EXPLORING THE NORTHERN DIMENSION

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Human biomonitoring is needed to improve well-being and mental health of Arctic people

This policy brief focuses on the importance and necessity of human biomonitoring in the Arctic. An individualized monitoring system is needed to assess the risks of public health disorders (including mental health) which result from the deficiencies of essential trace elements and vitamin D. These deficiencies are caused mainly by the unbalanced local diets combined with the lack of sunlight in the North, and they affect not only a person's physiological health but also his or her mental state and social well-being. At the moment we do not have enough data on the nutritional situation in the Arctic, but the few publications available highlight the relevance of the problem of deficiencies for Arctic residents. This Policy Brief summarizes what essential elements and vitamin D are, and how their deficits and overabundance affect the human body. It further elaborates the following policy recommendations for addressing this issue:

- **Recommendation 1.** To develop and implement an individualized monitoring system of essential elements and vitamin status of Arctic residents.
- **Recommendation 2**. To inform people living in the Arctic about health risks connected with essential nutrients deficiencies, and to develop dietary recommendations for those Arctic residents who maintain the traditional way of life.
- **Recommendation 3.** To supply remote Arctic settlements with bioactive food additives, when needed.
- **Recommendation 4**. To strengthen international and interdisciplinary research cooperation on the topic by establishing a network of focal competence centers.

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COVID-19 pandemic has increased health risks in the Arctic

Living in the harsh Arctic climate has always been associated with increased risks to human health. Demanding weather conditions, low average annual temperatures, lack of sunlight, poor variety of nutrition and low population density in the North affect both physiological and psychological health of individuals. As a consequence, residents of the Russian Arctic have considerably lower life expectancy and poorer general health than the national average [1]. The COVID-19 pandemic has worsened the situation and raised the psychological and emotional well-being of individuals as an urgent concern. The identified problems are associated with increased worries of people about the health and well-being of themselves and their family members, long-term social isolation, and travel restrictions within and between countries. These new challenges highlight the need for urgent measures to identify the factors that affect the physiological and psychological well-being of people in the Arctic, and to develop preventive measures. One of these factors is the deficit of essential elements and vitamins (vitamin D, in particular).

Balance of essential trace elements is vital for human health

Essential trace elements play an exclusive role in ensuring vital activity, as they are **mandatory components of the human body**. This group includes iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), molybdenum (Mo), cobalt (Co), chromium (Cr), selenium (Se) and iodine (I). These elements enter the human body with food and drinking water and are among the essential micronutrients. **Deficiency, excess and imbalance** of these chemical elements in the human body significantly contributes to the development of various **pathological health consequences**. For example, **iodine (I), iron (Fe) and zinc (Zn) deficiencies** have similar effects on the development of the **human brain** as POPs, Mercury (Hg) and Arsenic (Pb) [7]. However, the information on concentrations of these elements in Russian Arctic population is almost non-existent in international peer-reviewed literature. **Some recently published research results** confirm that the lack of essential elements is **widespread** among the people living in the Arctic. Moreover, **Fe and I deficiencies among Arctic women** are of **great concern** to scientists and doctors [1]. Furthermore, there are **daily norms** of micronutrients recommended by the World Health Organization (WHO), but the **balance of essential elements depends on individual physiological characteristics** such as gender, age, physical and mental stress, nutrition, as well as the presence of concomitant diseases and medication. Thus, the need for these elements is **individual for each person**.

Figure 1 – Expedition to the Nenets Autonomous Okrug, Russia (Photo by Yu. Varakina)

Vitamin D deficiency is connected to mental health problems

Vitamins are essential fatty and amino acids which are involved in cell nutrition and metabolic processes, and are part of the structure of the protein component of tissues. Vitamin D is a fat-soluble vitamin that plays an important role in maintaining normal levels of calcium and phosphorus in the blood. The term "vitamin D" refers to two steroid prohormones: Ergocalciferol D2 and Cholecalciferol D3. Vitamin D2 is not synthesized in the human body, but is produced from plant sterol and thereby must be taken from food. Vitamin D3 can be obtained from animal-sourced food, but it is also produced in the human body. When a chemical element 7-dehydrocholesterol that is present in the human skin is under the influence of ultraviolet radiation, it is converted first to provitamin and then to the vitamin itself.

It is commonly known that the **lack of vitamins negatively affects the human health**, including the **psychological** one. Many studies have already proven the **connection between vitamin D deficiency and certain mental states**. For example, recent studies published in 2020 confirm the relationship between D-vitamin status and psychotic personality disorders [5], the frequency of suicidal thoughts among healthy people [6], and other adverse psychological manifestations. The **problem of vitamin D deficiency is particularly acute in the Arctic region**. Among the factors provoking the deficit

conditions in the North is the **short daylight** (polar night) in winter, the critically small number of sunny days throughout the year, and **poor local diet**.

Dietary habits in the Arctic are changing

Traditional lifestyle in the North and the need to adopt to the harsh environmental conditions have contributed to the development of a **specific diet**, which consists mainly of products of local origin and **enables normal human growth and development**. The diet of local residents depends on the season, the area of residence (inland or coastal) and the lifestyle (settled or nomadic). One of the main sources of protein is **reindeer meat**, which is also a source of **vitamin C**. The most common food product is **fish**, both freshwater and marine, which is a source of many **essential micronutrients**. Some species of northern fish are rich in **Omega 3 fatty acids**. The local diet also includes migratory birds, marine mammals and other seafood. **Wild berries** (cranberries, cranberries, cloudberries, etc.) are rich in **dietary fiber, organic acids, and vitamins.** The local population also uses wild herbs in cooking.

Currently, we are witnessing a **change in the diet of Arctic residents**. For example, in schools, only 4-8% of the menu consists of national dishes [9]. Arctic people are increasingly consuming canned products, as well as soups, salads, cereals and other **processed food**. **Sugar-rich** confectionery products (waffles, jams, sweets, etc.) now occupy a special place on the tables of local residents. All these dietary changes **negatively affect the health** of people. For example, a recent study conducted in the Russian Arctic (Figure 1) and covered 204 local women found that 66.0% of them were overweight or obese [8].

Human biomonitoring as a basis for health policy decisions

Biological monitoring is a system of **complex and continuous observations on the state of biota and human health**, and it is also in the Arctic the most appropriate tool for tracking changes and **accumulating information** necessary for decision-making (Figure 2). Continuous monitoring allows determining the effectiveness of measures taken to reduce the pollution of human habitat and improve the health of the Northern residents. Monitoring makes it possible to **identify individuals at risk** and at the same time draw conclusions about the **vitamin and elemental status** of the population as a whole. Thus, monitoring information can be used to **inform the Arctic residents** about existing health risks and to give them **dietary recommendations**. It also provides the knowledge base for authorities to take needed measures, such as the **supply of bioactive food additives** to the region or the introduction of changes in the existing regulations.

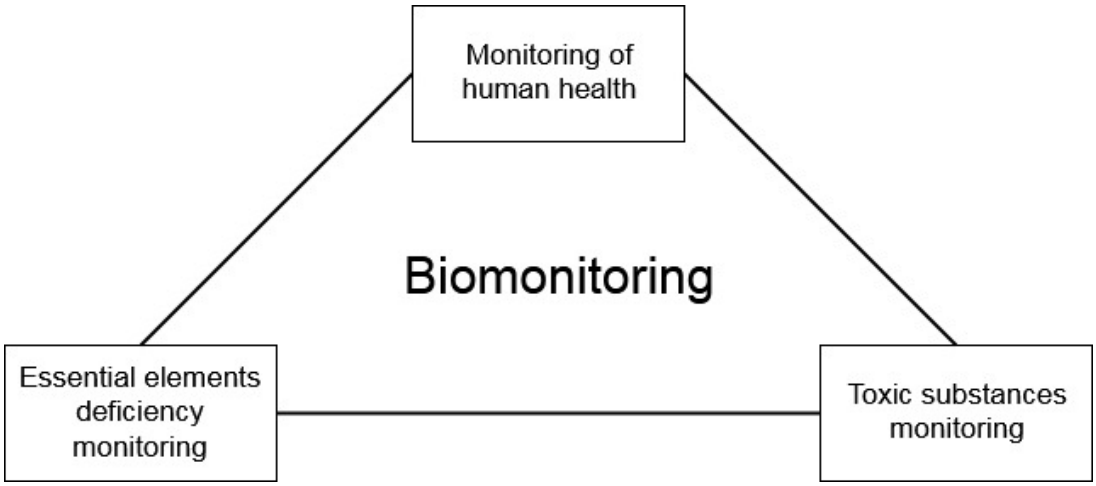

Figure 2 – Elements of the Arctic biomonitoring

Currently **biological monitoring in the Arctic is carried out** by separate scientific groups and working groups of the Arctic Council. However, they all use **different research protocols**, so it is not always possible to compare the obtained results. Therefore, collaboration would be needed to **harmonize the research protocols** and bring Arctic monitoring activities to a more systematic and reliable level. This would require the Arctic States to better recognize **biomonitoring as part of the Arctic scientific agenda**, and to foster **international scientific collaboration** in this area. The establishment of a more effective biomonitoring system would also call for an **interdisciplinary approach** with the involvement of researchers from fields such as analytical chemistry, public health, environmental sciences, nutrition, biology, sociology, economics and law.

The establishment of **focal points or competence centers** for the collection, processing and dissemination of biomonitoring information will contribute to improving the effectiveness of biological monitoring in the Arctic, and data and information management. Such focal points could appear at the Arctic research centers or universities. Such approach would ensure the **objectivity of the data** obtained and the **responsiveness** to the identification of individual and population risks. It would also ensure **timely information** of Arctic residents and the authorities about these risks. Research centers and universities could also take responsibility for conducting workshops and seminars, and **educating people** about the existing health risks and peculiarities of the northern diet.

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