Litwa Ewelina, Dobosiewicz Anna, Różański Gracjan, Badiuk Nataliia. Biological effects of cold and its use in sport. Pedagogy and Psychology of Sport. 2020;6(2):197-202. elSSN 2450-6605. DOI http://dx.doi.org/10.12775/PPS.2020.06.02.19
https://apcz.umk.pl/czasopisma/index.php/PPS/article/view/PPS.2020.06.02.19
https://zenodo.org/record/4021165

The journal has had 5 points in Ministry of Science and Higher Education parametric evaluation. § 8. 2) and § 12. 1. 2) 22.02.2019.

Received: 15.08.2020. Revised: 27.08.2020. Accepted: 09.09.2020.

Biological effects of cold and its use in sport

Ewelina Litwa[1], Anna Maria Dobosiewicz[1], Gracjan Różański[1], Nataliia Badiuk[2]

[1]Scientific Circle of Exercise Physiology at Department of Hygiene, Epidemiology and Ergonomics. Division of Ergonomics and Exercise Physiology, Nicolaus Copernicus University in Toruń, Collegium Medicum in Bydgoszcz, Poland
[2]State Enterprise Ukrainian Research Institute for Medicine of Transport, Ministry of Health of Ukraine, Odesa, Ukraine

Abstract

Using the cold properly can have many health benefits. The impact of cold on the human body is multidimensional and affects various systems and organs. Cold has found its application in medicine, sport, biological regeneration and physical recreation in the form of cold baths.

Key words: human body; health; thermoregulatory reactions; biological influence

Introduction

There is a common belief that cold has a destructive effect on the human body. Colds, diseases associated with excessive body cooling, such as flu, angina or pneumonia, only reinforce this opinion. However, proper use of cold can produce many positive reactions. Cold was used hundreds of years ago. Ancient Egyptians and Romans used cold baths. Hippocrates also described the indications and contraindications for the use of cold. In the past, cold water, ice and snow were used. With the advancement of technology, dry ice and compressed cold air were used, among others. Currently, the most popular is local and general

cryotherapy in the so-called cryochamber [1, 2].

Biological influence of cold on the human body

The impact of the application of cold on the human body depends primarily on the range of temperatures used, the speed of tissue cooling, exposure time and the individual sensitivity of the body. Depending on these parameters, cold can both damage pathologically changed tissues and stimulate physiological processes [3].

Man is a warm-blooded organism, maintaining a constant internal temperature is extremely important for its efficient functioning. However, the temperature consistency mainly concerns the inside of the body and is not even, because the temperature of the superficial layers largely depends on external factors. Most of the heat is lost in those parts of the body that have a relatively large surface area in relation to their volume (this applies primarily to the limbs, especially fingers and toes). The fingers lose about ten times more heat than the torso [4]. Appropriately low temperatures result in an immediate lowering of the skin temperature, while the deeper tissues cool down much slower. The effect of cold on the body is called the seek response. It consists in ischemia and reperfusion [5]. This is a two-step reaction. The first phase (ischemia) consists in immediate vasoconstriction and reduction of blood supply to the skin, which causes the skin to turn pale locally. The vessels contract as a result of which the blood flow through the skin is reduced, thus reducing heat loss. Moreover, the effects of low temperature also lead to an increase in blood viscosity, which reduces perfusion. The gradual temperature of the skin, muscles and joints decreases. There is a local reduction in metabolism and increased circulation in the medulla. The effect of cold also reduces nerve conduction, increases the pain threshold, and increases the tone of skeletal muscles and vessels, which leads to an increase in arterial and venous pressure. The next phase takes place 3-5 minutes after the action of cold, it is called reperfusion [6]. In this phase, the blood vessels dilate and the blood supply to the skin increases, which is manifested by erythema and increased skin warmth. These changes are especially visible on the face, as well as around the hands and feet, around the kneecap, elbows, phalanges and certain areas of the chest. There is a slow increase in tissue temperature and an increase in metabolism in the core part. The tension of skeletal muscles and vessels is also reduced, and arterial and venous pressure is lowered. These changes last up to 15 minutes, and then the vessels narrow again [5].

Thermoregulatory reactions

Thermoregulatory reactions in the human body are triggered by thermoreceptors, specialized nerve structures that record changes in temperature over time. Among thermoreceptors there are: thermoexteroreceptors and thermoenteroreceptors. Thermoexteroreceptors are found in the skin and receive thermal stimuli from the environment. The latter controls the temperature inside the body.

Thermoexteroreceptors also differentiate between those that react to cold, heat and hot. They are most numerous in the skin of the abdomen, the front surface of the forearm and upper arm, on the face and fingertips, and their distribution is not parallel. There are many more receptors that receive thermal stimuli than receptors that receive cold stimuli. The number of the former is about 250,000, while the latter is only 30,000. The deficiency of thermoreceptors allows a person to feel comfort and thermal discomfort and is the basis of the sense of temperature [7].

The main role of thermoexteroreceptors is to transmit nerve impulses through the afferent pathways to the hypothalamus. In the hypothalamus, these impulses are integrated with the impulses generated in internal receptors sensitive to the current blood temperature. The result of this is the activation of mechanisms responsible for the production or dissipation of heat by the system [7].

Both the production and the emission of heat are regulated by two centers located in the hypothalamus. The heat dissipation mechanism protects the body against overheating and directs heat loss as a result of the expansion of the skin's blood vessels and the secretion of sweat. The second center responsible for heat generation protects the body against excessive cooling by narrowing blood vessels and stimulating thermogenesis [1].

Contraindications to the use of cold

In order to fully and safely use the healing effect of cold, it is necessary to read all contraindications to its use. Before starting treatments with the use of cold, consult a doctor or physiotherapist. The contraindications to the use of cold include, among others:

- acute respiratory diseases of various origins, circulatory and respiratory failure, severe cases of spontaneous angina, venous and arterial shunts in the lungs

- destabilization of the circulatory and brain systems:

* past or threatened heart and / or brain infarction,

* heart rhythm disturbances with a heart rate above 200 beats per minute,

* defects of the heart valve apparatus in the form of stenosis of the crescent aortic valves or stenosis of the mitral valve,

- acute infectious and viral diseases as well as unexplained fever conditions,
- risk of embolism and blood clots in the venous system,
- atherosclerotic and trophic changes in the vascular system that make it difficult or impossible to react properly to cold,
- the use of drugs, especially neuroleptics,
- cold intolerance diseases such as Raynaud's disease
- epilepsy,
- pregnancy,
- open wounds and ulcers,
- hypothyroidism,
- exhaustion and hypothermia,
- alcohol use before or during exposure to low temperature,
- age over 65 [3, 8].

The use of cold therapy in physical recreation

Cold medicine has been used in many fields of medicine, including in basic treatment, kinesiotherapy as well as biological regeneration and sport. Biological regeneration is a relatively new field, the main task is to help restore lost functions of the musculoskeletal system, especially popular among athletes in order to quickly regain form. Biological renewal consists in accelerating physiological rest processes. We are constantly looking for new and better ways to quickly revitalize and gain fitness and endurance, allowing for high activity. Biological renewal largely uses thermotherapy, in which only natural stimuli are used. The following are particularly popular: saunas, baths, heating and cooling treatments, hydrotherapy and cryotherapy [1]. Cryotherapy is an extremely common method because it allows athletes to quickly return to physical activity. It is used to treat acute injuries, such as muscle contusion, muscle hematoma, joint sprain and ligament damage. It is also very effective in the treatment of chronic overload syndromes, e.g. tendopathy, patellofemoral disorders. The use of cold in the prevention of overload injuries, in the course of intensive training and preparation for competitions in championship competitions, finds more and more supporters and becomes a permanent part of the sport culture. Additionally, cold therapy can be used as an adjuvant after surgical procedures of intra-articular reconstruction and reconstruction of ligaments, tendons, muscles and bones [9].

Cold is also used in physical recreation. More and more people are taking advantage of the benefits of cold with the so-called swimming, ie taking a bath in cold water reservoirs

in the autumn and winter [10]. Most people start their sea adventure out of curiosity, and over time it becomes their hobby. This form of recreation is available to everyone, it does not require financial outlays or a lot of free time. In Poland and in the world, more and more clubs and associations of people who take cold baths (winter swimmers) are created, for whom sea life becomes a lifestyle. Meetings are organized in many places around the world, during which numerous groups of walruses take a bath together in the icy water. The International Walrus Rally in Mielno is especially popular in Poland. These meetings enjoy high attendance and popularity, which means a constantly growing interest in this form of cold therapy [9].

The analysis of 10 most important basic life support systems of human body — cardiovascular (CVS), respiratory (RS), nervous (NS), digestive (DS), endocrine (ES), immune (IS), excretory (EXS), brain (BS), musculo-skeletal (MSS), hematopoietic (HS) was carried out. Based on this analysis two levels of ensuring the reliability of organism's work were revealed: sequential and parallel.The system of logical equations for reduced sequential system is: Ys1 = CVS RS BS, where is the notation for the conjunctions of set elements. The system of logical equations for the reduced parallel system is: Ys2 = NS DS ES IS HS EXS MSS, where is the disjunction of the scheme elements. Visualization of human STC changes the concept of the kinetics of age-related changes in the organism and the role of determinants of health as a stable factor accompanying a uniform, smooth transition from the most pronounced functions of the body to their gradual extinction. For human STC is formulated the following regularity kinetics of involutionary processes: after 30 years of age in the human body morphological changes regress in arithmetic progression, and the functions of organs in a geometric one. Assumption of health as a state redundancy of functions is suggested [11].

The research is devoted to the fundamental issue of medicine and biology – the study of factors limiting the life span of a person. As a model, the system of adaptation of the human body to the forces of natural gravity is chosen, the disadaptation to which manifests itself in falls and everyday injuries. The object of the study was the selection of severe fractures of bone tissue due to fall, taken in the age aspect. Statistical and meta-analytical research methods were used. It is shown that the age-related increase in mortality due to household falls, coming to severe bone fractures, is non-linear and increases in geometric progression. As a result of the coincidence of the age characteristics of bone fragility and age-related kidney function, an assumption is made about the role of involution of the renal tissue in the development of osteoporosis in the elderly and the need for a new approach to the prevention of osteoporosis and domestic injuries [12].

Bibliography:

1. Żyżniewska-Banaszak E., Mosiejczuk H., Cichocki P., Fizjoterapia i odnowa biologiczna – czy dla wszystkich? „Roczniki Pomorskiej Akademii Medycznej w Szczecinie", 2010; 56(3), s. 113-20.

2. Kwolk A., Rehabilitacja medyczna. Tom I, Wydawnictwo Medyczne Urban & Partner, Wrocław, 2003; s. 366-367

3. Kasprzak W., Fizjoterapia kliniczna. Wydawnictwo Lekarskie PZWL, Warszawa, 2011; s. 175-80

4. Sieroń A., Cieślar G., Krioterapia – leczenie zimnem. Alfa Medica Press, Bielsko-Biała, 2007; s. 47-48.

5. Robertson V., Ward A., Low J., Reed A., Fizykoterapia, Aspekty kliniczne i biofizyczne. Wydawnictwo Elsevier Urban & Partner, Wrocław, 2006; s. 338-339, 341-342, 369-373.

6. Straburzyńska-Lupa A., Straburzyński G., Fizjoterapia. Wydawnictwo lekarskie PZWL, Warszawa, 2006; s. 55,70.

7. Bauer J., Skrzek A., Fizjologiczne podstawy krioterapii. Medycyna sportowa VI/1999, nr 94.

8. Wesołowski R., Woźniak A., Mila-Kierzenkowska C., Zastosowanie krioterapii w leczeniu reumatoidalnego zapalenia stawów, [W:] Chory przewlekle – aspekty pielęgnacyjne, rehabilitacyjne, terapeutyczne, J. Rosińczuk-Tonderys, I. Uchmanowicz I. (red.), MedPharm Polska, Wrocław, 2011; s. 231-240.

9. Wesołowski R., Gackowska M. I in., Oddziaływanie zimna na organizm człowieka-morsowanie jako forma rekreacji ruchowej. In P. Kalmus (Ed.), Wiosna Młodych Fizjoterapeutów; s. 39–49, Wydawnictwo Uczelniane WSG.

10. Nuckton T.J., Kohn M.A., Body composition of cold-water swimmers: The San Francisco Polar Bear Swim Study. The Open Sports Medicine Journal, 2012; 6, s. 48-52

11. Gozhenko A., Biryukov V., Gozhenko O., Zukow, W. Health as a space-time continuum. Journal of Education, Health and Sport, 2018, 8(11), 763-777. DOI: http://dx.doi.org/10.5281/zenodo.2657000.

12. Gozhenko A., Biryukov V., Muszkieta R., Zukow, W. Physiological basis of human longevity: the concept of a cascade of human aging mechanism. Collegium antropologicum, 2018, 42(2), 139-146.