Changes in immunological and physiological parameters in urine during Antarctic Scientific Expedition

Short Communication

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Abstract
The aim of this study was to examine the effect of extreme climatic conditions on certain immunological and physiological parameters in urine in participants of the 9th Czech Antarctic Scientific Expedition, January – February 2015. The studied parameters were pH, number of leukocytes in 1 µl urine and the amount of proteins, nitrites, blood and haemoglobin in urine. A total of 45 urine samples were collected during 3 series of sampling (first pre-departure, second during the first 2 weeks of the stay in Antarctica, and third in the last 2 weeks of the stay). Paired t-test was used for comparison of the data from the Czech Republic and the Antarctica. We have found statistically significant decreases in pH and in the number of leukocytes in urine during the stay in Antarctica. The other parameters showed no changes. We conclude that several factors of the Antarctic environment (with lack of stress, pathogenic microorganisms and pollutants) may have positive effects on certain aspects of human health, and discuss the likely causes and mechanisms.

Key words: Antarctica, extreme environment, urine, leukocyte, pH

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Introduction

Recently, changes in human blood levels of several immunological parameters and biochemical markers in blood during a stay in extreme conditions of Antarctica have become a subject of a number of studies. Mehta et al. (2000) studied the effect of psychosocial stress in a group of expeditioners during Antarctic winter. The authors observed impaired function of immune system, represented by diminished cell-mediated immune response and reactivation and shedding of latent viruses. Mucosal immunity in an overwintering group of Antarctic expeditioners was studied by Gleeson et al. (2000). The authors concluded that the effect of cold and stress led to reduced activity of the immune system, *e.g.* reduced resistance to infection. Similar results are reported in a study done by Lugg et Shepanek (1999). On the other hand, polar conditions may have also positive influence on health status, as referred by Palinkas et Suedfeld (2008). The authors stated that polar expeditioners experienced so-called salutogenic outcomes (enhanced self-sufficiency, improved health, and personal growth) resulting from successfully coping with stress.

Similarly, in a study by Brat et al. (2014), possible positive effects of polar conditions on some aspects of human health have been observed. The authors studied the effect of moderate- to high-level physical performance on the phenomenon of post-exercise cardiac biomarkers (troponin T, D-dimer and NT-proBNP) serum level elevation (formerly described in endurance athletes). The results showed that a long-duration of physical activity performed in a high latitude may affect this phenomenon in a positive way (*i.e.* the incidence/ probability of post-exercise elevated levels of cardiac biomarkers was decreased).

The aim of our research was to examine the effect of a short-term stay in Antarctica on selected physiological parameters in urine of expedition members during austral summer season. The studied physiological and immunological parameters included: pH, number of leukocyte in 1 µl urine, quantitiy of proteins, nitrites, blood and haemoglobin in urine.

Material and Methods

Background

J. G. Mendel research base is a summer-operated station located on James Ross Island, east of the Antarctic Peninsula. Coordinates of the station are 63°48' S 57°53' W, altitude 9 ma.s.l.. Main scientific activities performed during each summer season comprise the research on climate change, and the following disciplines: glaciology, geology, biology of lower plants, microbiology, chemistry and others. The 9th Czech Antarctic Scientific Expedition (held between December 2014 and February 2015) consisted of 15 participants, including 12 scientists and 3 technicians.

Subjects

In the study, Fifteen subjects (volunteers) participated, of these 3 women and 12 men. All participants were of European origin, age ranged between 25 and 61 years (mean 37.9 years, median 35 years). The participants were healthy, none of the subjects were treated for any kind of disease. None was taking any regular medication before the expedition. During the stay in Antarctica, the scientists worked several hours a day in the field, covering daily walks ranging 10-15km in average. Exceptionally, they had some 30-35 km long walks in a day to distant areas from J. G. Mendel station.

Laboratory analyses

A total of 45 urine samples have been collected in 3 series. The first was taken before the expedition members left the Czech Republic (December 23rd – 29th, 2014), the second during the first month of the Antarctic stay on January 20th, 2015, and the third before the end of the expedition on February 10th, 2015 at James Ross Island.

The samples were collected in the morning and analysed by diagnostic test strips PHAN that are intended for semiquantitive analysis of urine. A total of the following 6 parameters were studied: pH, number of leukocytes in 1µl, the amount of proteins, nitrites, blood and haemoglobin.

Statistical analyses

For each parameter, mean values, their standard deviations (SD) and medians were calculated. Paired t-test was used to compare data from the Czech Republic and from Antarctica. Results were considered to be statistically significant when $p < 0.05$.

Results

We have found statistically significant differences in two out of the 6 tested parameters (the pH value and the number of leukocytes in 1 µl of urine). The decrease in pH of urine was observed as early as at the second sampling (when compared to the pre-departure values) ($p << 0.01$). Further decrease in pH was detected at the end of the expedition ($p << 0.01$), (Fig. 1, Table 1). Similar results were observed in the number of leukocytes found in 1µl of the urine. Statistically significant decreases in the leukocyte counts in urine appeared in both of the two samplings in Antarctica when compared to the initial values in the Czech Republic ($p << 0.01$), (*see* Fig. 2, Table 1).

No differences were observed in the quantity of protein in urine in the 3 series of urine samples. The other parameters (blood, nitrites and haemoglobin presence in urine) were negative in all samples. The results are summarized and presented in Table 1.

Series of sampling	**1**	**2**	**3**
pH	6.12 (± 0.44)*	5.48 (± 0.35)	5.48 (± 0.32)*
leukocytes (10^9x l^{-1})	13.83 (± 6.18)*	2.5 (± 4.56)	3.5 (± 7)*
proteins (g x l^{-1})	0.65 (± 1.21)	0.05 (± 0.09)	0.6 (± 0.07)
blood	neg	neg	neg
nitrites	neg	neg	neg
haemoglobin	neg	neg	neg

* $p < 0.01$

Table 1. Represents an overview of the results. Values are presented as means ± SD.

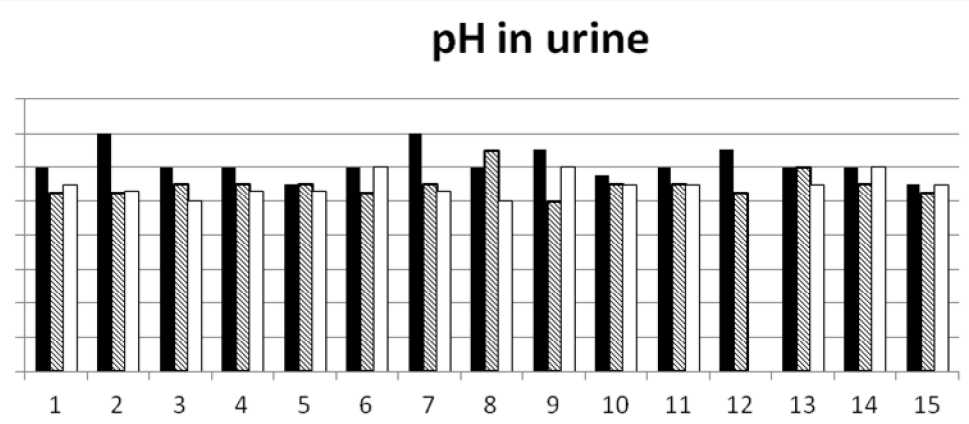

Fig. 1. Represents the measured changes in pH values of urine in each subject.
x-axis: pH of urine, ***y-axis***: number of subject
Black: pre-departure values, ***Grey***: values measured on January 20th, 2015, ***White***: values measured on February 10th, 2015.

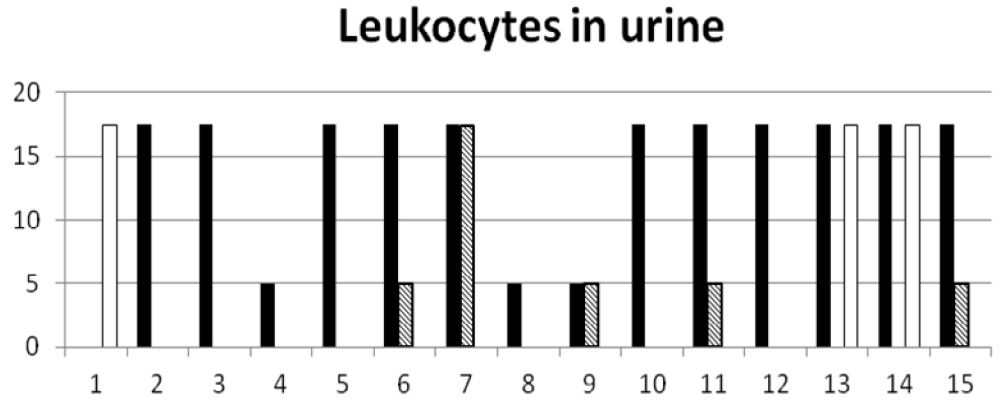

Fig. 2. Represents the measured values in leukocyte counts in urine in each subject.
x-axis: number of leukocytes in 1 µl of urine, ***y-axis***: number of subject
Black: pre-departure values, ***Grey***: values measured on January 20th, 2015, ***White***: values measured on February 10th, 2015.

Discussion

In last decades, the numbers of tourists, industry employees and scientists visiting the high latitude regions (particularly in the Arctic) have increased dramatically (Kaltenborn, 2000). Therefore, it is important to know the principles of adaptation of human body to the extreme conditions of these environments.

Several authors have studied the effect of polar (extreme) conditions on human immune system. Most of the studies were performed on polar research stations during long-term (typically one year long) stays. During such long periods, the persons are exposed to different climatic conditions, isolation, changes in circadian rhythms and in dietary patterns. Due to isolation, a relative lack of antigenic stimuli during long-term stays in the polar regions in apparent. Lugg et Shepanek (1999) reported almost 50% reduction in T-cell proliferation to mitogen phytohaemagglutinin, expansion of polyclonal latent Epstein-Barr virus infected B-cell populations, as well as increased numbers in latent HSV infections. Gleeson et al. (2000) and Francis et al. (2002) demonstrated alterations in mucosal immunity (IgA and IgM concentration) in response to stressors associated with a long-term isolation. Shirai et al. (2003) studied whether long-term isolation in Antarctica may have any effect on T-cell-mediated immune functions. The authors concluded that the exposure to an Antarctic winter seemed to induce TH1-mediated immunity in humans. An overview of metabolic changes and and of homeostasis in humans during a stay in high latitudes is presented by Panin (2007).

Our study was performed during a two-month period of the Antarctic summer. We have found statistically significant differences in the pH value and the number of leukocytes in 1 μl of urine) during the stay in Antarctica when compared to inicial, pre expedition values.

In our opinion, changes in the measured parameters might occur as a positive effect of a stay in an environment with a relative lack of pathogenic microorganisms and pollutants. In some of the participants, also psychological factors might play a role, since several persons had less stress and administrative work when compared to their profession in the Czech Republic. It is questionable, if the pH value might be affected also by the different chemistry of the drinking water. There were no differences found between the values measured at the beginning and at the end of the expedition. This can be explained by the constant environmental and meteorological conditions during the stay. None of expeditioners manifested changes in amount of proteins or in biochemical parameters (blood, nitrites, haemoglobin) in urine. This was a result of an overall excellent health status of all expeditioners.

Conclusion:

In our study, we have found significant changes (decreases) in leukocyte numbers and pH values in urine that during the stay in Antarctica. There were no changes observed in the rest of the studied parameters (amount of proteins, blood, nitrites and haemoglobin) in urine. We may conclude that the Antarctic environment with a relative lack of stress, reduced quantities of pathogenic microorganisms and pollutants may have a positive effect on certain aspects of human health.

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