correlation coefficient was $r=0.56$ and $r=0.41$ ($p<0.001$), respectively.

Conclusions: In the majority of the children (c. 60%), a reduction in bone mineral content was found. The lowest Z-score (-1.850) was revealed in the oldest children, which may disturb the process of reaching the optimum level of the peak bone mass.

Key words: calcium intake low, bone mineral density, children.

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Introduction

It is commonly accepted that the peak bone mass reached by a man at the age of 25-30 is to a large extent subject to genetic control. Genetic determinants are non-modifiable risk factors of osteoporosis [1,2].

However, the effect of modifiable factors associated with lifestyle and nutrition on normal mineralization of the skeleton at any age, but especially at the skeleton growth cannot be excluded [3,4].

Elimination of these factors is the major task of osteopenia and osteoporosis prevention.

Material and methods

The study involved 89 children (49 girls and 40 boys) aged 5-18 years, referred to The Outpatient Rheumatological Department of Children's Teaching Hospital in Białystok due to motor organ pains. In all the children, inflammatory arthropathies, metabolic and endocrine disorders, and other ailments affecting bony metabolism were excluded. Data on dietary calcium intake were obtained via a standardised interview. The children with a history of low dietary calcium content (below 500 mg/day) were recruited. The study group was divided according to age: group I (children before puberty), age 5-9 years; group II (early puberty), age 9-15 years; group III (late puberty), 15-18 years.

Anthropometric parameters (height, weight) were measured and body mass index (BMI) was calculated in the study groups.

Table 1. **Characteristics of the study group with regard to gender and age**

	Age (years)	Height (cm)	Weight (kg)	BMI kg/m^2
Girls n=49 (55.1%)	12.75±3.78	147.83±17.15	39.25±10.81	17.54±2.39
Boys n=40 (44.9%)	11.79±3.29	149.48±20.44	43.56±16.97	18.64±3.62
Together n=89 (100%)	12.32±3.5	41.19±18.61	41.19±14	18.04±3.03

Table 2. **The percentile structure of bone mineral content (according to norms for age and gender)**

BMD percentile	Total BMD n = 89		Spine BMD n = 89	
	n	%	n	%
below 5th	49	56.98	45	51.95
5-25	26	29.21	29	31.10
above 25th	14	15.73	15	17.05

Table 3. **Bone mineral density with regard to gender and chosen anthropometric parameters**

Parameter	Girls			Boys			
	Mean	Mediana	SD	Mean	Mediana	SD	p<
Age (years)	12.75	13.00	3.78	11.79	12.00	3.29	NS
Height (cm)	147.83	153.00	17.15	149.48	151.00	20.44	NS
Weight (kg)	39.25	41.00	10.81	43.56	44.50	16.97	NS
BMI kg/m^2	17.54	17.43	2.39	18.64	18.07	3.62	NS
Total BMD g/cm^2	0.912	0.933	0.10	0.903	0.923	0.11	NS
Spine BMDg/cm^2	0.835	0.859	0.19	0.731	0.716	0.17	0.01
Z-score	-1.379	-1.510	1.14	-1.339	-1.720	1.12	NS

Table 4. **Bone mineral density in the study group according to age**

	The study group n=89						
Age (years)	**Group I** 5-9		**Group II** 9-15		**Group III** 15-18		
Z-score	mean	SD	mean	SD	mean	SD	p<
BMI kg/m^2	15.58*	1.98	18.85	3.36	18.5	1.55	0.001
Total BMD	0.786*	0.07	0.913	0.08	1.010	0.06	0.001
L2-L4 Spine	0.565*	0.09	0.789	0.15	1.001	0.07	0.001
Z-score	-1.194	0.85	-1.201	0.93	-1.850**	0.49	0.05

*p<0.001 compared to groups II and III; **p<0.05 compared to groups I and II

Clinical assessment allowed identification of children with a positive history of fractures.

Dual energy X-ray absorptiometry (DEXA) was applied for densitometric measurements, using DPX-2 System (LUNAR), Radiation Corp, in a 1.3z version. Bone mineral density (BMD) was evaluated in the whole skeleton (total BMD), in vertebrae L2-L4 in AP projection (spine BMD) in g/cm^2, in percentiles according to the norms for age and gender [5] and as Z-score (the number of standard deviations differentiating bone density of the study patient from the finding obtained in a statistically healthy subject matched for gender, race and age).

Concentrations of Ca, Ca^2, P, activity of alkaline phosphatase (AP) and its bony isoenzyme were determined in the serum.

Statistical analysis

The results of the study were analysed statistically with the use arithmetical means. The level of investigated parameters in the subgroups was compared with t-Student test or U Mann-Whitney test (depending on the distribution of the parameters). Person linear correlation ratio was used in order to evaluate the correlation ratio between the parameters. Alternative hypotheses were considered true when p<0.05.

Results

No significant differences were noted in BMI in relation to gender. However, the assessment of chosen anthropometric parameters shows a significantly lower BMI in group I (15.58) as compared to groups II and III (18.85 and 18.50, respectively); (p<0.001) (*Tab. 1*, *Tab. 4*).

Total bone mass below 5th percentile was observed in 56.98% of the children enrolled in the study; in 27.21%, bone mineral density values were within 5-25, while in 16.73% above 25th percentile (*Tab. 2*).

A significant reduction was found in the mineral mass of the spine in boys (p<0.01) as compared to girls (0.731±0.17 g/cm^2 and 0.835±0.19 g/cm^2, respectively (*Tab. 3*).

Table 5. **Significant correlations of BMD and Z-score with chosen anthropometric parameters**

Bone Mineral Density	Total BMD		L2-L4 BMD		Z-score	
	r	p<	r	p<	r	p<
Age	0.82	0.001	0.83	0.001	-0.20	0.05
Height	0.81	0.001	0.80	0.001	0.02	NS
Weight	0.80	0.001	0.71	0.0001	0.09	NS
BMI	0.56	0.0001	0.41	0.0001	0.07	NS

The lowest mean Z-score (-1.850) was observed in group III as compared to group I (-1.194) ($p<0.01$) and group II (-1.201) ($p<0.05$). There were statistically significantly positive correlations between total and spine BMD and BMI. The correlation coefficient was $r=0.56$ and $r=0.41$ ($p<0.001$), respectively.

Findings of basic serum laboratory parameters of mineral balance were within normal limits for age, although significantly lower Ca^2 and P levels were noted in the serum of girls ($p<0.05$). Significantly negative correlations were revealed between total and spine BMD and AP ($p<0.05$): (-0.515) and (-0.472), respectively.

Thirteen children had a positive history of fractures (14.68%), the percentage being higher in group II (10.11%) and definitely higher in boys (11.31%). Interpretation of the study outcome is difficult due to a small number of subjects involved in the study.

Discussion

Bone is a living tissue subjected to the opposing remodelling processes: formation and resorption. Bone remodelling occurs throughout life. In childhood and adolescence the predominance of osteoblastic bone formation results in skeletal mass growth, while bone-loss processes intensify since 6th decade of life [6-8].

Size, mass or density of the bone – terms commonly used as synonyms – is strictly dependent on age, with its peak bone mass controlled by the genetic code [9,10].

The peak bone mass is 90 per cent deposited during the period of growth, which lasts up to the closure of the epiphyses, i.e. to the age of 20 years.

The maximum value of peak bone mass is obtained during the so-called skeletal consolidation period (25-35 years). It is a specific "bony mineral bank" – since according to epidemiological data, low peak bone mass is a major risk factor of osteopenia and osteoporosis in later life [11,12].

Thus, childhood and adolescence are the critical periods for bony tissue development.

Proper diet and healthy lifestyle can prevent low bone mass [13,14]. Models of eating habits are handed down within the family in the early childhood up to approximately 10 years of age and then become fixed as routines. Research studies carried out by The Institute of Food and Feeding in Warsaw on the nutrition modes of Poles have revealed a greatly inadequate dietary supply of calcium and vitamin D, which are responsible for normal mineralization of bones, as well as high content of phosphorus from food additives (with phosphorus excess, calcium chronically obtained from bones increases the risk of their demineralization) [15].

In the current study, approximately 60% of calcium-deficient children had low bone mass (total BMD and spine BMD <5th percentile in relation to age and gender). Bone mineral density expressed as the mean Z-score was the lowest in the group of adolescents over 15 years of age (-1.86 ± 0.49), who despite already active sexual hormones are in danger of low peak bone mass and osteoporosis in the future.

Our findings seem to confirm the fact that mineralization disorders appear in the spine at the earliest, which is associated with its trabecular structure. We found statistically significant differences between bone mass for L2-L4 as compared to total skeletal mass: in boys – spine BMD 0.731 ± 0.17 g/cm^2 and total BMD 0.902 ± 0.11 g/cm^2; in girls – 0.911 ± 0.10 g/cm^2; 0.835 ± 0.19 g/cm^2, respectively ($p<0.01$). Literature data indicate that metabolism in the trabecular bone is 8 times higher; mineralization disorders occur earlier and are more advanced [16].

Many researchers emphasize that for normal bone growth and mineralization children and adolescents should receive adequate amounts of calcium and vitamin D, supplied in everyday diet and pharmaceutical preparations if need be. Moreover, to be effective, vitamin D requires a varied diet and active leisure in the open air [17,18].

Badurski et others stress the significance of osteoporosis prevention, which should concern the whole population and include education on the environmental risk factors and proper lifestyle, intensification of physical activity, daily calcium intake of approximately 1200 mg and vitamin D of 400-800 IU [19].

Our own observations confirm the unquestionable role of preventive actions especially in the developmental age population. Prevention of osteoporosis, a dangerous civilization disease, should be a primary task of the therapeutic team.

Conclusions

1. Densitometric findings showed a reduction in bone mineral density in most of the study children (c. 60%).
2. Osteopenia expressed as Z-score (-1.850) was found in group III (the oldest children), which may preclude reaching the optimum level of peak bone mass.
3. Our research indicates that it is necessary to introduce a public prophylactic scheme to prevent osteopenia and osteoporosis in children, especially at the beginning of puberty.

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