Mineral deficiencies

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In this paper, we intend to summarize the results of researches with micronutrients that we have developed at the College of Pharmaceutical Sciences of USP in the last twenty years. We will also try to comment briefly on some nutritional problems both in the world and in Brazil and present special recommendations concerning iron, zinc, calcium and selenium. Finally, we would like to propose some solutions to improve the nutrition conditions in Brazil.

As has already been said, according to the forecasts, until 2020 malnutrition will still be high; even though the projection indicates a decline, which will be only by 15% compared to 1995. Micronutrient deficiency, despite being easy to solve, is still a problem for about two million people. Overweight and obesity already affect about 250 million adults, and this number is increasing. Iron deficiency is one of the main causes of anaemia, affecting 46% of the children and 48% of the pregnant women worldwide, according to the World Health Organization (WHO). Even though the seriousness of vitamin A deficiency has declined, it still affects between 240 and 250 million pre-school students. Thanks to the fortification of table salt, iodine deficiency has not been large in Brazil. Nevertheless, today the opposite problem is emerging, that is, iodine excess, which causes thyroid gland disorders. That derives mainly from the increase on salt intake verified in the last few food intake surveys. Also selenium – the intake of which is very low in certain Brazilian regions – is closely related to the thyroid's function since it participates on the de-iodination of thyroxine (T4) to triiodothyronine (T3), that gland's most active hormone.

Recent researches show, however, that mother-child malnutrition is closely related to the non-transmitted chronic diseases. Today the repercussions of the mother's nutrition on the uterus are being studied, and the results have shown that it can generate changes in the genic programming, by influence of the nutrients ingested. For that reason, it's very important to consider that context as a whole and emphasize as much as possible feeding since the intra-uterine phase.

What can be verified in Brazil? Energy deficiency? Protein deficiency? Micronutrient deficiency? What are the consequences of the changes in eating habits that we have verified?

As far as energy is concerned, unfortunately it's difficult to assume that there is a deficiency and to indicate in what proportion, since the measurement instruments available to us are very precarious. The difficulty is even greater

when the results are expressed in terms of the "average intake" of a population, an inference that we know to be hardly true. Thus, that's a very important aspect when one intends to propose strategic actions for the improvement of eating and nutrition conditions, and there is no doubt that we should be looking for more sensitive biomarkers for those assessments.

As far as proteins are concerned, according to the latest recommendations of the Dietary Reference Intakes (DRI), elaborated for the populations of both the United States and Canada, one can reach up to 35% of the total energetic value of the diet, provided it is balanced with the remaining nutrients that comprise them. That does not mean that we must ingest more proteins; it means that in the general estimate of a diet, a greater elasticity was given to that proportion, which previously ranged between 10 and 15%, a percentage always overcome when we evaluated the diets as a whole. The best carbohydrates proportion has also been discussed: would 65% be the ideal? And would it be proper to limit simple sugars to 25% of that total?

The studies have increasingly been searching patterns for the composition of macronutrients and micronutrients that define balanced feeding.

As far as the eating habits changes are concerned, we have seen – and our researchers have discussed that – that people who live in slums tend to eat more industrialized products. And what is the impact of the new food that is entering the market, of that so-called functional food and of the marketing that comes along with it? How important is it? How can we correct occasional distortions? If we want to reach an adequate eating pattern, one that reduces the risks of a disease, what path should we take?

As far as the micronutrients are concerned, in Brazil the greatest problem is still anaemia due to iron deficiency (ferropriva). As far as vitamin A is concerned, there is still deficiency to be found in some regions. The problem of iodine, from the deficiency point of view, has been minimized thanks to the fortification of table salt. As far as zinc is concerned, nutritional assessment data on specific groups of our population shows deficiency. Selenium is deficient in some regions and calcium ingestion is very reduced, considering the recommended figures.

The evaluation of the minerals intake in Brazilian diets, carried out through the laboratorial analysis of the minerals present in foods from the different regions of Brazil, prepared according to the usual ways, shows that our calcium ingestion is about 300/500 mg per day, although the current DRI recommendations are approximately 1,000 mg for adults. Sodium intake, which is very high, is as much as five times higher than the recommended. The excess of sodium may also interfere in the utilization of calcium. Magnesium ingestion is lower, but in some regions it is bordering. As far as iron is concerned, even though some groups ingest a recommended amount, its bioavailability in Brazilian diets is low; the current recommendation for iron is 8 mg for men and 18 mg for women in their fertile period. Zinc ingestion is bordering for certain population groups and very low for others – for example,

elderly people; some of those results were confirmed by the association with biochemical parameters of the individuals belonging to such groups. Copper ingestion is also bordering. That of selenium varies according to the region; in Brazil, the regions of the States of São Paulo and Mato Grosso present the lowest concentration of selenium in the soil and are where the greatest such eating deficiency is verified (Table 1).

Considering the evaluated data on the minerals intake in different groups of children, it can be observed that calcium and iron ingestions are low, that of sodium is high, that of magnesium and zinc is bordering and that of selenium varies according to the geographic region (Table 2).

Data from the national literature indicate that the prevalence of anaemia reaches 50%. However, according to data from the Federal University of São Paulo (Unifesp), that rate can be as much as 80% for certain groups. Our main iron sources are beans and meats. Iron bioavailability in the average Brazilian diet ranges between 1% and 7%. It is known that the best source is that of heminic iron, that is, meats, and that is why we can verify a high incidence of it.

As far as zinc is concerned, our laboratory research results show that diabetic and obese children present a very harmed distribution in relation to it. In 48% of the obese children, zinc concentration in the plasma was lower than the reference pattern of 75/110 μg/dL (some authors consider the reference as 70/110 μg/dL), while in only 9.5% of the normal children the level was low. As for the concentration in the plasma of children with Down syndrome, a great variability was verified. Other groups have systematically presented bordering or low figures. Considering the elderly people, all the individuals presented plasmatic concentrations lower than the recommended, with an average of 68 μg/dL. In normal adults, the variation verified ranged between 58 and 109 μg/dL, with an average of 78 μg/dL, although many of them were below, while others presented levels that were closer to the recommended.

We also use the concentration in the erythrocytes as a parameter to evaluate the nutritional status in relation to zinc. In some situations, such as in Down syndrome and chronic renal insufficiency (CRI), higher average figures were verified, which shows that in some diseases, mainly in those related to an iron deficiency, higher concentrations of that nutrient in the erythrocytes can be verified – and that is an interesting information that we must investigate better.

The reference figures for zinc in the erythrocyte range from 40 to 44 μg/g Hb. In the group of elderly people those figures were close to 40 μg/g Hb. The remaining groups that were studied – normal adults; obese adolescents; normal children and adolescents; pre-school students – also had lower figures.

To evaluate the bioavailability of zinc in our diet and to test the hypothesis that it would be low, the more precise technology was used, with the use of stable isotopes. Although the results have varied a lot from one individual to another – the group was comprised of eighteen male young adults –, the

figures verified were the same as can be observed in the literature, about 30%. Therefore, the zinc problem is not about bioavailability in the Brazilian diet.

As far as selenium is concerned, the richest food is certainly our Pará nut or Brazil nut, which contains between 25 and 49 μg/Se per gram. Two years ago a selenium survey was made in Brazil, analyzing beans, cattle meat, water and the soil. Let's see the differences: in Ceará, for example, beans have 1.2 μg of Se/g; in São Paulo, they have 0.016 μg of Se/g. Therefore, it can be seen that the selenium content is influenced by the environment where the plant grows. If a food composition table was taken and we wanted to calculate how many people are ingesting selenium, there would be completely different ingestion levels in Ceará and in São Paulo. With globalization, that calculation becomes even more difficult, since it's impossible to know for sure what kind of beans people are consuming, where do they come from and which table is being used.

By analyzing the biochemical parameters relative to selenium obtained for certain groups of the Brazilian population, figures below the average referred in the literature can be verified. In turn, in a study carried out in Macapá, where flour from Brazil nut is used in the school snack, it can be seen that all the biochemical parameters analyzed in children were much higher than the reference figures, which indicates the need for being careful as for the possible harmful effects – selenium is toxic in high doses, above 400 μg per day. After the study was completed, we advised the Macapá city hall to reduce the use of that flour.

The toxic character of selenium is associated to frailness, hair and nail loss, irritability, fatigue, abortion and infertility. However, its deficiency must also be evaluated since, although the main function of that nutrient is related to the antioxidant activity, it can also interfere in the metabolism of the thyroid gland, since it is key to the activity of the type II de-iodinase, which turns T4 hormones into T3 (more active). It must also be considered that in regions where there is an iodine deficiency, if there is also a selenium deficiency, the disorders caused by such deficiencies will be more serious.

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Table 1 – Minerals in Brazilian diets

Minerals / Diets	Ca (mg)	Na (g)	Mg (mg)	Fe (mg)	Zn (mg)	Cu (mg)	Se (g)	Reference
Northeast	440	nd	nd	16.7	8.1	nd	nd	Pedrosa & Cozzolino
Manaus -AM	438	3.5	252	11.2	8.7	1.13	98	Yuyama & Cozzolino
Santa Catarina I	287	2.0	158	6.4	5.2	0.69	55.3	Tramonte & Cozzolino
Santa Catarina II	508	3.6	122	11.6	9.8	1.21	114.5	Tramonte & Cozzolino
Cuiabá - MT	356	nd	192	12.5	9.9	1.12	60.0	Boaventura & Cozzolino
São Paulo - Elderly	377	1.2	nd	5.2	3.5	0.32	30.0	Cordeiro & Cozzolino
São Paulo - Adults	636	3.7	nd	19.0	11.6	nd	53.0	Mafra & Cozzolino
São Paulo I AG	525	nd	313	15.8	10.4	1.46	36.0	Favaro & Cozzolino
São Paulo II APG	1069	nd	nd	10.8	11.0	0.91	18.5	Harada & Cozzolino
DRI	1000	0.5	320-420	8 - 18	8 – 11	0.9	55	NRC

nd = non-determined.

DRI = Dietary Reference Intake (IOM 1997, 2000, 2002).

AG = Undergraduate students.

APG = Graduate students

Table 2 – Minerals in Brazilian diets – Children

Minerals	Ca (mg)	Na (g)	Mg (mg)	Fe (mg)	Zn (mg)	Se (g)	Reference
Children 4 to 6 years old	162 84.4-263	2083 1925-2274	119 86-210	7.0 5.4-8.2	4.4 2.9-6.0	12.9 5.6-17.2	Chicourel, Fisberg & Cozzolino
Children 4 to 6 years old	458 322-596	2137 1869-2410	122 107-152	8.3 5.0-12.3	6.0 4.5-7.3	17.9 12.4-21.0	Chicourel, Fisberg & Cozzolino
Children 4 to 6 years old	311 228-391	1746 1142-2212	117 86-151	5.0 3.3-6.7	5.0 3.3-7.7	9.1 7.0-13.4	Chicourel, Fisberg & Cozzolino
Children 3 to 7 years old	438 241-777	1502 872-2407	nd	5.3 4.2-7.5	4.8 3.3-7.4	26.3 15.9-39.7	Michelazzo, Fisberg & Cozzolino
DRI	1-3y = 500 4-8y = 800	2-9 years 300-400	120	10	5.0	20	

DRI = Dietary Reference Intakes.

metabolism of the thyroid gland, since it is key to the activity of the type II de-iodinase, which turns T4 hormones into T3 (more active). It must also be considered that in regions where there is an iodine deficiency, if there is also a selenium deficiency, the disorders caused by such deficiencies will be more serious.

Final thoughts

What are the future perspectives concerning the nutrition conditions in Brazil?

Above all, it's necessary to improve the population's understanding about the importance of food and its nutrients for health, by means of nutritional education in all levels. It's necessary to divulge better the importance of the nutritional information present in the label of processed food, mainly to avoid the excessive intake of highly calorific food.

It's also necessary to guide the population about the association between a healthy diet and the practice of physical activity. When an individual is sedentary, in order to keep his or her weight, he or she will have to ingest less calories, which may lead to micronutrient deficiency; when he or she practices a physical activity, on the other hand, it's necessary to ingest more food and, with them, more micronutrients. Food choice is certainly the key; the intake of foods that are richer in micronutrients must be emphasized. As has already been observed, one of the main problems verified in the slums is the excessive intake of sugar and fat, which are highly calorific foods with almost any micronutrients.

In the public health realm, the strategies may be based on the food itself, that is, on the fortification, on the multiple supplement with micronutrients, on such practices as breastfeeding, immunization etc., on the stimulus to domestic vegetable gardens and even on genetic engineering, along with sociopolitical and environmental measures.

Normally, fortification is applied when a certain nutrient is deficient for a large number of people. Supplement takes place when specific groups show a greater deficiency in a certain nutrient – for example, supplement for pregnant women, children or elderly people. In Brazil, there is iodine in the table salt, vitamin A supplements, margarine fortified with vitamin A and D, water with the addition of fluorine in certain regions and, more recently, the obligatoriness to add iron e folic acid in the wheat and corn flours.

When one thinks about intervention programs, it is essential to pay attention to the interactions among nutrients. The excess of a certain nutrient may interfere in the absorption of another. The occurrence of interactions among kinds of food in the diets is less likely than in those situations in which an isolated chemical compound is added, for example, to watery solution.

Let us remember that the development of food supplements has occurred in an intense manner, motivated by the study of the functional foods, which could reduce the risk of non-transmissible chronic diseases.

Picture by France Presse Agency

Overweight and obesity already affect close to 250 million adults all over the world.

Thus, there is currently in the market a great variety of products with different textures and flavors that make people like them. There is an increasing use of new ingredients, and that could change the quantity of micronutrients we ingest. It is necessary to follow those trends and evaluate them.

Another current aspect is biofortification. Embrapa has been developing such products as beans that are richer in iron and other kinds of food that could, through genetic engineering, complement the nutritional interventions. That strategy could be used in the future.

As far as the medicinal supplements are concerned, the needs of each individual must be verified, to make safety assessments, to elaborate exposure estimates and to create mechanisms to monitor intervention. That is a very important theme and it has been widely debated nowadays. In May 2005, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) sponsored a workshop in which there was a debate on

how to evaluate the exposure risk of the people to the high nutrient doses, mainly through supplements. It is very difficult to determine how many of them are reaching the maximum tolerable borders. In general, the people that are most concerned about their own health are those who try to get more information, who buy more fortified food and who use supplements. Those aspects must also be considered in order to avoid the risk of excessive ingestion.

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Abstract – In this paper we will try to report the Brazilian micronutrients status, as well as in worldwide, specifically for minerals. Minerals have major importance on human body, becoming indispensable for the development and health of individuals. There is not yet an integral assessment of micronutrient status in the Brazilian subjects, but there are some studies pointing to the need of observation of alimentary tendencies that might lead to deficiencies, with adverse consequences to the population's health and the development of our country.

Keywords – Minerals, Nutritional status, Fortification, Supplement.

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