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OBSERVATIONS CONCERNING THE INVOLVEMENT OF Ca^{2+} IONS IN THE METABOLIC BALANCE OF THE BODY

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Key words: *Ca^{2+}, clinic investigations, homeostasis of electrolytes*

INTRODUCTION

Calcium is an essential constituent of the human body, found in larger quantities in the body than any other cation (1100 g calcium compared with 80 g sodium). Most of it (over 1000 g) is stored in the bone tissue. Approximately 10 g calcium is found within cells and less than 1 g in the extracellular areas (plasma, interstitial liquid, connective tissue).

Together with phosphorus, it forms the solid part of the skeleton; in its circulating form, it is essential to maintaining normal neuromuscular activity, being an important factor in coagulation, and a cofactor in many enzyme reactions.

Without calcium, the body would not be able to function correctly, because this mineral is essential for the development and strength of bones and teeth. Calcium ions intervene in changing the permeability of cell membranes and capillaries, decrease neuromuscular excitability and are needed for myocardial contraction, being a part of our life. Calcium ions are also involved in the activation of enzyme systems, including those involved in coagulation.

Calcium deficiencies lead to many diseases that damage the developmental processes of children (ricketiness) and adults (osteoporosis).

The defective metabolism defective of the calcium ion generates a number of disorders, ie mental disorders, from depression to hallucinations, memory loss, decreased memory and attention capacity, dizziness to loss of consciousness, insomnia, numbness that can manifest especially in the limbs, irritability, menstrual disorder, growth retardation in children, hair degradation and loss, nail fragility, rough skin that peels, lack of appetite, rapid fatigue to little effort.

Therefore, the first step is getting awareness of a disease and its prevention.

MATERIAL AND METHODS

The biological material for the study of Ca^{2+} ion variability was the peripheral blood sampled from patients hospitalised in *Instituția Medico-Sanitară Publică Centrul Național Științifico-Practic de Medicină Urgentă,* Chişinău, Republic of Moldova, in the sections *Pediatrics*, *Preterm births, Septic surgery, Neurological surgery,Hematology, Endocrinology, Gastroenterology, Hepatology, Cardiology.*

The sampling group comprised a total of 90 patients aged between a couple of months and 85 with different diseases which influenced the concentrations of electrolytes from serum as well as subjects with disturbed electrolyte homeostasis as a result of the evolution of some tumours and cysts. The investigation was conducted in two seasons: spring and winter.

For determinations, there was used the electrolyte analyzer Model *AVL 988-3*, which determines Na^+ , K^+ , Ca^{2+} ,Cl^- şi Li^+. The normal concentrations of calcium are 1.13-1.32 mmol/L.

RESULTS AND DISCUSSIONS

In Table 1 are recorded the results of calcium determinations on for patients investigated during the summer period. The data processing in indicated by graphs.

Most patients in the sampling group investigated during summer are aged between 31 and 40 (23%), male (80%) and urban residents (57%) (Figures 1, 2 şi 3).

The subjects investigated during the summer manifest mostly skeletal damage in number of 11 cases, different infections – 6 cases, nervous system disorders – 3 cases, articular system disorders – 3 cases, tumors and cysts – 2 cases, and one one patient with liver disease, muscle disease, respectively, respiratory problems (Figure 4).

According to the ionic calcium concentrations registered in summer, normal levels were recorded in 12 subjects, lower concentrations in l-16 cases and higher concentrations – two patients investigated. The majority present low concentrations for calcium ions, respectively hypocalcemia (53%) (Figure 5).

Table 1. Patients and investigations during the summer period

Crt. No.	Age	Sex	Origin	Diseases	Ca mmol/L
1.	02	M.	Urban	Perinatal encephalopathy	1.22
2	02	M.	Urban	Brain lesion	1.17
3.	03	M.	Urban	Viarl hepatitis	1.15
4.	02	F.	Urban	Bronchopneumonia	1.10
5.	5	F.	Urban	Ribcage deformation	1.25
6.	16	M.	Urban	Cardiopathy	1.34
7.	5	F.	Urban	Arthritis	1.25
8.	15	F.	Urban	Miositis	1.12
9.	7	M.	Urban	Facial nerve paralysis	1.17
10.	05	M.	Urban	Hemangiom	1.40
11.	49	M.	Rural	Open wound of eyelid	1.03
12.	74	M.	Rural	Oral fibroma	1.08
13.	21	M.	Urban	Retromolar abscess	1.15
14.	55	M.	Rural	Lower jaw fracture	1.16
15.	37	M.	Rural	Post-traumatic osteomielytis	1.17
16.	37	M.	Rural	Infected cyst	1.10
17.	72	M.	Urban	Mandibular fracture	1.10
18.	22	M.	Urban	Submandibulary phlegmon	1.08
19.	45	F.	Rural	Open femural fracture	1.09
20.	57	M.	Rural	Infected bond of left gamba	1.10
21.	22	M.	Rural	Chronic osteitis with fistula of the shin bone	1.15
22.	40	M.	Urban	Osteomyelitis with fistula	1.19
23.	38	M.	Rural	Gambar osteomyelitis	1.07
24.	68	F.	Urban	Arthritis with pilon bacteria	1.15
25.	37	M.	Urban	Septic knee artritis	0.70
26.	34	M.	Rural	Post-traumatic osteomyelitis	1.10
27.	19	M.	Rural	Furunculosis	0.90
28.	25	M.	Rural	Mandibular fracture	1.09
29.	36	M.	Urban	Toxic osteomielytis (Narcoman)	0.87
30.	24	M.	Rural	Furunculosis	1.08

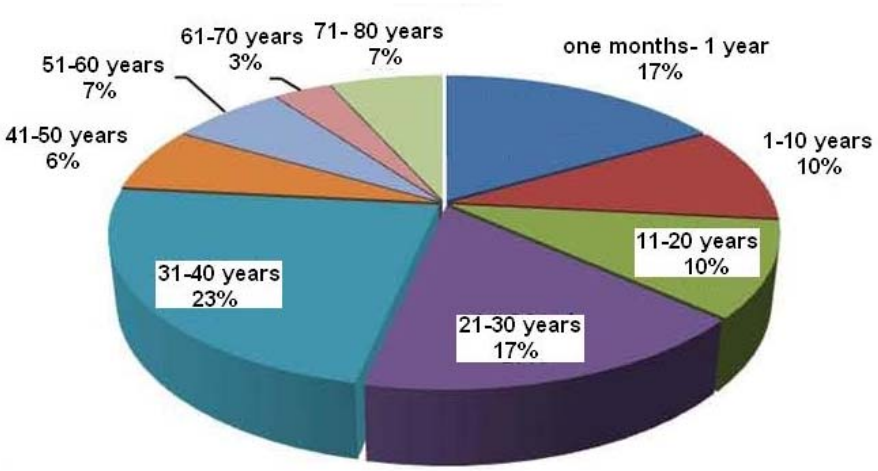

Fig. 1. Age of subjects during summer

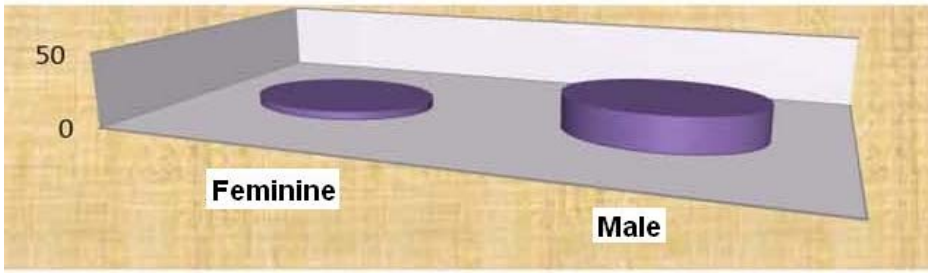

Fig. 2. Distribution of investigated patients during summer

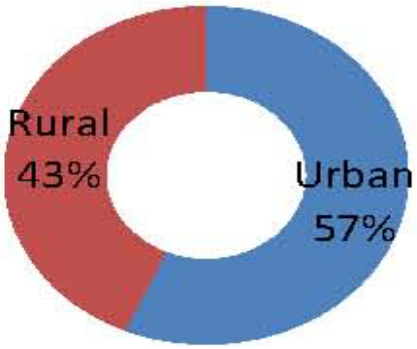

Fig. 3. Provenance distribution of investigated patients during summer

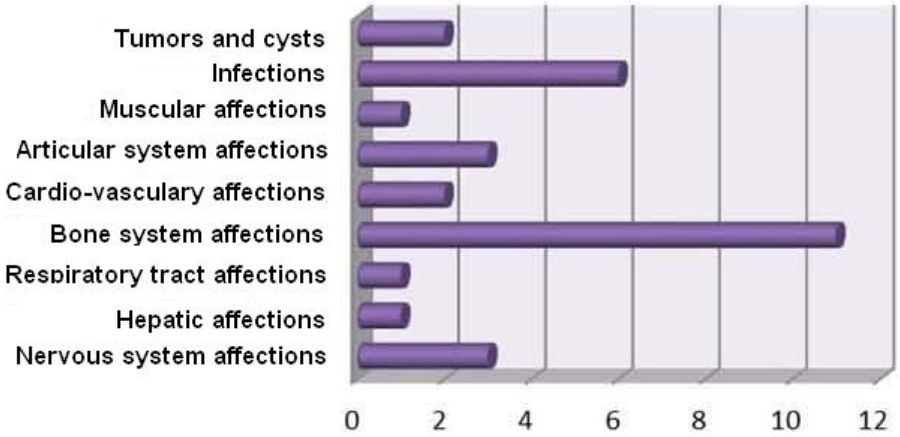

Fig. 4. Affection distribution of patients during summer

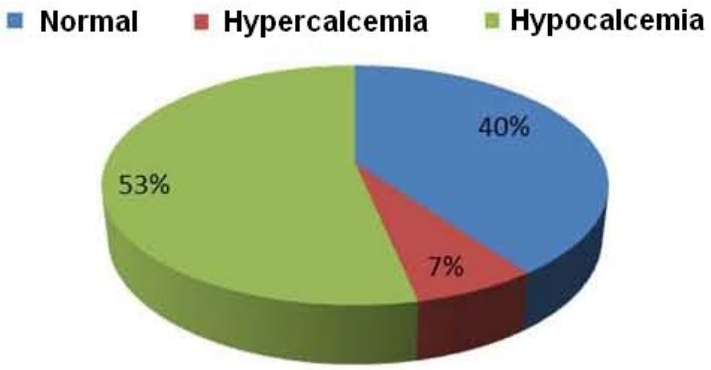

Fig. 5. Distribution of patients according to ionic calcium levels during summer period

During the winter months, from December to February, Ca^{2+} ion fluxes are recorded in Table 2.

Most patients in the sampling group investigated during the winter period are aged between 51 and 60 (20%), female (67%) and rural residents (70%) (Figures 6, 7 şi 8).

Most subjects investigated in winter present endocrine disorders – 17 cases with cardiovascular disease – 6 cases, infections – 3 cases, skeletal affections – 3 cases and less nervous system disorders (1 case); (Figure 9).

The ionic calcium fluxes during winter arre mostly low (97%), so few cases present normal concentrations (3%); (Figure 10).

Table 2. Patients investigated during winter time

Crt. No.	Age	Sex	Area of provenance	Affections	Ca mmol/L
1.	19	M.	Urban	Boil	1.04
2.	72	F.	Urban	Acute periodontotis	1.03
3.	33	F.	Urban	Hemorrhage	1.04
4.	43	F.	Urban	Salivary gland infection	0.95
5.	50	F.	Urban	Chronic sinusitis	1.13
6.	43	F.	Rural	Cutaneous abscess	0.96
7.	22	F.	Rural	Phlegmon and dental abscess	1.03
8.	55	F.	Rural	Phlegmon and dental abscess	1.01
9.	65	F.	Rural	Acute lymphadenitis	0.99
10.	11	M.	Rural	Bronchopneumonia	0.88
11.	8	M.	Rural	Premature birth	0.82
12.	14	F.	Rural	Hemorrhage	0.92
13.	1	M.	Rural	Intracranial hemorrhage	1.03
14.	01	M.	Rural	Bronchopneumonia	1.0
15.	9	M.	Rural	Hemorrhagic vasculitis	0.93
16.	01	M.	Rural	Bronchopneumonia	0.87
17.	01	M.	Rural	Bronchopneumonia	0.67
18.	19	M.	Rural	Furunculosis	0.99
19.	25	M.	Rural	Mandibular fracture	1.09
20.	15	F.	Rural	Hemophilia A	0.41
21.	57	F.	Urban	Thyrotoxocosis with diffuse goiter	1.11
22	74	F.	Rural	Diffuse goiter	1.05
23.	9	F.	Urban	Obesity and fat intake	1.06
24.	52	F.	Rural	Hypothyroidy	1.12
25.	55	F.	Urban	Obesity	0.92
26.	72	F.	Rural	Multinodular goiter	0.97
27.	75	F.	Rural	Hypothyroidy	1.04
28.	36	F.	Urban	Thyroidy	0.96
29.	53	F.	Rural	Hypothyroidy by subclinical iodine deficiency	1.02
30.	55	F.	Rural	Gastroenteritis	1.06

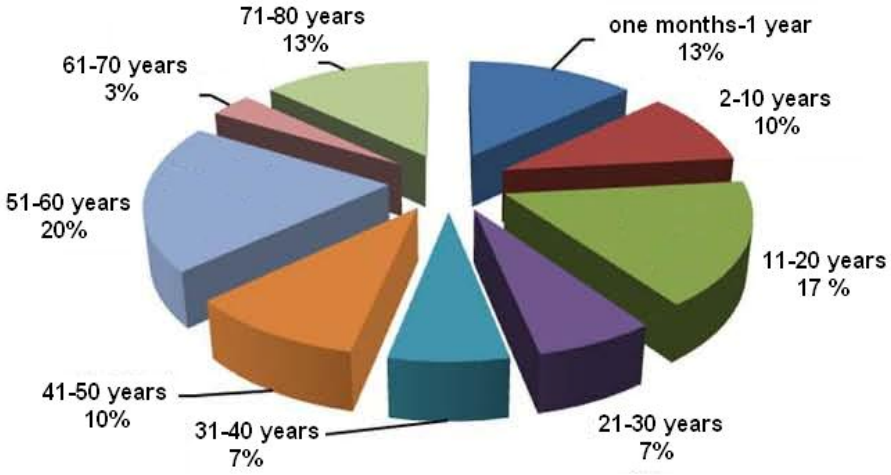

Fig. 6. Age distribution of patients investigated during winter months (December-February)

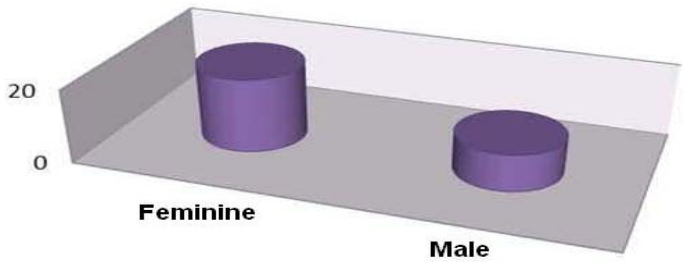

Fig. 7. Sex distribution of patients investigated during winter period

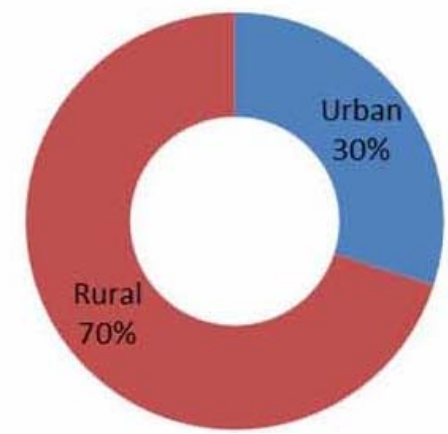

Fig. 8. Provenance distribution of patients investigated during winter period

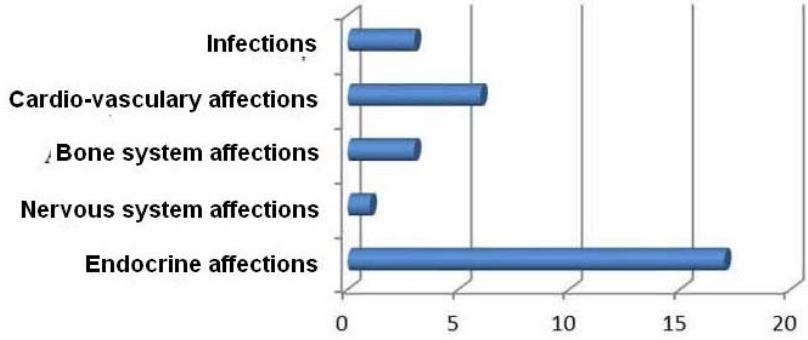

Figure 9. Affection distribution in patients during winter

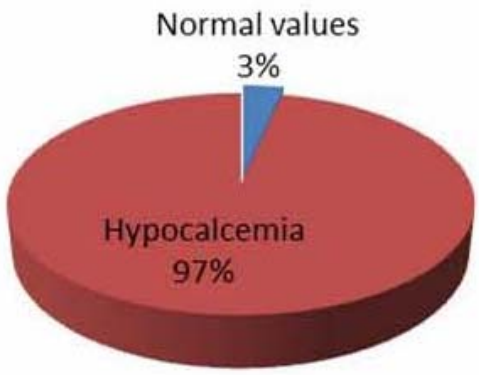

Fig. 10. Distribution of patients according to ionic calcium levels during winter

The most important mineral for the proper functioning of the human body is calcium. The total amount of calcium in the body is 99% in bones and teeth, which is a huge reservoir for maintaining seric calcium levels, and the rest is distributed in body fluids and soft tissues. In addition to the role of calcium in bone and teeth structure under the form of calcium phosphate crystals, contributing to bone fracture healing, the functions of calcium ion are extremely important in nerve conduction, blood clotting with vitamin K, contraction of muscles and internal organs, regulation of enzyme with magnesium. Moreover, calcium protects the cardiovascular system and ensures normal heart rhythm in membrane permeability and cell metabolism. Lastly, calcium decreases the incidence of allergies.

Human body has about 1-2 kg of calcium, more than 98% of which is in the skeleton (calcium phosphate crystals). In the blood stream, it appears in calcium complexes (protein or nutrient), or freely (47%). Although the calcium in the blood stream has definite roles, it is only free ions concentration that has a direct effect on the functioning of nerves and muscles. For this reason, measuring the concentration of free ions is more important for diagnosis than total calcium.

Calcium levels are strictly regulated by the body, excess or deficit is rapidly corrected by fixing calcium in bones. Critical concentrations range from low levels <6 mg/dL to high levels >13 mg / dL.

Regarding **hypocalcemia**, low calcium blood levels are common today due to a highly deficient intake of this mineral or lack of fixation under conditions of vitamin D deficiency. This situation occurs in people who are not exposed to sunlight or do not consume animal products.

Hypercalcemia – increased seric calcium levels – is caused by poisoning in case of excess of vitamin D or parathyroid hormone (primary hyperparathyroidism). Sometimes, certain cancers can accompany chronically increased calcium levels. These levels may be associated with the development of kidney stones. Hyperparathyroidism, a disease that is becoming more commonly diagnosed in postmenopausal women, causes increased bone resorption and leads to the development of osteoporosis, with an increased incidence of bone fractures. High concentrations of serum calcium can cause disorders of heart activity that can lead to death.

Based on the distribution of investigated subjects in the winter period, there was a major decrease in the concentration of calcium ions: 97% of patients had concentrations below normal and only 3% normal levels (Figure 10), because, in winter, calcium is more difficult to absorb by the body. In summer, however, our body is able to synthesize vitamin D by itself, due to prolonged exposure to natural light, whereas, in winter, when sunlight is reduced considerably, the level of vitamin D is reduced substantially, which decreases the amount of calcium available, causing pain and bone disorders. Therefore, in winter, the body needs more calcium, mainly from water and food.

During lifetime, although it seems to have a stable structure, bone is a tissue that evolves continuously, which is visible during child growth and development (Figures 1 and 6); but after this process ends, the bone continues to grow and, if the body calcium deficiency manifests especially in patients over 40 years, it worsens with decreasing ionic fractions (Figures 1 and 6).

In children, hypocalcemia is due mainly to nutritional deficiencies, when the skeleton is developing, while in adults it is caused by many diseases of the nervous, respiratory, endocrine, cardiovascular, muscular systems, tumors and cysts, infections (visible in figures 4 and 9). Disruption of normal calcium concentration does not depend on patient gender or area of provenance (Figures 2, 3, 7, 8).

Thyroid disorders lead to many diseases; in case of hypothyroidism, they include: degradation of bone mass, brittle nails, hair loss, scoliosis, arthritis, obesity, heart attack, spasms, cramps, atrophy of connective tissue, slowed growth, etc. Some of these diseases were recorded in the patients investigated (Tables 1 and 2). In the case of hyperthyroidism, they include: endemic goiter, exolftalmic eyes, hyperactivity, thyroid toxicosis and excessive growth problems (table 2).

After completion of the long bone growth, bone mass continues to increase up to the age of 30.

CONCLUSIONS

- Laboratory investigations on Ca2 + ion concentrations are required in most cases in the diagnosis and disease stages. In addition to the early identification of problems, the analysis can signal a predisposition to certain diseases, identify risk factors and measures needed to stop the progression to disease stage.
- Women are more sensitive to changes in ionic calcium levels, especially in certain physiological periods such as pregnancy, lactation, during menstruation and particularly sensitive in the first decade after menopause, being more prone to osteoporosis, especially after 40 years.
- The increasing frequency of bone disorders, especially during childhood, should be a warning to reconsider our lifestyle, the habits and especially eating habits which should involved the calcium intake required depending on age, sex and season.
- Generally speaking, any severe pathological condition of the body is accompanied by electrolyte disturbances, so it is very important to involve Ca 2+ in general metabolism.

ABSTRACT

The present paper determined the concentration of Ca 2+ ion in a sampling group that included a total of 90 patients aged from a few months to 85 years, manifesting various health conditions that have influenced the concentration of electrolytes in serum, as well as subjects of electrolyte homeostasis disturbed by the development of tumours and cysts. The investigation was conducted in two seasons, summer and winter. For determinations using the analyzer of electrolytes in the blood, there was used Model AVL 988-3, a device for determining Na +, K +, Ca2 +, Cl and Li + levels. In winter, there was a major decrease in the

concentration of calcium ions: 97% of patients had concentrations below normal and only 3% normal, while in summer, 40% of patients had normal levels of calcium, 53% hypocalcemia and 7% hypercalcaemia. The results obtained constitute a warning that we need to reconsider our lifestyle, especially habits and nutrition.

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