KASHIN-BECK DISEASE: EVALUATION OF MINERAL INTAKE IN YOUNG TIBETAN CHILDREN FROM ENDEMIC AREAS

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The main objective of this work was to measure the mineral content of most consumed Tibetan foods and to compare it to international reference tables. Highlight excess or deficiency among young Tibetan children from endemic areas was a secondary objective. 24-hour food recalls were collected by the means of prospective nutritional questionnaire. Mineral daily intakes were evaluated combining foods mineral contents and 24-hour food recalls.

Introduction

Kashin-Beck Disease

Kashin-Beck disease (KBD) is an endemic and chronic osteochondropathy characterized by short stature and skeletal deformities especially in long bones and joints. Joints become enlarged, stiff and painful. Mobility of limbs become limited and muscles can be atrophied. Peoples suffering from KBD get tired quickly and are weak. Symptoms appear during childhood (3-5 years) and get progressively worse. This disease principally occurs in the Tibetan Autonomous Region and in several provinces of the People’s Republic of China. Although many studies have already been conducted and many others are still underway, its etiology remains unknown. A multifactorial hypothesis has been proposed:
- selenium deficiency;
- high concentration of organic matters in drinking water (fulvic acids);
- mycotoxin poisoning by fungi infecting cereals.

Discussion and results

Minerals and bone metabolism

Table 2: Important dietary minerals involved in bone metabolism, their main functions and adverse effects of deficiency or excess consumption.

<table>
<thead>
<tr>
<th>Chemical element</th>
<th>Main functions</th>
<th>Adverse effects of deficiency or excess consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus (P)</td>
<td>Co-factor of many enzymes involved in bone metabolism.</td>
<td>Long term P excess combined with Ca deficiency could have negative impact on bone mineralization and periosteal metabolism.</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>Co-factor of many enzymes involved in bone metabolism.</td>
<td>Long term calcium deficiency (or vitamin D) is a risk factor for osteoporosis and bone fracture.</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>Co-factor of many enzymes involved in bone metabolism.</td>
<td>Magnesium is an important ion responsible for the intracellular calcium homeostasis.</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>Deficiency of Fe impairs enzymes involved in iron metabolism (cytochrome-c oxidase, heme synthesis).</td>
<td>Iron deficiency is a risk factor for anemia and can lead to neurocognitive outcomes.</td>
</tr>
<tr>
<td>Iodine (I)</td>
<td>Deficiency of I impairs enzymes involved in a-iodination (thyroid hormone synthesis).</td>
<td>Iodine deficiency is the main cause of mental and motor retardation in children.</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>Deficiency of Cu impairs enzymes involved in bone metabolism.</td>
<td>Copper deficiency can lead to impaired bone mineralization.</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>Deficiency of Mn impairs enzymes involved in bone metabolism.</td>
<td>Manganese deficiency can lead to impaired bone mineralization.</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>Antioxidant role and cofactor of many enzymes involved in bone metabolism.</td>
<td>Selenium deficiency is a risk factor for cardiovascular disease.</td>
</tr>
</tbody>
</table>

Kashin-Beck Disease

This work constitutes an original nutritional study in the Kashin-Beck ethology context. The nutritional survey confirmed a monotonous and unbalanced diet. Most of foods are highly rich in iron while selenium is clearly deficient. Serious deficiency and excess have been highlighted in young Tibetan children from endemic areas. Nevertheless, this work presents some limits and restrictions: Some unmeasured foods were not take into account in this study such as chang, meat or even water. They are likely to supply sizeable amounts of minerals though. Even if executed in two different endemic regions, the observed tendencies cannot be extrapolated to every endemic area. A larger study over a longer term covering both endemic and non-endemic regions is required for definite conclusions to be reached.

Dietary reference intakes can vary with the type of diet and it is important to notice that DRIs tables are established for a standard population with a quite balanced diet. Yet, Tibetans may not be compared to a standard population and they do not have a balanced diet at all. Bioavailability of elements largely influences DRIs. It notably depends on the chemical speciation, on the presence of antinutritional factors (e.g. chelating agents), on the type of diet and on the individual. The bioavailability of minerals is a critical point that deserves further investigations.

Materials and methods

Tibet Autonomous Region

10 families were selected in two regions according to three criteria:
- Living in endemic area
- Including a 5-12 years old child
- Having an elder KBD child

Nutritional survey and foods sampling were done twice: January and May.

24-hour food recalls of the 9-5 years old children by the mean of a prospective questionnaire.

Foods process
Perishable foods have been dried in a laboratory of the Tibet Center for Disease Control and Prevention.

Materials and methods

Tibet Autonomous Region

Materials

- Minerals measurement: Certified reference materials (CRM) + repeatability
- Mineralized solutions were measured by several methods:
  - Atomic absorption spectrometry (AAS, ICP-OES, HG-AAS and co-IP-AES)
  - Atomic emission spectrometry (ICP-AES)
  - Molecular absorption spectrometry (UV-Vis)

Conclusion and perspectives

Dietary reference intakes can vary with the type of diet and it is important to notice that DRIs tables are established for a standard population with a quite balanced diet. Yet, Tibetans may not be compared to a standard population and they do not have a balanced diet at all. Bioavailability of elements largely influences DRIs. It notably depends on the chemical speciation, on the presence of antinutritional factors (e.g. chelating agents), on the type of diet and on the individual. The bioavailability of minerals is a critical point that deserves further investigations.

Table 1: Recommended Dietary Intakes (RDI) and Adequate Intakes (AI) for the considered life stage groups has been investigated in the present study. Based on the Institute of Medicine of the National Academies.

<table>
<thead>
<tr>
<th>Life stage group</th>
<th>RDI/AI*</th>
<th>U.S. RDA/AI*</th>
<th>U.S. RDA/AI*</th>
<th>U.S. RDA/AI*</th>
<th>U.S. RDA/AI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 years</td>
<td>100mg</td>
<td>1000mg</td>
<td>1000mg</td>
<td>100mg</td>
<td>10mg</td>
</tr>
<tr>
<td>7-13 years</td>
<td>100mg</td>
<td>1000mg</td>
<td>1000mg</td>
<td>100mg</td>
<td>10mg</td>
</tr>
<tr>
<td>&gt;14 years</td>
<td>100mg</td>
<td>1000mg</td>
<td>1000mg</td>
<td>100mg</td>
<td>10mg</td>
</tr>
</tbody>
</table>

The 24-hour food recalls of each child has been listed for January and May. The results of the survey are as follows:
- Tibetan’s diet is principally based on cereal products.
- Fruits, meats and dairy products are low consumed.
- Brewed black tea and butter tea are the most common beverages.
- Chong, a local made alcohol, is also largely consumed.
- There is a low diversity of recipes.

Nutritional survey

Survey

Daily intakes were estimated combining mineral measurements and nutritional survey results. They were computed via the Kidmenu® software. This software already included Tibetan diet recipes from a previous study of the National Nutrition Bureau of Tibet. In order to get an approximation of Se intake, LOD and LOQ adapted values were encoded. The results are as follows:
- We confirm a marked deficiency in calcium;
- Cu/P ratio are always low (f0.1);
- Iron and copper intakes are excessive;
- Zinc is the most probably deficient;
- Selenium intakes approximation suggests a deficiency;
- Manganese intakes often exceed toxicity thresholds.