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EXCESSIVE PHYSICAL EXERCISE IN TOURISM AND RECREATION AND ITS METABOLIC EFFECTS

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An excessive physical exercise destructively influences on humans. This question has now a not overpriced meaning because there are more and more popular extreme kinds of tourism, recreation and sport, and far shifting limits of results attained in elite sport, and there are wider range of time and loads of professional work, which can lead even to work holism. If compare human body organization to not oversized device or building construction, one has to say that human body is in the same way subjected to stress, it means energy expenditure. A subjection to permanent stress without a full recovery can cause an abiding change of a metabolism regulation level. It means strain of this regulation. It is a shift within a genetically programmed range of homeostasis and a change of biological requirements of human body subordinative to maintenance a relative and very labile metabolic balance. However, it is not free. Each physical exercise is a download of an energetic credit from human body energetic substrates. If this credit is too high, it can cause a dysfunction of some functional spheres of a human being and can turn into an overtraining status. Usually, it manifests in suppression of the most energy-consuming function, it means reproductive function. It occurs in both genders. Then, this question is very complicated from the psychic sphere of human being, too.

Key words: extreme tourist and recreational activity, excessive exercise threat, work holism, gender

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INTRODUCTION

All situations associated with energy expenditure by humans are considered as catabolic conditions. For example: mental work, physical work, digestion, disease, emotion (both positive and negative). They have, of course, their anabolic counterparts as, responsively, sleep, resting, absorption of nutritive elements, convalescence and relaxation. It gives as a result a labile balance of metabolic processes in humans. This phenomenon is known under the idea of homeostasis which determines a range of possible adaptation of organism to actual environmental conditions as ambient temperature, level of nutrition and an intensity of physical effort, physical activity. It is also known that homeostasis is far more stable in women than in men (Charzewski 1996, Szczepanowska 2001). It means men are more trainable " adaptive, eco-sensitive " than women (Wolański 1999). It is a result of a reproductive function of each human gender. Stable internal metabolic conditions of female organism guarantees a proper internal environment to create a new life. And also a range of homeostasis is narrower for older people (Szczepanowska 2001). It means their adaptation to environmental conditions is weaker and occurs through a worse organism's tolerance (Szczepanowska 2001). The apogee of human homeostasis stability in each gender is round the age of forty. So, it is understandable why astronauts, cosmonauts and ticonauts are flying into the space at this age. The very disadvantageous influence of open space, without gravidity, can cause less damage at this age than in other periods of human life. These damages are easy comparable on earth to the results of bed rest, from one side, or from the other - to an excessive physical load, associated sometimes with emotional stress, and they are very often not possible to compensate. Then, the recovery of organism to its previous function is sometimes not possible.

If compare human body organization to not oversized device or building construction, one has to say that human body is in the same way subjected to stress, it means energy expenditure. A subjection to permanent stress without a full recovery can cause an abiding change of a metabolism regulation level. It means strain of this regulation. It is a shift within a genetically programmed range of homeostasis and a change of biological requirements of human body subordinative to maintenance a relative and very labile metabolic balance. Very often it means a disease, sometimes a permanent one – to the end of life. This disease can also make life shorter.
However, this shift " strain " is not free. Each physical exercise is a download of an energetic credit from human body energetic substrates. If this credit is too high, it can cause a dysfunction of some functional spheres of a human being and can turn into an overtraining status. Usually, it manifests in suppression of the most energy-consuming function, it means reproductive function (Hackney et al. 2003). It occurs both in women and men. Then, this question is very complicated from the psychic sphere of human being, too. Research indicates that endurance exercise training, as prevailing in the tourist and recreational training, has significant effects upon the reproductive endocrine system of humans. Until recently, this effect was thought to be limited primarily to females (Bullen et al. 1984, 1985). However, a growing body of evidence demonstrates that the male reproductive endocrine system is also affected. Specifically, the circulating hormonal levels of testosterone are found to be at low concentrations and, the hypothalamic-pituitary-testicular axis that regulates testosterone production is altered in endurance trained men. Potentially, the lowered testosterone levels of the endurance-trained male could disrupt some of their anabolic or androgenic dependent processes (Hackney 2001). Fatigue may modify the hormone responses to exercise. Overall fatigue from prolonged endurance activity may introduce a resetting in the pituitary-adrenocortical component of the endocrine system, expressed either by intensified or by suppressed endocrine functions (Viru et al. 2001). The findings of suppressed reproductive hormones in males and females may exist because they are overtrained or are developing the overtraining syndrome (Hackney 1996, Hackney et al. 2000, Hackney 2001). The overtraining syndrome is a pathological disorder, where there is consistent and persistent exercise performance incompetence in a qualified tourist participant that does not reverse itself after a few days of rest and recovery. It indicates a change of endocrine system secretion to suppression and extremely low circulating levels of testosterone in males, and estrogens and progesterone in females, and also gonadotropins: lutropin, follitropin (Hackney 2001). Thus, the hormonal changes between overtrained and chronic endurance trained males and females are similar. Overtraining and decrease of hormone levels causes an infringement of immune system (Hackney 2001, Miles et al. 1999). And excessive

extreme exercise is a reason of a decreased protein synthesis and muscle mass development, then bone demineralization – severe mineral loss from bones (Hackney 2001).

Physical exercise under conditions of excessive physical load may cause many disadvantageous somatic and metabolic changes. These changes are multifactor. To enumerate a majority of them there are as follows: oxidative stress, risk of cardiovascular disease, cardiac injury, overtraining and decrease of hormone levels, then deterioration of metabolic regulation and integration of organism, infringement of immune system, deterioration of cell membranes, and even a syndrome of anorexia athletica. Today one can observe extreme antithetic forms to realize human dreams: from one side only conveniences, comfortable life and limited physical activity, and from the other - a desire to be the best in every respect, also from physical activity point of view. In any case it is connected with human psyche because motivation and consciousness are the most important determinant of performance – physical capacity. It is more important than oxygen supply, resources of energy substrates and efficiency of equalization of homeostasis disturbances " efficiency of effective recovery. Therefore, today it is a great need, from one hand, to propagate a praise of being physically active. This problem is worked out by many persons involved with civilized diseases. And there is also, from the other hand, a great need to propagate a praise of resting, just simply of being lazy (M.N.M. 2001). Health gets benefits of sleeping eight to nine hours a night, taking naps and avoiding long work hours and extreme exercise. The benefits of moderate exercise are far more healthful than more intensive exercises. Extreme forms of tourist and recreational excessive activity are forms of extreme kind of sport, indeed. There are many changes of human body during this kind of qualified tourism. For example, an effect of high altitude exposure during a mountain climbing expedition is confirmed by weight loss and decrease of body mass components. Physical demand of mountain climbing to high altitudes significantly impacts the overall body composition reducing the body's primary components, i.e. fat and lean body mass (Shaw et al. 1995). Practicing exercise, even at the tourist and recreational level, is associated with increased energy expenditure, which typically changes body composition parameters (Lehmann et al. 1999).

Considering an influence of extreme loads on humans one has to notice that today limitations and threats of excessive physical exercises are known. This problem seems to be very interesting now when people are conscious in undertaken of risk forms of physical activity.

Despite the many known health benefits of exercise, there is a body of evidence suggesting that endurance exercise is associated with oxidative stress. The extreme endurance exercise results in the generation of lipid peroxidation with a concomitant increase in vitamin E disappearance (Mastaloudis et al. 2001). When endurance training is coupled with antioxidant vitamin supplementation it reduces blood creatine kinase increase under exercise stress (Rokitzki et al. 1994).

Although physical exercise is beneficial to health of people who exercise at high intensities throughout their lifetime it may have increased risk of cardiovascular disease (Sharman et al. 2004). Aerobic exercise, as it is mentioned above, increases oxidative stress and may contribute to atherogenesis by augmented oxidation of plasma lipoproteins. Obtained findings suggest that people with high aerobic power, due to extreme endurance exercise, have plasma with decreased antioxidant capacity and higher susceptibility to oxidation which may increase their cardiovascular risk (Sharman et al. 2004). The relationship between extreme exercise and coronary artery disease is not well understood, and the information available is contradictory. Conditions in which the partial pressure of environment oxygen varies constantly, it means during extreme mountain bike challenges for example, can induce myocardial cell injury (Ortega et al. 2006). In male amateur mountain bikers, this kind of strenuous exercise may induce sub-clinical myocardial injury (Ortega et al. 2006). The basis role of etiology in this disease may play cardiac troponin I. Strenuous endurance exercise can change levels of cardiac troponin I (Neumayr et al. 2001). It causes health hazards of extreme exercise but hypotheses explaining the exercise-induced cardiac injuries are not confirmed yet (Neumayr et al. 2001).

It is well-known that persons with a drug addiction experience feelings of anhedonia during "normal" daily activities. It has been proposed that these symptoms of anhedonia are the result of direct pharmacological influences of drugs on the dopamine system. Anhedonic symptoms in skydivers who regularly expose themselves to thrillful extreme kind of tourist activity (and then experience intense hedonic feelings) are tested to confirm the assumption that non pharmacological processes are also involved in anhedonia. The main findings of the study is that subjects who engage in the high-risk activity of sky-diving have experienced more anhedonic symptoms than subjects who do not engage in such an extreme kind of activity and then, prefer a low-risk activity like rowing. This finding supports the notion that skydiving has similarities with addictive behaviors and that frequent exposure to "natural high" experiences is related to anhedonia. This suggests that the negative emotional state as observed in drug users may not be exclusively the results of exogenous psychopharmacological effects, but might also result from psychological mechanisms that are partly responsible for these anhedonic feelings (Franken et al. 2006).

Exercise gives benefits to human body but too much exercise causes disadvantages, known as a syndrome of anorexia athletica (Current Health 2004). It is characteristic for many qualified tourists. The benefits of exercise are clear. Exercise helps control weight, tone muscles, strengthen bones, and improve cardiovascular health. It can reduce stress and give a mental lift, too. But there is such a thing as exercising too much. Some exercise addict young people, often teenage girls exercise compulsively. This can be dangerous. How one can tell if exercise program is getting extreme? Here are some warning signs: being preoccupied with weight and exercise, exercising even when somebody is ill, withdrawing from family, social, or school activities in order to exercise instead, getting upset whenever accompanying person cannot exercise, worrying that somebody will gain weight if he do not exercise, using herbs, diet aids, or other chemicals to "improve" himself physically, being dissatisfied with physical achievements of other people. This situation describes an important need to get medical and psychological help (Current Health 2004).

Experiments on animals and clinical studies in athletes have shown also a negative impact of extreme exercises on the physicochemical characteristics of biomembranes. The resultant decrease in the activity of different isoforms of the multienzymatic system of hepatic cytochrome P450 may underline firstly, the formation of a vicious circle of increases in the microviscosity of biomembranes and membrane-dependent processes and, secondly, the lowered resistance of athletes environmental factors, which should be borne in mind during the professional activity of high-class athletes (Tverdokhlib & Nikonorov 2002). Then, throughout the deterioration of cell membranes and a microscopic damage to muscle fibers, a full deterioration of metabolic regulation and integration of organism succeeds (Tverdokhlib & Nikonorov 2002).

It is a wide range of biochemical and biomechanical methods to investigate metabolic and mechanic effect of a hard exercise in humans. To choose only a few of them one can enumerate: a study of formation of the EMN index (Electrophoretic Mobility of Cell Nuclei in epithelial tissue - ratio of cells with mobile nuclei to cells with non-mobile nuclei); then an indication of sexual hormones, especially testosterone, in the group of trained and sedentary control subjects, and a measurement of grip force differences of power in finger muscle flexors (PFMF) between right and left hand in physically active men (PAM) - in consecutive categories of their vocationally active age - and in sedentary men (SM).

Aim of work

The aim of work is to introduce three examples of our own studies carried out in regard to metabolic changes as a result of a great volume of exercise, it means a product of multiplication between intensity and time of exercise during practicing tourism and recreation, and also as a result of a hard physical work during the vocational period of life.

The first example

The EMN index is a percentage ratio of buccal epithelium cells with nuclei vibrating (moving) in an electrical field to cells with non-vibrating (moving) nuclei. This phenomenon is related to metabolic processes occurring in the area of the cell nucleus (Markiewicz & Cholewa 1979) and also to cellular physicochemical properties (Shakhbazov & Colupaeva 1991, Shckorbatov et al. 1995a,b,c, Shckorbatov et al. 1998, Shckorbatov 1999). Increased metabolic processes accelerate the activity of a cell nucleus and change its structure. Then, the resultant charge is changed. The electro-negatively charged nucleus vibrates in compliance with the change of the imposed variable magnetic field to the electrodes, moving towards the anode (Shakhbazov et al. 1986). The lowering of pH of plasma through an increase of acidity during exercise captures anions and changes the permeability of cellular membranes in the direction of a decrease of homeostatic imbalance inside and outside the cellular milieu. The Electrophoretic Mobility of Cell Nuclei (EMN) index reflects physiological changes in the body associated with environmental factors potentially harmful to the health of the individual (Czapla & Cieślik 2000). Electrophoretic activity within cell nuclei is assessed by intracellular microelectrophoresis (Shakbazov et al. 1986). The EMN index is used then as an indicator of biological age (Czapla 2000, Shckorbatov & Shakhbazov 1992) and physiological conditions of the body (Czapla 1999, Czapla & Cieślik 2000, Shakhbazov et al. 1996, Shakhbazov et al. 1997). An average, the EMN index rises progressively during development, reaching maximal values at 17-18 years of age and then declines gradually with advancing age (Figure 1).

The EMN phenomenon is related to the biochemical composition and physiology of

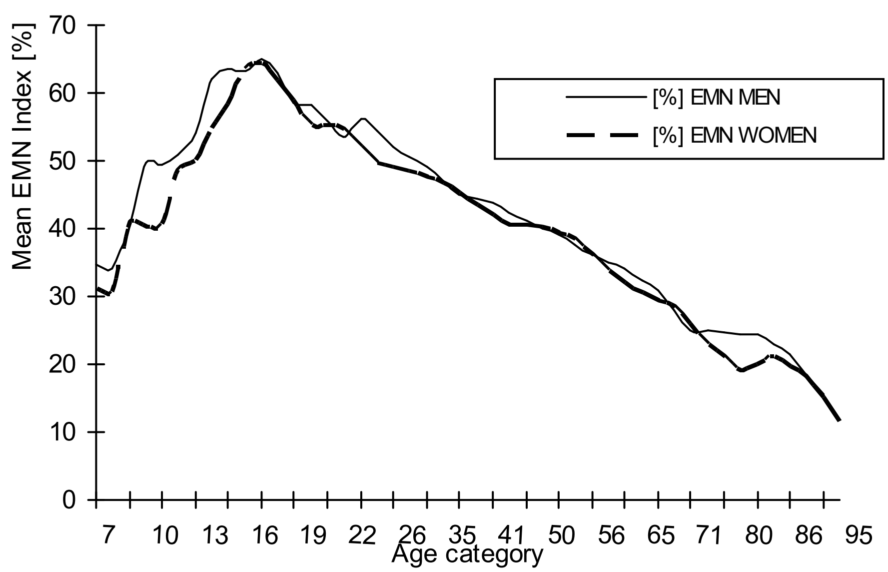

Fig. 1. Average values of the EMN index in human being ontogenesis formation. Rising line- progressive phase (Cieślik et al. 1994), dropping line- stable and involutionary phase (Czapla 1999, Czapla 2000).

cellular structures and to properties of physical and chemical nature, or to electrokinetic and electrostatic properties of nuclei and other cellular structures changing with age (Czapla 1999). The EMN index describes the physiological state of the body not only at resting status but also under intensive exercise conditions.

The physiological condition of the body changes in genetic limits defined by homeostatic mechanisms specific for individual structures and functions. One of these mechanisms is acid-base balance of blood, cerebrospinal fluid and extracellular liquids. Regular tourist and recreational training may shift the level and direction of this balance: on one hand, more effectively eliminating acid products of metabolism and energy conversion, and on the other hand, buffering blood volume extension (Szczepanowska 2001). It is an adaptation to the demands of rigorous training due to a more efficient metabolism which under extreme conditions of exercise in trained individuals as compares to untrained ones permits an achievement of a high level of performance, and also can show metabolic differences between maximal and supermaximal exercises.

The purpose of this study is to evaluate the relationship between changes in the physiochemical characteristics of buccal epithelial cells measured by the EMN index and physiological parameters of the blood acid-base balance (pH, BE and LA) during maximal and supermaximal exercises.

Two groups of females practicing rowing as a form of spending their leisure time have been subjected to the study. One group (N=33) has been younger, at the average age 15 y.o. and the second was older (N=10) at age 22 y.o. As expected, practicing experience is greater in the older group as compares to the younger one. Two types of exercise tests on Concept II (Morrisville, USA) rowing ergometer have been administered to all females:

1. Supermaximal – accruing extreme exercise intensity in the shortest period of time during 2000 m. Under these conditions, intensity has reached supermaximal level above maximal oxygen uptake (VO_2max).

2. Maximal - accruing exercise intensity up to VO_2max. Exercise intensity has been increased every 3 minutes by 30W up to VO_2max.

Arterial blood from the finger tip has been drawn out 3 minutes before and 3 minutes after the exercise in order to measure acid-base balance parameters (pH and BE) and lactic acid concentration (LA). Buccal epithelial cells have been collected before and just after the exercise bout by disposable, sterile spatulas. It was a non-invasive, bloodless and painless procedure. The nuclei have been placed in 0.9% NaCl solution and have been observed under the microscope, magnified 200 times, on a special plate in an alternating electric field of 20-30V and 0.1mA intensity and 1"2Hz electric field frequency alterations.

Changes in the EMN index, pH, BE and LA concentration before and after the exercise bouts have been calculated statistically, also with correlation analysis. The following parameters: pH, BE and LA have changed significantly ($p<0.05$) from pre- (resting) to post-exercise status, while the EMN index has changed only in younger group of females under super-maximal conditions. Correlations between the EMN index and pH, BE and LA are stronger after super-maximal exercise, and also stronger for younger group ($p<0.01$). Correlations between the EMN index and these acid-base balance physiological parameters reflect the homeostatic disturbance associated with intensive exercise conditions. The decline in the EMN index appears to be dependent on the post-exercise changes of an organism's acidity.

In conclusion, the EMN index reflects acid-base alterations and may be useful in evaluating systematic reactions to stress an expression of energy expenditure and thus production of metabolic intermediates (e.g. pH, BE, LA).

It is clear that super-maximal exercise of a deep acidity produces the greatest changes in the physicochemical features of buccal epithelial cells. No significant changes in the EMN index for the older group may reflect an effective metabolic mechanism to compensate stress during intensive exercise in these females. It has meant that the older group could show deeper acid reaction after the exercise.

The second example

The determination of hormone levels by radioimmunoassay is a commonly known method to recognize hormone changes during different conditions of humans. This method has been used just in the following work together with the infusion of gonadotropin-releasing hormone (GnRH) to induce testicular testosterone production via subsequent elevations of lutropin. Testosterone production rate has been statistically analyzed with adjustments for confounding factors and compared between groups.

This study can show an influence of recreational training of long-distance running on a level of sexual hormones, especially testosterone. These hormones besides an obvious reproductive function are responsible for a proper regulation and also integration of circulating system.

Research indicates that nevertheless, in a recreation long-distance running of 100 km per week, endurance-trained men have lower basal testosterone concentrations than age-matched sedentary control men. Therefore, in this study the peripheral component in the hypothalamic-pituitary-testicular (H-P-T) axis in endurance-trained men is examined to determine if basal testicular production of testosterone is suppressed. The study design has been retrospective, with a case-control approach. All examined men have been 40 y.o.

Recreational long-distance runners as trained men (N=5) and sedentary control men (N=6) have been infused with gonadotropin-releasing hormone (GnRH) to induce testicular testosterone production via subsequent lutropin elevations. Testosterone production rate has been statistically analyzed with adjustments for confounding factors and compared between groups.

The basal testosterone concentrations have differed significantly between the trained and sedentary control men groups [pooled mean values; 13.9 (3.0) nmol*l^{-1} vs. 23.4 (3.2) nmol*l^{-1}, $p<0.05$]. The testosterone production rate has been significantly lower (~20-30%; $p<0.05$) in the trained men as compared with the sedentary control men following GnRH infusion.

It is concluded that the exogenous stimulated testicular production rate of endurance-trained men is suppressed. This finding may account, in part, for the lower circulating basal testosterone concentrations found in these men. The present evidence supports the hypothesis that endurance exercise training induces a degree of peripheral adaptation (i.e., testicle) in the H-P-T axis. One can assume that this adaptation in the axis could be both a permanent or transient phenomenon. It seems to be dependent on the period of time as a practicing experience. Organism sacrifices a sexual-reproductive function to survive, it means to preserve life. Too heavy exercise then can disturb the most energy-consuming function of human body. Literature data have shown this phenomenon firstly in females, and then researches had observed the similar behavior of males' body. It is characteristic also for overtraining, work holism, and exercise addiction (Hackney et al. 2003).

The third example

From the mechanical point of view there are some types of handgrip. They are mainly associated with a vocational work. A finger-palm grip multipoint, called also power grip, is used in power type of work (Fiutko 1989, Dunnet et al. 1995). The increase in electrical activity of the finger flexor muscles with an increase in the grip force is observed to be most significant under static as well as dynamic loading conditions

(Gurram et al. 1995). Finger motion is a balance of flexor muscles and intrinsic extensor muscles and provides incredible versatility of finger and hands (von Schroeder, Botte 1997).

In this example it is necessary to analyze the influence of a high physical exercise load during a majority of life spans. The measurements of power in finger muscle flexors (PFMF) can then describe a development of decrease of muscle mass. In this work it is shown within the period over 30 years (between 21-54 y.o.) in PAM and SM.

The aim of this work is to analyze differences in a breakdown of PFMF between right and left hand and to compare them between PAM (during a vocational period of life in consecutive categories of their vocationally active age) and SM.

The group of PAM consisted of 38 subjects and group of SM of 42 subjects. The range of age for both groups is between 21-54 y. Body height of physically active is 178.5 cm (SD=4.97 cm) and for sedentary ones – 173.9 cm (SD=6.21 cm).

A PFMF value of right and left hand has been determined by the JAMAR hydraulic hand dynamometer Sammons Preston INC. To obtain additional quantities the following measurements have been carried out: width of elbow epiphysis, width of distal forearm epiphysis, upper extremity length, and forearm length. All principles of measurement methods have been preserved (Drozdowski 1998). All subjects are right-handed. Examined subjects show also asymmetry in morphological features of upper extremities (right and left). Massiveness of skeleton in upper extremity has been greater in PAM (width of elbow epiphysis and width of distal right forearm epiphysis between both groups: $p<0.0001$; width of distal left forearm epiphysis between both groups: $p<0.05$). Length of upper extremity has been comparable in both examined groups (ns difference for both extremities). These results can be explained by a high workload in PAM during many years of their vocational activity. However, in the whole age range PFMF mean value of right hand is higher in SM (a ns difference), and PFMF mean value of left hand is higher in PAM ($p<0.05$). Furthermore, taking under the consideration the dynamics of this feature in both hands it is clear that a significant quick rate of PFMF increase ($p<0.01$) appears in PAM between 31-35 y.o. The highest development of PFMF in SM is between 26 30 y.o. The PFMF increase in SM is then milder than in PAM. In PAM, in turn, there is a decrease between 36-40 y.o. of both hands (pd"0.05). In this group after 50 y.o. PFMF of left hand is higher than right hand ($p<0.05$). In the case of SM PFMF of both hands achieves the highest value between 46 50 y.o. At the age 36 45 y.o. a value of PFMF in PAM is equal to the value of PFMF in SM. In PAM since 46 y.o. is a regression of PFMF in both hands as compares to SM. Concluding, a decrease in PFMF observed in PAM can be caused and explained by a higher physical exploitation of this work organ in this vocational group as compare to SM (Quaine et al. 2003).

DISCUSSION

Even if submit a hypothesis that there are not differences between genders in relationships to the development of maximum force (Hackney, Gilliam 1984) and also find that women are more resistant to the fatigue (Ziemba 1998) in endurance exercise it is worth to mention that females are stronger gender. It is connected also with the psychic sphere of organism's function. The excessive exercise any how plays a destructive role in body structure, function and psychics from the point of understanding a supercompensation phenomenon, too. The whole proceeds mainly by impossibility to realize the entire, complex recovery. Each exercise is a stress for organism – throughout energy expenditure – the recovery means reconstruction of this lack of energy and achievement of a metabolic balance – homeostasis. Homeostasis means health. Noncompliance of a normal, healthful lifestyle, incomprehension of principles of this way of life causes an excessive exploitation of organism's biological structures. If this process lasts many years it means a degradation of body, its function and psychics. During an explosive development of technology it is necessary to understand limitations of humans. There are exact limits of human biological possibilities and remarkable adaptations enabling withstand extreme conditions. However, some scientists have discovered a genetic mutation in muscle cells that can cause extreme exercise intolerance (Kallen 2000). It creates a new future situation for a great differentiation of humans in regard to their physical possibilities.

CONCLUSION

A need to explore what happens to human body in inhabitable environment should be accompanied by a common sense allowing preserve health and life.

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