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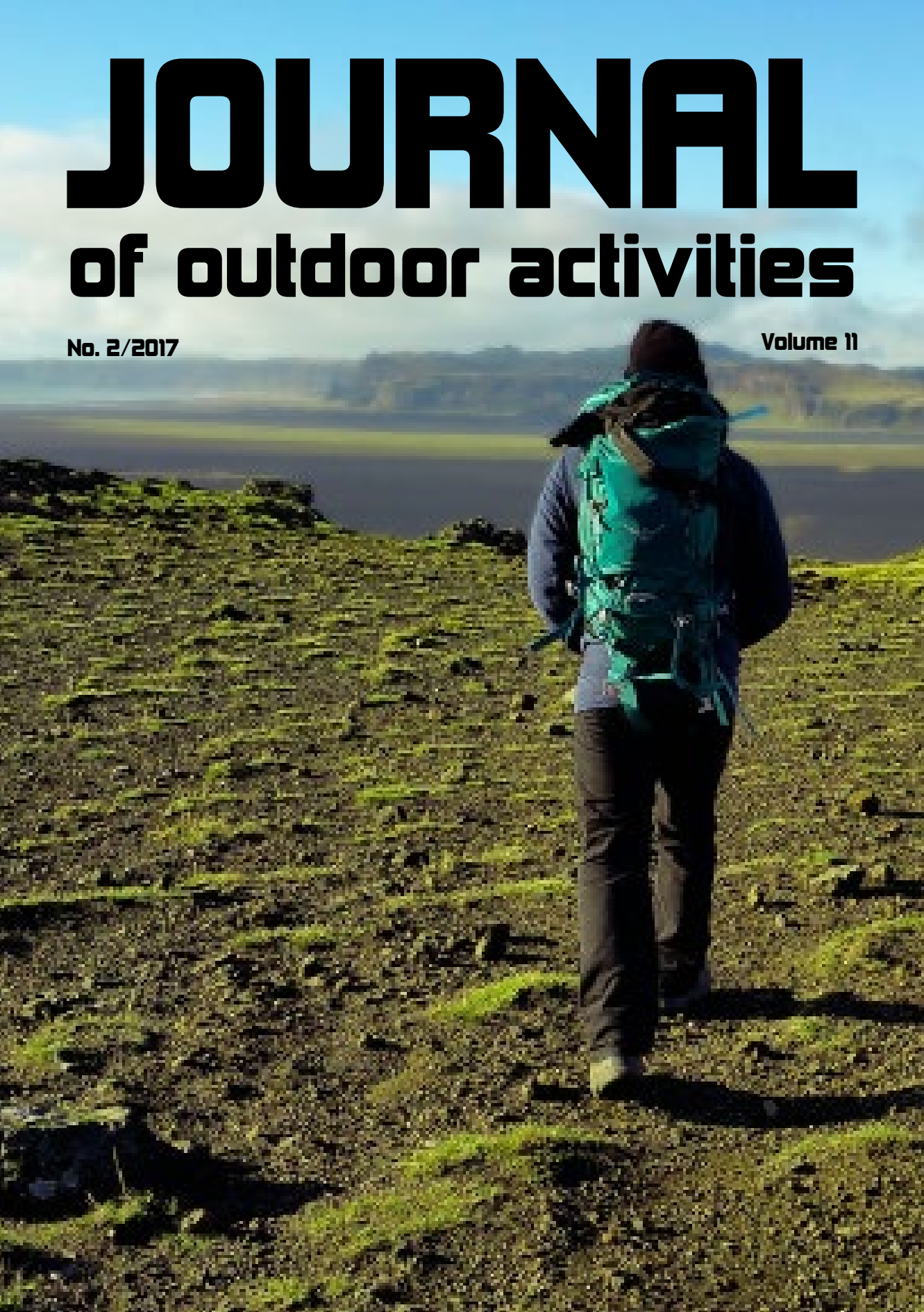

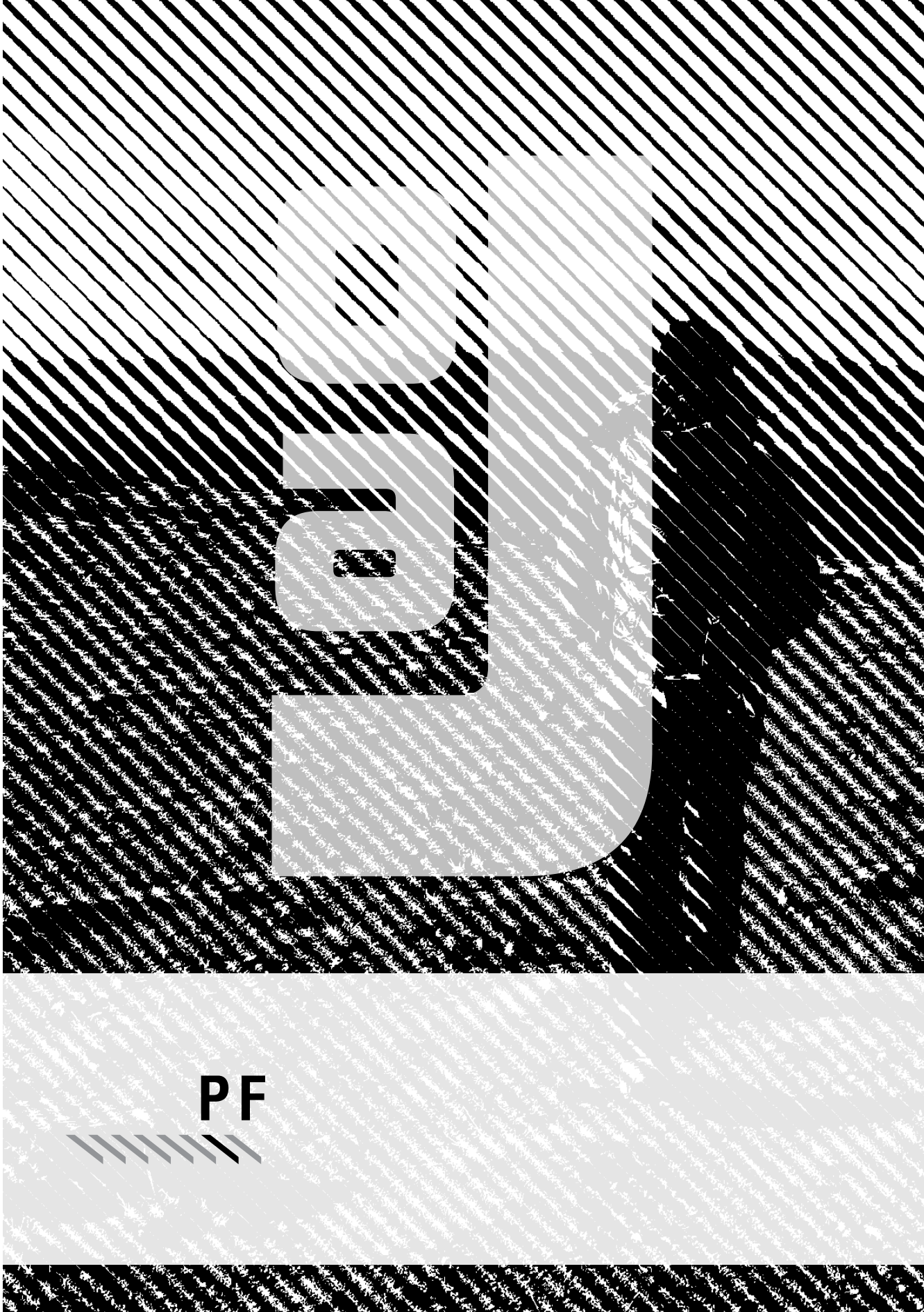
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Content

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THEORETICAL PAPERS

Catharsis in the biodromal perspective and with focus on sports and outdoor activities

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Abstract
Background: The old concept of catharsis *(purification, purgation) is known from Aristotle, who saw in it both raison* d´être *of arts, especially of theatre and music, and the special benefit for spectators. Yet our inspiration is also taken from Plato and his dialogue* Sophist*, where* catharsis *is used against diseases, deformity, vices and ignorance. Modern inspiration is sought in reality of today sports and outdoor activities.*
Objectives: Search for manifestation of catharsis in the field of sports and outdoor activities.
Determine the place of catharsis in the lives of individuals and societies, using an interdisciplinary approach. Specify the type of movement, demonstrated in catharsis*.*
Methods: Phenomenological approach, analyzing concrete manifestations of catharsis*, especially in the field of emotions, morality, medicine and sports practise, helps us to find an invariant of* catharsis*. The philosophical synthesis needs also to use hermeneutics.*
Results: A specific emotional "transformer", for which was created a neologism metapatheia*, forming complement to the established concept of* metanoia*, is seen in catharsis. Today sport, especially its outdoor form, can play specific role of trigger for catharsis. The specific existential movement showing itself within catharsis can enrich the concept of three movements of existence according to the Czech philosopher Jan Patočka.*
Conclusions: Catharsis ought to be understood not only as an instrument for reduction of tensions of different type, but has potential to play an important bio-hygienic role in our lives and be part of Ars Vitae.

Key words
catharsis, existential movement, outdoor activities, philosophy of sport, psychology of sport

Souhrn
Východisko: Starověký pojem katarze *(očištění, očista) je znám díky Aristotelovi, který v ní spatřoval jak raison* d´être *umění, zejména divadla a hudby, tak i speciální benefit pro diváky. Inspirovali jsme se však také Platónem a jeho dialogem Sofistés, kde katarze funguje jako prostředek proti nemocem, deformacím, nectnostem a ignoranci. Moderní inspirací je pak realita současného sportu a outdoorových aktivit.*
Cíle: Hledat projevy katarze v oblasti sportu a outdoorových aktivit. Vymezit pomocí interdisciplinárního přístupu místo katarze v individuálním i společenském životě. Specifikovat typ pohybu, který se v katarzi projevuje.
Metody: Fenomenologickou analýzou konkrétních manifestací katarze, zejména ve sféře emocí, morálky, medicíny a sportovní praxe, hledáme její invariant. Filosofická syntéza využívá posléze i metodu hermeneutickou.
Výsledky: V katarzi shledáváme specifický emoční "transformátor", pro který jsme vytvořili neologismus metapatheia*, komplementární s již etablovaným pojmem* metanoia*. Dnešní sport, zejména ve své outdoorové podobě, zde sehrává roli katarzního spouštěče. Katarzí se vyjevuje specifický existenciální pohyb, který může obohatit koncept tří pohybů existence českého filosofa Jana Patočky.*
Závěry: Katarze by neměla být chápána jen jako redukce tenzí různého typu – má potenciál sehrát v našich životech důležitou biohygienickou roli a stát se součástí Ars Vitae.

Klíčová slova
katarze, existenciální pohyb, outdoorové aktivity, filosofie sportu, psychologie sportu

Introduction

"Tragedy is a representation of a serious, complete action … accomplishing by means of pity and terror the catharsis of (such) emotions." This is the famous sentence from Aristotle´s "Poetics" (VI 1449b), associated usually with *catharsis. Katharmoi* (agents) are *eleos* (also compassion or grief) and *fobos* (also fear or thrill) in original Greek language here.

Other *katharmos* acts within music: *enthusiasmos* (see Aristotle´s "Politics", VIII 1340a). These Aristotle´s findings are subject of many discussions up to now – especially for art historians and aestheticians. An emotional and ethical aspects will be a matter of interest for us as well.

Yet even earlier on in Plato´s "Sophist" remarkable thoughts concerning catharsis were expressed: "There is the purification /*katharsis*/ of living bodies … effected by medicine and gymnastics … and of souls ... effected by chastisement and education." (227a). To put it briefly: medicine against diseases, gymnastics against deformity, chastisement against vices and education against ignorance. A lot of inspiration for carers of soul and body!

Our paper is an attempt to find modern parallel to these old concepts and determine the role of catharsis in the lives of human beings. Because our main interest directs to sports practise, we will search a special context of it in each analyzed manifestation of catharsis.

Methods

Phenomenological method proves to be the most advantageous instrument for formulation such an enigmatic concept like catharsis. Firstly we shall follow manifestation of the cathartic phenomena in emotional sphere, later in ethical and bio-medical areas. Of course, other areas (especially artistic, pedagogical and religious) could be added, yet our selection is influenced with our focusing on sports practice, forming horizons of our reflections.

Because the effect of catharsis observed in the structure of human personality is mediated primarily by the emotions, this area is more extensively analysed. To find the opposite and the closest emotion ought to help to determine the notion of *catharsis* more precisely.

The final philosophical synthesis needs to use some instruments of hermeneutic method, especially deeper interpretation of partial findings and their continuous getting to compare with the whole of human being.

Emotional manifestation of catharsis

There are two possible explanation of cathartic effect here:

A. (negative) emotions are evoked to be discharged;
B. emotions are cleaned out → refined.

Transformation of emotions is the result in both cases – it can be expressed with neologism META-PATHEIA, forming complement to the established concept of *metanoia*. Transformation of knowledge is strenghtened with transformation of emotions in optimal case.

Catharsis itself can be recognized as a specific emotion with a role to appeal to the other emotions. Does some other emotion play the same or similar role? Using Paul Ekman´s taxonomy of positive ("enjoyable") emotions (see Ekman, 2007, 190-212), we can find *elevation* (beside 10 others). It seems to be the closest to catharsis – according to determination of the author of this term, Jonathan Haidt, "elevation is elicited by acts of virtue or moral beauty; it causes warm, open feelings in the chest; and it motivates people to behave more virtuously themselves. (Haidt, 2003, 276). Although there is a potential to transform emotions in both cases, differences are more numerous: elevation opens people up and turn their attention outwards, towards other people, therefore its effect is altruistic, the effect of *catharsis* is above all cleansing and secondary working within the area of own personality; affective phenomenology (what it feels like) can be described as a feeling of elevated sentiments and/or a feeling of moral improvement in the case of elevation, while less pleasant (if not unpleasant) feelings are joined with *catharsis*.(See especially Plato´s types of catharsis, or situations within a tragedy according to Aristotle. Only when enthusiasmos is a mediator between trigger and catharsis, the scene is similar to elevation.).

To find an opposite emotion to *catharsis* will be useful for more accurate determination as well. It ought to be situated at the purity – pollution axis. If *catharsis* leads (in an optimal case) to purity, our sought emotion ought to cause a certain type of pollution. A pollution of a human being as a whole, or of its parts (body, mind, soul, "heart", memory, ...). We assume anxiety is the emotion with named impacts. Anxiety of our everydayness, not biodromal anxiety of our existence joined with a phenomenon of death. Anxiety as a subject of psychologists, not of philosophers (see especially analyzes of Kierkegaard and Heidegger). While *catharsis is*

a process of getting to cleanse, anxiety of getting to fill up. A short feeling of fear or surprise is changed with a relief within catharsis; emotion of anxiety is burdensome. Catharsis opens the door for possible restart of life; anxiety closes it and is joined very often with a feeling of hopelessness. We could continue in getting to find further opposite processes and/or states.

The area of sports so far has considered especially cases sub A – discharging of emotions is expected within spectators as a result of sport competitions; it is usually spoken about „reduction of psychic tension". The most quoted author here is Gordon Allport (1954 and later), though father of this concept is Sigmund Freud.

Yet one condition has to be fulfilled: high-quality of the performance with power to trigger catharsis. A parallel experience was described within art – especially theatre one (see e. g. Wilson, 1988). Yet the critical point of catharsis lies in situations of "bad" performance/competition (repeated fouls of players, hostile atmosphere etc.): emotions (especially in the form of pent-up frustration) are not discharged but transformed into aggression, not into catharsis. There are hundreds studies concerning this topic with social impacts – let us name only synthetic one from Gordon W. Russell (Russell, 2008).

Reduction of physical tension can be added to psychic one in the case of athletes as a result of training – cathartic effect of this type is generally accepted within sports.

Yet we ought to think through also the effect of B in the cases of long distance athletes of all types (especially their states of heavy exhaustion with decline of form/shape, or when experiencing so called exceptional human experiences) – the most often runners are mentioned here.

Defeat/loss is more cathartic here than victory/win or states of flow because it leads to emptiness, which represents ultimate border of a specific cathartic movement. Athletes speak often they hit rock bottom. We can consider deep(er) catharsis in these situations.

All situations mentioned above can be experienced in the course of outdoor activities (not necessarily within sports) as well. Struggle with own body, mind and will is combined with influence of natural surrounds here. We can regard natural phenomena as another trigger of catharsis.

Ethical manifestation of catharsis

Ethical consequences of catharsis lead to the forming of virtues. Observing six core virtues which have crystallized across the millennia and across cultures, we can find minimally three of them as a result of an optimal process of catharsis: wisdom/knowledge, love/humanity and (openness for) spirituality and transcendence. American psychologist Martin Seligman named – after comparison of many „catalogues of virtues"– courage, justice and temperance as well beside our selection (Seligman, 2004, 269).

Catharsis ought to be practised in cooperation with selfreflection – both with wider impact on level of our knowledge, morality and quality of life. It is in the line of Patočka´s thought that permanent (self) reflection is also purification of fundamental relations to the world and to others (see e. g. Crowell, 2011, esp. 9-14).

Yet positive ethical effect needs strong *katharmos* – e.g. examples of sacrifice or heroism, but also of betrayal, cowardice or injustice; influential acts of (un)fair play in sports etc. – and activity of our purified mind in the next step. We would like to underline the last claim: an old wisdom talks about *horror vacui* in our mind as well and necessity to fill in an empty space. See e.g. a short story about return of an "unclean spirit" in Luke 11:24-26.

Especially mountain climbing gives us a lot of examples where mentioned stages of catharsis are manifested. Only one illustration here: the well-known story from the Siula Grande (the Peruvian Andes) with two main character, Joe Simpson ("the one who survived in hopeless situation") and Simon Yates ("the one who cut the rope"). Emptiness is well demonstrated in the title of Simpson´s bestseller: "Touching the Void" (Czech translation „Setkání se smrtí" has death as keyword here, yet void or emptiness is more accurate – minimally considering catharsis. Maybe we could speak even about touch the nothingness in the context of Simpson´s fight for life.) and Joe had felt its power during his unbelievable descent/fall from the mountain. The whole situation was described and analyzed from ethical point of view in JOA in 2012 (see Hurych, 2012, 131-133).

Simon Yates expressed feelings of emptiness as well: "I was alive, and for the moment that was all I could think about. Where Joe was, or whether he was alive, didn´t concern me in the long silence after the cutting. ... There was no guilt, not even sorrow. I felt haunted by emptiness." (Simpson, 1997, 103-104).

Simon´s *catharsis* was long process and Joe was undoubtedly right, writing that Simon "ruminated questions of conscience that might have remained a decade or so after the event." (Simpson, 1997, 203). He had to face numerous heated debates about the ethics of his decision and harsh or unfair criticism in subsequent years. According to his book "Against the Wall" (1997), he came to persuasion that his conscience is clear. Maybe more important is that the same persuasion had Joe Simpson (see Simpson, 1997, 203).

Because the whole case has more facets and open questions, let us conclude in general level: purification of conscience is the optimal result of ethical catharsis.

Catharsis has potential to influence wider communities as well – we can even speak about catharsis of mankind, or of nations. Catharsis is usually a consequence of some disasters (catharsis of almost global population after world wars, or of national population after some big natural calamities etc.). Sometimes catharsis isn´t fully put into practice – the area of sports still waits for catharsis after doping scandals; IOC didn´t use the potential of Kumaritašvili´s death just before the Winter Olympic Games in Vancouver 2010 etc.

A bit different type of catharsis emerges in situations when *enthusiasmos is katharmos*: good example can be a collective sharing of sports spectators, leading through catharsis even to "ritual happiness" in some rare situations (see parallel with dance at Crease, 2002, 119).

Bio-medical manifestation of catharsis

Psychosomatic healing effect of catharsis is generally accepted.

Its somatic mechanism can be described in brief like this:

first of all homeostasis is disturbed → tears, sweat, increased pulse, pilomotoric reaction etc → "drainage" for toxins → relief through somatic cleansing → re-integration.

Speaking about psychic point of view, we have underlined the role of emotions (see above). In the case of deeper intervention and optimal conditions *catharsis* can proceed as follows: excitement of fixed mental templates → "rejuvenation" of our ability to react to new situations → impulse for creativity of different type.

Catharsis and its natural bodily anchoring is the opportunity to look for relevant physical forms. Proper exercise using cathartic elements (unwittingly or wittingly) shows power to harmonize the whole of human being. Steiner's eurythmy can be named as example of the former one, therapy „Kinesiology - One Brain", or special cathartic exercise represents the latter one. Authors of the monograph "Hledání katarze" [Searching for Catharsis] put together simple exercise of 12 steps, where struggle with a gravity is in the beginning, following with a central cathartic figure, its opposite figure in the form of shrinking to vanishing point and finishing with balanced quiet position (Bednář, & Bednářová, 2013, 90-92). The cathartic figure is near the position of the "Vitruvian Man" – only a head is bending back.

Results, or philosophical synthesis

What is common denominator for all analysed forms of catharsis? A specific movement and its emotional influencing.

Catharsis can be seen as the life countermotion (*enantiodromia*) acting against the prevailing forward trajectory of life. Similarity to the basic existential movements according to Patočka suggests itself here. The Czech philosoper determined them as 1. SELF-ANCHORING; 2. SELF-PROLONGATION; 3. SELF-ACHIEVEMENT

(Patočka, 1998) . Interpretations in English e.g. Crowell (2011) and Bednář (2006) & Martínková (2006) within sports practise.

We think his triangle of movements could and ought to be enriched with phases of

4. SELF-PURIFICATION.

Phases (plural!) of self-purification are helpful before new anchoring/rooting, especially in critical points of our life, when a ground for different life period has to be prepared; they are necessary within the second movement (named also movement of work from Patočka), where play the role of relief from the burden of everyday existence and centre stage can take in the third movement, when everydayness is transcended.

Patočka wakes us up to possible misunderstanding: these three movements cannot be seen in some time succession – they are "polyphony of three voices" (Patočka, 1998). Our cathartic movement fits fully to this intention and adds another "voice".

Yet catharsis has potential to catapult the cleansed persons to meaningful aims. It plays the role of emotional transformer (*metapatheia*) – in cooperation with *metanoia*, the transformer of our knowledge and meaning (*see noein!*) – both together can lead to personal transformation and form the specific "art of self-turning". We are also persuaded that catharsis is the important part of all stages of

Maslow´s pyramid of needs including self-actualization.

We mean that the main - cleansing – effect represents only one face of catharsis and ought to be completed with filling stage. The cleansed scope "calls" for positive repletion. We arrived at the conclusion that catharsis must be seen in its complexity.

Open discussion in conclusion

•"With age we accumulate an increasing number of cognitive templates. Consequently, a growing number of future cognitive challenges is … covered by a pre-existing template, or will require only a slight modification of a previously formed mental template (Goldberg, 2005, 20). We can see that these fixed templates play an important role especially during old age; catharsis can be questionable in this period of life when creative power is lower and purification can lead to disorientation.

•The model of radical catharsis could be discussed as well, where the purification aims for "emptying" (*kenosis*). It can be the opportunity for decisions or even life restart leading to perfection/excellence (*arete*) or even up to "fullness" (*pleroma*). In more concrete form we can speak about axe between "emptiness of life" and "meaning of life". Daniel Campos tries to solve this topic even in the field of football (Campos, 2010).

•We wrote that reduction of both physical and psychic tension (cathartic effect) in the case of athletes as a result of physical activities is generally accepted within sports. Yet maybe it is too optimistic?! Wider society voices speak about higher within athletes and the media often present negative acts of athletes. Is the arena of sports source of aggression, or a school how to subdue it? Are athletes more aggressive than majority of population? Research at the Canadian universities comparing level of hostile aggressiveness of athletes and non-athletes ended in a "draw": no difference was proved (Lemieux, McKelvie & Stout, 2002). Yet is not university environment a special one? Question, if sport is accelerator or inhibitor of aggressiveness, is still opened.

•The old "biodromal project" *care of soul* can be and ought to be completed with *care of memory*: hint comes from a "work" of the body rebuilding itself in sleep and especially from the healing and cleansing function of brain during sleep with a positive effect on memory (see Xie et al., 2013). Our task is to purify memory intentionally and continuously with target to reach negentropy when things become more in order. We mean it is just necessity in the age of information explosion with attack of both useful and weedy information.

•Our lives can be seen as a pendulum between catharsis and anxiety. Process of getting to fill up with undesirable contents ought to be replaced with process of getting to remove from them. A proper timing of catharsis is the part of Ars Vitae and just the bio-hygienic necessity.

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Summary of Present Researches of Hyperoxia in Sports Training and Outdoor Activities

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Abstract
The main goal of this overview article is to sum up the available information about the technics of hyperoxia, the possibility of its usage in outdoor activities, its influence on sports performance and recovery between loads. Results have been taken from the relevant reviewed documents published, in full, in scientific magazines and specialist monographies. Articles were expanded by a reference pick ("snow ball" method) of other works written by the same authors and works of cited authors in these articles.
In our study, we are mainly focused on using long-term inhalation of a hyperoxic mixture to replecate the actual condition in outdoor activities (climbing and diving), but we are also focusingon using short-term inhalation of a hyperoxic mixture, which is used more often, primarily in cycling, canoeing and swimming. In this article we are pursuing the usage of hyperoxia for maximum performance.
We have two options on how to provide the hyperoxic environment. Firstly, to use pressurized bottles with more concentrated oxygen, which is good for direct usage. Secondly, to use oxygen concentrators, which separate oxygen from common air. For acute conditions, which can happen in outdoor activities, it is very important to start the inhalation of pure oxygen as soon as possible. Eligible scientific sources are split about the impact in sports training.

Key words:
Hyperoxia, oxygen, emercency, submaximal exercise, mountain sickness, decompression sickness, outdoor activities

Souhrn
Hlavním cílem přehledové studie je shrnout dostupné informace týkající se techniky aplikace hyperoxie, možností jejího využití v outdoorových aktivitách, dále pak jejím vlivem na sportovní výkon a zotavení mezi zátěžemi. Informace byly získány z relevantních recenzovaných dokumentů publikovaných v plném znění ve vědeckých časopisech a odborných monografií. Články byly rozšířeny referenčním výběrem (metoda „sněhové koule") o další práce stejných autorů a o práce autorů v těchto článcích citovaných.
V naší studii se zabýváme především využitím dlouhodobé inhalace hyperoxické směsi pro překlenutí akutních stavů při outdoorových aktivitách (horolezectví, přístrojové potápění), ale i využitím krátkodobé inhalace hyperoxické směsi, která je ve sportovním tréninku, zejména cyklistice, kanoistice i plavání, využívána více než dlouhodobá inhalace hyperoxické směsi. V článku se zabýváme vlivem hyperoxie na úroveň maximálního výkonu, přičemž na základě výzkumů se ukazuje, že tento vliv je minimální.
Pro aplikaci hyperoxické směsi existují v zásadě dvě možnosti a to použití tlakových lahví, které slouží jako zásoba plynu vhodného k přímému použití, či koncentrátorů, které separují kyslík z okolního vzduchu. Při akutních stavech, které mohou nastat v outdoorových aktivitách, je důležité neprodleně zahájit inspiraci čistého kyslíku. V případě sportovního tréninku se dostupné zdroje rozcházejí ve vlivu hyperoxie na sportovní výkon.

Klíčová slova:
Hyperoxie, kyslík, neodkladná lékařská péče, submaximální cvičení, akutní horská nemoc, dekompresní nehoda, outdoorové aktivity

Introduction

Hyperoxia is an increase in the partial pressure of oxygen above the normal values, meaning above 20 kPa (150 mm Hg). Paleček (2001) states that reaching those values of partial oxygen in tissues and blood is not possible via a physiological way. That is why it is necessary to expose the human organism to the inhalation of a gas mixture with an increased partial pressure of oxygen. It can be done in a few ways. Firstly by breathing air with the common concentration of oxygen with an increased partial pressure (e.g.: scuba diving), or secondly by breathing air with an increased concentration of oxygen, or thirdly by a combination of both ways.

Short-term inhalation of hyperoxic mixture is used mainly in the Department of Clinical Medicine as an oxygen therapy (e.g.: spanning acute conditions of a lack of oxygen) (Müller et al., 2008). Last but not least, hyperoxia is used in acute conditions in different outdoor sports, such as mountain climbing or scuba and free diving. In mountain climbing, it is used in the case of acute mountain sickess (AMS), described as a condition in individuals who have ascended too high too quickly, typically above an altitude of 2,500 m Salisbury & Hawley (2011). In scuba/free diving, we use hyperoxia as a treatment for decompression sickness (DCS), which mostly happens due to surfacing from deep water too quickly.

Hyperoxia has been used for a long time in urgent medicine, mostly in treating acute and chronical respirational and circulatory problems (Gosseling et al., 2004). A positive impact has been observed in the inhalation of concentrated oxygen on training load and recovery (Kay, Stannard, & Morton, 2008; Morris, Kearney & Burke, 2000; Pupiš et al., 2010; Sperlich et al., 2011; Suchý, 2012). Training load is perceived as a motion activity, which is causing not only a desired acute change of functional human acitivity, but furthermore, consistent structural and psychosocial changes (Dovalil et al., 2009). However, these changes are not passing off during this motion activity, but after its ceasation in the recovery phase. If the intensity of the sport performance drops under a certain level, the oxidative transformation of lactate into pyruvate takes place in the muscles, which is occurs in mitochondria cells by means of enzymes in the respiratory chain of the cell to produce ATP. In the liver, hepatic glycogen is then resynchronized from the lactate. Both of these transformations are oxidative and their speed depends on the load of oxygen, which is provided by circulatory system. Increasing the intake of oxygen with inhaling a hyperoxic mixture has a positive impact on the regeneration of muscles after training. By inhaling a hyperoxic mixture with an oxygen concentration of 90 -100%, inhaled oxygen uptake is increased by up to 10%, resulting in an increased oxygen supply to the muscles and a decreased heart rate. By that, it is possible to increase training intensity and achieve higher effectivity of sports training (Hollmann & Hettinger, 1980).

An increase of performance with the inhalation of hyperoxic oxygen was observed mainly in actitivities, which lasts 2 to 3 minutes (Haseler, Hogan & Richardson, 1999; Nummela, Hamalainen & Rusko, 2002), but also in ice-hockey players (Suchý, Pupiš & Novotný, 2012). Results of many studies confirmed that the inhalation of concentrated oxygen is possible to accelerate recovery between short-term training loads by increasing the saturation of blood and tissues with oxygen (Suchý, 2012; Pupiš, Babaríková, Brunerová & Suchý, 2011). A reduction in the perceived effort has also been observed (Peeling & Andersson, 2011). On the contrary, performance improvement due to hyperoxia was not demonstrated in the short-term load under submaximal and maximum effort and also in the long-term load (Robbins, Gleeson & Zwillich, 1992).

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Methods

This review article was developed based on expert studies available from the primary databases 'Web of Science and Scopus'. Information was searched by using key words such as: Hyperoxia, Oxygen, Emergency, Submaximal exercise, Mountain sickness, Decompression sickness and Outdoor activities. The data for the review of the technical means used for hyperoxia was drawn from the internet sources Linde Gas (n.d.), Philips Respironics (n.d.) and Kröber Medizintechnik (n.d.).

The selection of primary documents, which were used for the study, was that the full publication had been in a major peer-reviewed scientific journal and/or in an academic monograph. Articles were expanded by a reference pick ("snow ball" method) of other works written by the same authors and works of cited authors in these articles.

Results

The result part of this review study deals with the use of hyperoxia in the treatment of acute conditions in

outdoor activities, the health limits of hyperoxia use, the effects of the inhalation of hyperoxic mixture on sport performance and the technical equipment necessary for hyperoxia.

Health limits for the use of hyperoxia

The State Institute for Drug Control (SIDC) warns that the toxicity of oxygen, duringnormobaric inhalation in concentrations exceeding 40 %, is usually possible up to 48 hours. At a concentration from 60 to 70 % up to 24 hours and 100% oxygen up to 6 hours. In hyperbaric inhalation of pure oxygen at a maximum of 3 bar, the treatment dose is limited to 6 hours, with the possibility of repeating up to three times a day. The exception is the CO poisoning therapy in which hyperbaricity is performed until the blood carboxyhemoglobin concentrations are sufficiently diminished. By the inhalation of pure oxygen at a pressure above 3 bar, the patient should be monitored for signs of oxygen overdose such as sinusitis, confusion, convulsions, vision impairment (SIDC, 2016).

Technical equipment for hyperoxia

In order to breathe air with an increased oxygen concentration, devices such as pressure bottles (or oxygen sprays) or facial mask units must be used. Pressure cylinders are designed mainly for the transport and storage of gases. The so-called water volume, typically 1-50 liters, is determined, and they have a maximum fill pressure that is usually 200 bar or 300 bar. For example, 400 liters of gas can fit into a 2 liter bottle with a filling pressure of 200 bar. Due to the high gas pressure, the cylinders are not intended for direct use, but as an oxygen device with a reduction valve (Linde Gas, n.d.) has to be used. Oxygen sprays where oxygen is pressurized to a much lower pressure and are thus designed for direct use, and their components do not have a pressure reducing valve. Their disadvantage is a lower supply of oxygen, typically 5-15 liters and a higher price in proportion to volume. Oxygen devices and oxygen concentrators can be arranged as the aggregates. Oxygen devices use an oxygen supply in a pressure bottle and include a pressure reducing valve that reduces the gas pressure in the bottle to a value suitable for inhalation. The gas flow through the reducing valve is adjustable over a wide range and it is possible to deliver a large amount of gas. Oxygen concentrators can separate oxygen from the ambient air, so they do not need gas in the form of pressure bottles. Typical types are able to achieve approximately 90-95% oxygen concentration at a controllable flow rate of up to 5 liter/min (Philips Respironics, Kröber Medizintechnik, n.d.).

Use of hyperoxia in outdoor activities (emergency states)

Primarily, hyperoxia was used in urgent medicine. Basically, it is the use of normobaric and hyperbaric hyperoxia. Hyperoxicity increases blood saturation and tissues with oxygen, which reduces the venous blood buffer capacity and the binding of CO^2 and CO to hemoglobin. Another important role of hyperoxia is its antibacterial effect. For these reasons, inhaled hyperoxic mixture is used to treat CO poisoning, infection, burns, and severe anemias. Treatment of gas emboli and decompression sickness requires hyperbaric hyperoxia (hyperbaroxia) (Jabor et al., 2008).

According to Salisbury & Hawley (2011), more and more people are taking up alpine tourism. While in 1950-1989 2,631 people reached Himalayan summits, in 1990-2009 it was 9,199 climbers. The authors further state that AMS was the third most common cause of climbers' deaths in 1950-2009 when they attempted to reach Himalayan peaks above 6,000 meters (see Table 1). In the treatment of decompression sickness and AMS, a therapeutic method is used in the form of hyperbaric chamber utilization. In hyperbaroxia, pure oxygen is usually inhaled at a pressure that is 2.5-3 times higher than atmospheric pressure. Therefore, the partial pressure of oxygen in the hyperbaric chamber can be up to 15 times higher than under normal conditions (Czech Society of Hyperbaric and Aerial Medicine, n.d.).

The cause of AMS is not entirely clear. Hultgren (1997) claims that hypoxia increases the blood flow to the brain, to vasodilatation and thus to brain swelling. Berré, Vachiéry, Moraine & Naeije (1999) found that when breathing the hyperoxic mixture, the blood flow to the brain decreases, which has a beneficial effect on the symptoms of acute mountain sickness. This decrease was observed both in climbers who had an increased tolerance to AMS symptoms and in those who had problems with higher altitude. The main symptoms are usually headache, nausea, insomnia, malaise and fatigue. A longer stay at this altitude can lead to the swelling of the lungs, brain swelling and death (Luks, Swenson & Bärtsch, 2017). The most effective treatment of these conditions is, in lighter cases, the normobaric administration of pure oxygen and an accelerated descent to lower altitudes. In the case of pulmonary or cerebral edema, it is advisable to use hyperbaric hyperoxia,

Table 1: Causes of death for all Himalayan peaks in 1950-2009 (Salisbury & Hawley, 2011)

Cause of Death	Expedition members		Hired members		Total	
	Count	Precentage	Count	Precentage	Count	Precentage
AMS	46	7.6 %	20	8.9 %	66	7.9 %
Exhaustion	18	3.0 %	2	0.9 %	20	2.4 %
Exposure/Frostbite	35	5.8 %	1	0.4 %	36	4.3 %
Fall	237	39.0 %	31	13.8 %	268	32.2 %
Crevasse	15	2.5 %	5	2.2 %	20	2.4 %
Icefall Collapse	2	0.3 %	15	6.7 %	17	2.0 %
Avalanche	175	28.8 %	104	46.4 %	279	33.5 %
Falling Rock/Ice	14	2.3 %	9	4.0 %	23	2.8 %
Disappearance	26	4.3 %	2	0.9 %	28	3.4 %
Illness (non-AMS)	26	4.3 %	15	6.7 %	41	4.9 %
Other	12	2.0 %	12	5.4 %	24	2.9 %
Unknown	2	0.3 %	8	3.6 %	10	1.2 %
Totals	608	100.0 %	224	100.0 %	832	100.0 %
AMS-related	67	11.0 %	18	8.0 %	74	8.9 %
Weather/Storm-related	44	7.2 %	6	2.7 %	50	6.0 %

e.g., using an inflatable hyperbaric chamber while inhaling pure oxygen and a transfer to a medical facility is necessary (Peacock, 1998).

Scuba diving has recently been easily available for laymen and, unlike acute mountain sickness, whose symptoms appear slowly and gradually, a decompression accident can occur almost immediately (e.g. in the case of a rapid emergence). A decompression accident in connection with diving is caused by a rapid drop in the ambient pressure during a rapid submergence which forms bubbles of gas in the blood or tissues. The most serious consequences of a decompression accident are decompression sickness and arterial gas embolization. Decompression illness is caused by the formation of bubbles due to the release of inert gases (primarily nitrogen) dissolved in the blood and a rapid drop in ambient pressure. Microtrugs occur in different parts of the body, which are manifested by fatigue, itching of the skin and abdominal pain. Arterial gas embolization occurs when gas bubbles cause the collapse of the blood circulatory system. When treating a decompression accident, 100% oxygen is given as first aid regardless of the composition of the previous breathing compound during the dive. For more serious symptoms, such as headaches, jointache, dyspnoea,

paralysis, hearing impairment, vision, speech or bizarre behavior, it is necessary to place the diver on his back and administer pure oxygen until they are moved to a hyperbaric chamber. The lowest operational pressure in the hyperbaric chamber, wherte the patient should remain at least until the symptoms disappear, is recommended to be 2.8 bar (Novotný & Pácová, 2012).

Howle, Weber, Hada, Vann & Denoble (2017) have retrospectively monitored 3,322 drafts at different depths and different breathing mixtures. They found that in 5.7 % of the dives there was a decompression accident: 89.5 % of these accidents showed light symptoms (skin burns, headache or jointache) and 10.5 % of the symptoms were classified as serious (circulatory problems, serious Neurological symptoms).

The effect of hyperoxia on the training load and the course of recovery between the loads

In their study, Sperlich, Zinner, Hauser, Holmberg & Wegrzyk (2017) reported that the effect of hyperoxia on recreational athletes is likely to be lower than that of possible adaptation changes. It is believed that hyperoxia is of greater significance in top athletes who have already reached their limits in their adaptation.

The results of many studies show that hyperoxia improves performance during both maximal and submaximal loads under a cycloergometer training load (Grataloup et al., 2005; Linnossier et al., 2000; Lovering et al., 2008; Peltonen, Tikkanen, & Russia, 2001; Prieur et al., 2002; Tucker et al., 2007).

Haseler et al. (1999) and Nummela et al. (2002) report that an increased performance with using concentrated oxygen was observed primarily in activities lasting 2 to 3 minutes. Suchý et al. (2012) reported that performance gains also occurred in ice-hockey players in a sports-specific test, the length and course of which simulated one substitution in an ice-hockey match (i.e. about 50 seconds).

Peltonen et al. (2001) reported that inhaling a hyperoxic mixture with an oxygen concentration of 62 % during an all-out test on a rowing ergometer on a 2500 m track has a statistically significant ($p < 0.05$) positive effect on the time during the third 500m Section of the test and increases the mean power throughout the test.

Sperlich et. al. (2011) in his study stated that breathing pure oxygen during a 6-minute pause between five series of 40 swim strokes with maximum effort on a swimming isokinetic treadmill improves maximal performance and mean power during the third, fourth and fifth load intervals.

Robbins et al. (1992) argued that inhalation of 100% oxygen during a four-minute pause between three training loads with a submaximal effort on a running ergometer (the first two five-minute loads, the third load to exhaustion) did not affect the minute ventilation, heart rate, and fatigue perceptions expressed on the Borg scale (Borg, 1982).

Peeling & Andersson (2011), in their article, investigated the effect of hyperoxia on the rate of recovery of oxygen saturation during recurrent recoveries on a kayak ergometer. Probands (5 males and 2 females) underwent a six X three min load with a 2-minute recovery after each load, during which they either inhaled a hyperoxic mixture with 99.5% concentration or a placebo. Prior to testing, the initial oxygen saturation value was measured by a pulse oximeter. The inhalation of the hyperoxic mixture did not affect the average power, frequency of strokes, speed and heart rate. Also, the lactate levels measured 15 seconds before the end of the recovery period were not affected by hyperoxia. The time of the recovery of the oxygen saturation value was significantly reduced, but the subjective perception of recovery quality did not increase with inhaling hyperoxic mixture.

Vanhatalo, Fulford, DiMenna & Jones (2010) in their study investigated the effect of hyperoxia on muscle tissue metabolism and performance dependence on high intensity loading. The objective of the probands was to predict a constant load in single knee-leg extensions at the limit of critical performance (CP), at which a balance in lactate formation and its oxidative conversion back to adenosine triphosphate (ATP) occurred. Spectroscopic magnetic resonance of quadriceps was performed during the test, where the amount of inorganic phosphorus (Pi), ATP-bound phosphorus, intramuscular creatine phosphate (PCr) and phosphodiesters was determined. From the measured values, the pH in the muscle was calculated. At the critical power limit, the probands had the same PCr values (5-10 % of the preloaded value) and pH (~6.65), either with 70 % oxygen or placebo (common air) inhaled during the load. However, when the hyperoxic mixture was inhaled, the critical performance was significantly higher and achieved over a longer period of time compared with placebo inhalation.

Sperlich et al. (2012) dealt with the impact of inhalation of the hyperoxic mixture on the changes of maximal and mean power at the intermittent load with maximum intensity. Ten healthy, trained cyc-

lists performed five 30s of maximum load on a cycloergometer in isokinetic mode (120 rpm), and inhaled pure oxygen or placebo during a six-minute recovery period between the sets. The values of both the maximal and the mean power during the loading did not differ in the case of hyperoxia or normoxia, as did the pH, the concentration of lactate and hydrogen cations in capillary blood. Partial oxygen pressure in the blood and oxygen saturation of the blood increased in hyperoxia. Subjective perceived effort was reduced at the end of the recovery period after the fourth and fifth load cycles.

Discussion

From a technological point of view, the use of inhaled hyperoxic mixture in many sports is limited. Although oxygen inhalation is not on the World Anti-Doping Agency (2017) banned list, it cannot be used in many sporting competitions. It is essential to use the technical equipment to inhale the hyperoxic mixture immediately before or during exercise, which the rules of many sports explicitly prohibit – e.g. in athletic competitions where the competitor cannot bring the technical equipment for hyperoxia to the competition track and field area International Association of Athletics Federations (2017). For this reason, the effect of hyperoxia is investigated primarily in model tests. Many studies also deal with the use of hyperoxia during the recovery from high-intensity exercise to the following exercise performance, with the hyperoxic mixture being administered immediately after the end of the load to accelerate recovery (Nummela et al., 2002; Peeling & Andersson, 2011).

An important limit for the use of hyperoxia in sports is the length of sport performance itself and the intensity of the load. Vanhatalo et al. (2010) and Sperlich et al. (2012) showed that the inspiration of the hyperoxic mixture does not affect the maximum performance level. This is probably due to the fact that the maximum power is dependent on the immediate supply of ATP in the muscles, not on the O_2 delivery system by the circulatory system. On the contrary, some studies (Sperlich et al., 2011; Suchý, 2012) showed that hyperoxia during recovery has a positive impact on the following maximum high intensity performance, which is probably due to the faster conversion of the lactate produced in the previous load to ATP.

There is a limit to the possibility of continuously utilizing hyperoxia during exercise due to its technical difficulty.

In the treatment of acute conditions associated with AMS in mountaineering and scuba/free diving accidents, sources (Peacock, 1998; Novotný & Pácová, 2012; Berré et al., 1999) agree that the most basic option is the rapid initiation of treatment in the form of inhaled hyperoxic mixture, ideally pure oxygen. In the case of heavier AMS manifestations, thuis treatment is important to be supplemented by lowering the affected person to a lower altitude, and in the more severe cases of decompression accidents hyperoxic treatment should be performed hyperbarically.

Dean, Mulkey, Henderson, Potter & Putnam (2004) suggested that chronic or long-term (over 72 hours) exposure to an hyperoxic environment can cause cellular damage, therefore, hyperoxia in sports should be performed under medical supervision. However, short-term hyperoxia in the treatment of acute conditions is not harmful to health, no toxic effects on the brain and the circulation system have been demonstrated (SIDC, 2016).

Unlike hypoxia, exposure of the body to a hyperoxic environment in sports is an artificial improvement in performance. For this reason, inhalation of oxygen-enriched air, whether in sports competitions or training environments, raises ethical concerns. When using hyperoxia during training, it is advisable to closely monitor its possible negative effects on the health of the athlete, especially in hyperoxic training combined with higher altitude stays (Sperlich, Calbet, Boushel & Holmberg, 2016). Conclusions of some research do not confirm the positive effect of hyperoxia on sports performance, and there is insufficient information on whether chronic exposure on the organism of the hyperoxic mixture damages the health of athletes.

In some areas of hyperoxia use there are certain reserves. For example, in sports games such as ice-hockey, handball and floorball, the use of a hyperoxic mixture is offered during the course of a match, as the player, after about 1 minute of the load, goes to the rotation bench where it is possible to inhale air with increased oxygen concentration during the recovery. However hyperoxia is not used commonly in the competition on a larger scale.

Conclusion

The review study summarizes the available knowledge on the technical means of hyperoxia and the use of hyperoxia in outdoor activities and in sports training. There are basically two options for the application of a hyperoxic mixture, namely the use of pressure cylinders which serve as a supply of gas suitable for direct use, or of concentrators which

separate oxygen from the ambient air. In non-laboratory conditions, whether in outdoor activities or in sports training, it is preferable to choose cylinders that do not need electricity for their function.

In the case of hyperoxia in acute conditions in mountaineering and diving, it is important to immediately initiate the inhalation of pure oxygen. For mountaineers in connection with acute mountain sickness, it is important to descend to a lower altitude or to fit into an inflatable hyperbaric chamber that simulates this descent. When treating a decompression accident, it is necessary to deliver pure oxygen as soon as possible, irrespective of the composition of the previous breathing mixture.

In sports training, available resources differ in the effect of hyperoxia on sports performance. In the case of intermittent loading and use of hyperoxia during the recovery period, the positive influence on the mean or maximum performance was demonstrated in swimming (Sperlich et al., 2011). On the contrary performance improvement in a kayak ergometer (Peeling & Andersson, 2011) and on the cycloergometer (Sperlich et al., 2012) has not been demonstrated. In the case of a one-off load, a positive influence on performance was demonstrated in rowing (Peltonen et al., 2001).

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Impact of physical load on cardiovascular marker´s in outdoor sports: a review

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Abstract

The article is focused on effect of physical load on athletes' health in outdoor sports. The focus of this review is on effect of long-term physical load on heart function. The thought originates from the fact of ambiguous impact of long-term physical load on heart function and inflammatory biomarkers, such as troponin T (cTnT), troponin I (cTnI), creatine kinase (CK) and C-reactive protein. These types of biomarkers are presented in scientific literature as an index of myocardial necrosis. Myocardial necrosis can progress into heart attack. The aim of this review is to describe these issues and find out as many resources as possible with this topic. Through our research, we work with PubMed and Research gate databases. As we found out from scientific literature, there are some certain changes after long-term intensive physical load. The changes are proven on increased of cardiovascular markers in blood. In fact, the level of cardiovascular markers decline after 24-48 hours and the structures of blood are in normal again. In addition, literature say, that appropriately chosen range and intensity of physical load of outdoor sports belong into the most important elements for prevention of getting heart diseases.

Key words:

Sport, physical load, cardiac markers, troponin

Souhrn

Příspěvek se věnuje vlivu zátěže na zdraví sportovců v outdoorových sportech. Zejména se zaměřuje na vliv dlouhotrvající zátěže na činnost srdce. Zamyšlení vychází z faktu ne zcela jednoznačně dokázaného vlivu dlouhotrvající zátěže na srdeční činnost a zánětové biomarkery jako jsou troponin T (cTnT), troponin I (cTnI), kreatinkináza(CK) a kreativní protein (CRP). Tyto biomarkery jsou v odborné literatuře často popisovány jako ukazatele myokardiální nekrózy, která může přerůst v infarkt myokardu. Cílem příspěvku je popsání této problematiky a zmapování dostupných informací o této problematice. K získání informací bylo využito databází PubMed a Research gate. Z rešerše literatury vyplývá, že dlouhodobá intenzivní zátěž zvyšuje podíl srdečních markerů v krvi, ale po 24-48 hodinách se z pravidla tento zvýšený podíl vrací do normálního stavu. Současně literatura konstatuje, že vhodně zvolený výběr a intenzita zatížení outdoorové pohybové aktivity patří mezi nejdůležitějšími faktory pro prevenci vzniku srdečních onemocnění.

Klíčová slova:

Sport, zátěž, srdeční biomarkery, troponin

Introduction

In past few years, there is visible worldwide expansion of outdoor sports such as running, cycling, cross-country skiing, triathlon and more outdoor endurance activities. More and more people are active in these activities as recreational users, but no days, more adults tend to participate in all kinds of outdoor events. As an example, there is more than famous marathon in New York or Boston with up to 50 000 runners (NYCM, 2017). Other running races like 10K run, half marathon or marathon across the whole Czech Republic with more than 100 000 runners (Runczech, 2017; Runtour, 2017). More popular are becoming races on 50K, where

there is more than 30 of them in the Czech Republic with more than 5 000 participants (Behej, 2017). The same popularity is on the races such as cross-country skiing or long-distance triathlons (Bezkuj, 2017; Traitlony, 2017; Skitour, 2017).

This is truly positive news, that people are engaging more in sports activities. From kinatropology or medicine point of view we can state, that physical movement improves many functions and parameters of the human body. For example, increases performance of cardiovascular system, reduces blood pressure, but also helps with too low blood pressure, maintains body weight, increases the amount of active muscle mass, supports and improves the immune system, improves metabolism and breathing functions. At the same time, physical movement is one of the most effective medium for health preventing, the most for cardiovascular diseases. On the other hand, the lack of physical activity can cause many diseases or illnesses, for example of skeletal muscle equipment (Blahutková, Řehulka & Daňhelová, 2005; Sigmund & Sigmundová, 2011).

Questionable and ironical is that there are many cases, where the influence of inaccurate excessive physical load harmed the musculoskeletal system (scoliosis, harm on joint and muscular systems, etc.) or caused illnesses of cardiovascular system (arrhythmia, heart failure, etc.) (Máček & Radvanský, 2011). It is proven, that long-term endurance event such as marathon, ultra marathon, cycle marathon, long-distance cross-country skiing and others is not possible to complete without long-term and systematic work (Engliš, 2012; Mingles, Jacobs & Michielsen, 2009). If the athlete does not spend enough time practicing, the possibility of having issues with cardiovascular system is huge. According to new researches (Middleton, Shave, & George, 2006; Neilan, Januzzi, Lee-Lewandrowski, et al. 2006, La Gerche, Connelly, Mooney, MacIsaac, & Prior, 2008; Mousavi, Czarnecki, Kumar et al. , 2009), there is a significant increase of cardio nonspecific cardiac enzymes called creatine kinase. Some athletes experience also an increased of concentrated cardio specific cardiac troponins (cTn, cTnI, cTnT), which are considered as indexes of problematic heart function - heart attack, inflammation of the heart muscle or heart failure. According to certain researches (for example Middleton, George, Whyte, Gaze, Collinson & Shave, 2008), this phenomenon is happening at the competitors up to 100 % during 60 minutes physical load.

Troponins are proteins of tropomyosin complex of myocytes in skeletal muscles, which are involved in muscle contractility. Troponin C binds calcium ions, troponin I binds actin to restrain interaction between actin and myosin and the third type of troponin, troponin T supports muscle contraction with binding to myosin. All types of troponin are bonded in myofibrils. There are 3-8 % of troponins loosely in cytosol. In cardiology, cardiac isoenzymes (cTn) are used. In case, the cardiac muscle is damaged, troponin I (cTnI) and troponin T (cTnT) are released only from myocardium to blood and both of them provide stratification of another risk of cardiovascular issues. Troponins are visible in blood quickly after the certain damage and stays for few days (Morrow, Cannon, Jesse et al., 2007; Janota, 2011).

The causes of changes of concentration of troponins while exercising are not fully clear. According to certain researches, the cause of changes is consequence of boosted physiological regeneration of cardiomyocytes (Middleton, George, Whyte, Gaze, Collinson & Shave, 2008; Giannoni, Giovannini, & Clerico,2009). The second option of increased concentration of troponins might be reversibility of damaged cardiomyocytes of the cardiac wall (Rafai, Douglas, O'Toole, et al. ,1999). The third cause of increased concentration of troponins while exercising is considered an adaptation response to physical load. It causes an increased concentration of catecholamines, which goes over the capacity of physiological homeostasis (Dünser, Walter, & Hasibeder, 2009). Other studies consider as a cause, an increased pressure and volume of cardiomyocytes, which are connected with myocardial overload Hessel, Atsma, van der Valk, Bax, Schalij & van der Laarse, 2008). The last theory about increased concentration of troponins while exercising is that the increased is caused by ischemia of cardiomyocytes while the body is in extreme muscle anaerobic load (Chaitman, 2011; Middleton, George, Whyte, Gaze, Collinson & Shave, 2008).

There are new findings about cardiac biomarkers thanks to a development of new methods, that increase of troponins (cTn, cTnI, cTnT) already start while exercising, however the most visible changes are happening within 3 hours after race. The increase amount of cardio specific cardiac troponins is getting back in normal level after 24 hours after physical load, exceptionally, the increased level might last longer 48-72 hours after physical load (Lippi, Schena, Dipalo, Montagnana, Salvagno, Aloe & Guidi,2012; Middleton, Shave, & George, 2006; Scherr, Braun, Schuster, Hartmann, Moehlenkamp, Wolfarth, Pressler, & Halle, 2011).

It is important to run many researches on this topic, because our bodies are constantly changing and each outdoor sport has different effect on our body system. Therefore, we are trying to display as many cases as possible about outdoor sports and their influence on cardiac system.

METHODS

To reveal the results, there were used two types of theoretical methods - descriptive and comparative. These methods helped us to work with data from PubMed and Researchgate databases. The data, we worked with, were collected from last 7 years (2010-2017) and were focused on effect of long-term physical load on cardiac markers in outdoor sports. To make this review affected we chose these types of criteria: type of biomarkers, study population, type of load, distance of duration, sampling and outcome. Based on these criteria, there is a discussion about suitability and use of outdoor sports for prevention of getting heart diseases.

RESULTS AND DISCUSSION

In the following part, there are demonstrated available studies about the effect of high intensity physical load on health condition of athletes in outdoor sports.

Table 1. Summary of researches focused on impact of outdoor sports on cardio markers

Biomarker	Study population	Type of load	Distance of duration	Sampling	Outcome	Reference
CK, CRP	20 M (10 M with load – induced hypertension, 10 M normal)	Running	Ultra marathon 100km	Baseline, post load	CRP and CK more significantly increased in the hypertensive group than normal	16
cTnI	17 M	Running	Half marathon	After the run, 3,6 and 24 hour	cTnI were significantly increased in athletes (100%)	23
CK, cTnT	20 M	Running	Ultra marathon 24 hour	1day before, immediately after race	CK increased post-race, 2 runners showed increased cTnT(10%)	34
CRP, cTnT	7 M (amateur runners)	Running	48 hour ultra marathon	48,24,12 before, after race and 12,24,48 h of running	CRP, cTn showed increase after race(86%), Most of the changes dissolved during the 48 h post –race recovery	15
CK,cTnT	15 M (7 elite,8 non elite)	Triathlon	Ironman	Before, immediately, 2 hours and 7 days after finish	cTnT was significantly increased in the elite group after race (100%), not in non elite group, 7 days after recovery in both groups was normal CK	11
cTnT	1 elite African male	Running	Half marathon	Immediately, 3 hour after race, 3 days	cTnT was significantly increased after race (100%)	2

cTnI,	32 M (18 elite 14 amateur)	Rowing	30 min maximal rowing test	Before, after 5min, 1,3,6,12,24 h after test	Peak cTnI exceeded in 9 elite(50%), 3 amateur rowers	22
cTnT	31 M	Running	Ultra marathon 330 km	Before, halfway, immediately the race, 3 days after arrival	Increased significantly to halfway (75%), not permanent structural damage at the myocardium level	19
cTnT	15 M (amateur)	Triathlon	60 min maximal test in swimming, cycling, running,	Before, immediately after 5 min and 1,3,6,12 and24 hour	Increased of cTnT after physical load in all cases (100%), normal values after 24 hours in all cases	21
CK, cTnI	40 M (amateur)	Running	Marathon	Before, immediately after race	Increased of CK and cTnI after a race without a harm on heart of all competitors (100%)	44
cTnT, CK	13 M	Running	Test: long duration running 60 min and two series of 12x30 sec sprints	1, 4 hour after test	Significant increased of cTnT after sprints than after physical load with mild intensity (80%). Significant increased of CK regardless on exercise protocol	43
CK,cTnT	36 M, 29 F (elite athletes)	Dragon Boating	Test 30 min	Pre-training, 1 hour post-training	No increased of cTnT (0%), CK increase is more significant at males than females	3
CK, cTnT	14 M	Road Cycling	Race 177km	Before, immediately, 3 hour after race	Increased values for all competitors (100%). Later, all values reinstated	20
CRP,CK,	18 M (nonprofessional)	Running	Ultra marathon 2 days 130 km	Before, immediately - after first and second days, after1,3,5 days race	No changes after first and second day. After first race day, increased of values (100%), after that reinstated	1
cTnI,	26 M	Running	Ultra marathon 100 km	1 week before race, immediately and 1 day after finish	Increased values of cTn at 19 runners (73%), after 24 hours 8 runners still with increased values	25
cTnT	17 M	Running	Run 5 km	1 day before the race, 1 hour before race, immediately after race, 1,3,5 hour after race	Increased values of cTnT - 12 from 17 competitors (70%)	14

Explanation: M : Male, F: Female, CK: Creatine kinase; CRP: C –reactive protein; TnI – troponin, cTn – high sensitive cardiac troponin

The results presented above (Table no. 1) illustrate, that higher values of cardiac markers were appeared almost in every research focused on issues of physical load in outdoor sports.

Only in two investigations there was no increase in troponin in the blood of athletes. First was the case of German national team when dragon boating before World Cup (Bauer, Zießler, Walscheid, Mooren, & Hillebrecht, 2016). The second is the research of elite rowers (Legaz-Arrese, López-Laval, George, Puente-Lanzarote, Moliner-Urdiales, Ayala-Tajuelo, Mayolas-Pi, & Reverter-Masia (2015). Possibly, the physical load while paddling is not long enough for the release of substance. It is proven in other researches which address, if the physical load is shorter than 60 minutes, the cumulating is less possible (Middleton, George, Whyte, Gaze, Collinson & Shave, 2008). This statement is excluded by Keselman, Vergara, Nyberg, and Nystrom, (2017) who found out that short-distance running races completed with maximum effort, might cause metabolic stress and release of troponin T. The results display 75% increase of troponin at short-distance cross country runners (Keselman, Vergara, Nyberg, & Nystrom, 2017; Weippert, Divchev, Schmidt, Gettel, Neugebauer, Behrens, et al.(2016). Whereas, the half marathon runners prove 100% increase of troponin (Barakat, Pezzilli, & Prestinenza, 2014; Lippi, Schena, Dipalo, Montagnana, Salvagno, Aloe, & Guidi, 2012). This is proven by other researches by Lippi, Cervellin, Banfi and Plebani (2011) or Young-Joo, Jae Ki, Kyung-A., Chul-Hyun, Yoon-Hee and Kyoung-Min (2015), who claim, that up to 94% of athletes, who completed marathon, had increased level of troponin in their blood. The interesting fact is, that ultra marathon runners do not prove that significant increase of troponin in blood, it was found out at 68% of runners (Arakawa, et al.(2016); Klapczinska, Waskiewicz, Chrapusta, Sadowska-Krepa, Czuba, & Langfort, 2013; Le Goff, Kaux, Gergele, Millet, Viallon, Croisille, & Cavalier,2015; Li, How, Kao, Chiu, Meng, Hsu, & Tsay, 2017; Kim et al., 2012; Passaglia et al., 2013).

There are other analyses of outdoor sports, such as triathlon or road cycling, about their effect on cardio markers. The conclusions of these analyses are similar to results of long-distance runs. Athletes‘ biomarkers increased the amount to 100% at long-term high intensity physical load (Chan-Ho, Kwi-Baek, Jin, Jin-Goo, & Yi-Sub, 2014; Legaz-Arrese, López-Laval, George, Puente-Lanzarote, & Castellar-Oti´n, 2015, Le Goff, Kaux, D´Otreppe, Goffaux, Chapelle, & Cavalier, 2016).

The research literature explain, that long-term high intensity physical load increase the amount of cardiac markers in blood. However, all cases prove that increased amount of cardiac markers decline after 24-48 hours, which it is also presented by Le Goff, Laurent, Kaux and Chapelle (2011).

Conclusion

In conclusion, the research proves that intensity and duration of physical load significantly correlates with occurrence of cardiac markers in blood. That means, the shorter duration of physical load and higher intensity of physical activity, the higher probability of increased concentration of biomarkers. Another fact is that long-term high intensity physical load influences an amount of cardiac markers in blood (increase of cardio markers). However, after 24-48 hours, the increased level of cardiac markers decline and go into a normal level. Even though, the researches proves that high intensity physical exercise has an influence on heart function and higher concentration cardiac markers, the regular outdoor sports with right intensity and purpose have preventive effects on cardiovascular diseases and healthy life style.

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PROJECTS

Implementation of education in sport and outdoor activities within the project "The Award goes to Universities" at Matej Bel University in Banská Bystrica

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Abstract
Implementation of education in sport and outdoor activities within the project „The Award goes to Universities" at Matej Bel University in Banská Bystrica.
The article focuses on application of the „The Award goes to Universities" project at Matej Bel University. We introduce successful educational programme „The Duke of Edinburgh´s International Award" (DofE) and its future implementation into university curriculum which aim is to create new procedures and methodologies for education of future professionals of the DofE programme. Key parts of the project are spheres like sport and adventurous expedition which focuse on skills´ development, independence and support of healthy lifestyle. The aim category is young population between 14-24 years who have a chance to improve their skills and characters for real life, to fulfil their potentiality and help them to be successful in the life. The benefit of the project should be also the guide book for university lectors, study materials for university students, scientific results of programme´s benefits and education of professionals in particular sphere.

Key words:
Adventurous expedition, educational programme, sport activity, The Duke of Edinburgh´s International Award

Souhrn
Implementácia vzdelávania v športe a outdoorových aktivitách v rámci projektu „The Award goes to Universities" na Univerzite Mateja Bela v Banskej Bystrici.
Príspevok sa venuje problematike aplikácií projektu „The Award goes to Universities" na Univerzite Mateja Bela. Predstavujeme úspešný vzdelávací program „Medzinárodná cena vojvodu z Edinburghu" (DofE) a jeho budúcu implementáciu do univerzitného kurikula za cieľom tvorby nových postupov a metodík pri vzdelávaní budúcich odborníkov v rámci uvedeného programu DofE. Kľúčovou súčasťou projektu sú aj oblasti šport a dobrodružná expedícia so zameraním na rozvoj zručností, samostatnosti a podpory zdravého životného štýlu. Cieľovou kategóriou sú pre nás mladí ľudia vo veku 14 až 24 rokov, ktorým projekt DofE dáva šancu rozvinúť svoje schopnosti a charakterové vlastnosti pre reálny život, naplniť svoj potenciál a pomôcť im uspieť v živote. Prínosom projektu má byť aj príručka pre vysokoškolských lektorov, študijné materiály pre študentov vysokých škôl, vedecké výstupy z overovania prínosov programu a vzdelávanie odborníkov v príslušnej oblasti.

Klíčová slova:
Medzinárodná cena vojvodu z Edinburghu, vzdelávací program, športová aktivita, dobrodružná expedícia

Introduction

Many national educational programmes were realized last five years in Slovak republic, for example: Physical education and rising of children´s interest for physical and sport activities I. and II., Physical education at primary school and rising of children´s interest in physical and sport activities, Improvement of qualification of physical education teachers. The aim of these projects was to rise interest of the young in sport and physical education and to strengthen teachers´ knowledge and competences. Their long-term sustainability and effectiveness were often controversial and influenced by change of political spectrum. Our project is designed and realized by another way, however, it has some thoughts and aims in common with previous projects. The proved programme "The Duke of Edinburgh´s International Award" (DofE) has arrived into Slovak republic and it focuses on personal development of young people between 14-24 years in chosen sections. Sport and adventurous outdoor expeditions fall into chosen sections. This programme comes from "below" thanks to avid people and mentors despite of mentioned. Schools as centres of education at all degrees and they can become part of the programme together with natural centres thanks to teachers. The professional community will be definitely interested in created structure and methodology of two key aim spheres which are sport activity and adventurous expedition. Despite of this informal access, teachers who are working in the programme together with schools by the system of local centres, play very important role by the system of local centres. Our aim is to implement "DofE" into the university educational system because it has not been realized despite of its existence. The article is an addition of the project KEGA 044UMB-4/2016 „Outdoor activities, sports and specification of sojourn in nature"(text book for schools and public) which is interested in new trends of outdoor activities of the young.

History and philosophy of DofE programme

The Duke of Edinburgh´s International Award (DofE) is a complex developed programme which gives chance to young people (age from 14 to 24) to improve their complex skills and characters for real life, fulfil their potential and to be successful in life. The programme is realized in more than 140 countries over the world. In another word, the DofE is the world's leading young achievement award, giving millions of 14 to 24-year-olds the opportunity to be the very best they can be or it can be understood following way: to promote lifelong improvement for all young people by encouraging personal development and achievement. The programme is built on the thought that each young human being has a potential to be successful and developed by helpful educational form. The Duke of Edinburgh´s International Award was found and established in 1956 by duke of Edinburg Philip (husband of Elisabeth II.) together with German educator and big propagator of adventure and experience pedagogy – Kurt Hanh and also with the leader of the first expedition on Everest´s peak – Lord Hunt. The primary aim of the programme was to provide opportunity to British boys to improve themselves and be interested in something purposeful and meaningful mainly in the period between the end of compulsory education and joining the army because those boys lost their fathers in the World War II. The programme was opened also for girls after two years of its establishment and it was broaden around the world. The DofE programme changed some criteria and increased age limit on 24 years in 1980 and this form is known up to nowadays. (Guide book for leaders of "The Duke of Edinburgh´s International Award" programme, 2015). Basic statistical information about the project are summarized in table 1.

Table 1 Basic statistical information about the project.

Annual statistics of DofE
The programme is currently delivered in more than **140 countries and territories worldwide.**
Millions of young people have participated and achieved Awards from its foundation.
In 2014, participation increased to almost **1, 135,000 young people** taking part around the world in The Duke of Edinburgh's International Award.

1205 new participants are joining into the programme every day.
On the average of **548 participants finished** the programme every day.
In 2011, participants volunteered in development of local communities around the world in length of **3,9 million hours.**
More than 200,000 volunteers support young people around the world to achieve their Award.

Slovak National Office gained accredited licence 30.3.2016. Since April 2016 it has broadened its programme to particular section and it has created conditions for functioning of basic programme.

Aim

Young people lose their motivation and they stagnate because of the absence of opportunities for the young together with lack of society appreciation. That is why we are sure that increasing motivation and expectations together with balanced education and social appreciation can improve and enhance lives of the young in Slovak republic. Our aim is to implement the DofE programme into the university education system which has not been realized yet. Creation of the methodology, steps and system within the university education can open possibilities for development and research in DofE programme.

Methodology

Basic principles of DofE programme

Young people stated individual aims and challenges in particular activities in DofE programme. They enhance their responsibility and persistence, recognize and surpass themselves, gain new skills which are useful for academic and working life on the way to achieve and fulfil stated aims. Thanks to the joining of the young into the programme, they become a part of international community. The Duke of Edinburgh´s International Award is established on four key spheres into which the young are joined: talent´s development, voluntariness, sport and adventurous expedition. All spheres (timescales or sections) have three levels of difficulty, from bronze to the gold. When the young person achieves particular level he/she is immediately awarded and motivated to the next development. The main condition to be joined into the programme is to be 14-24 years old. Two main conditions are needed: join into chosen activities in all 4 spheres minimally one hour a week and fulfil individual aims for each programme´s sphere. Participants do not compete with each other but each one has to surpass oneself. (Guide book for leaders of The Duke of Edinburgh´s International Award programme, 2015)

Sections of development of the young in DofE programme

Development of the talent. Each person has a talent. Each participant decides what she/he wants to improve or she/he focuses into the sphere which is the most interested. There are many possibilities – play on the musical instrument, languages, ceramics (pottery), run a business, IT, natural sciences or the development of technical skills.

Sport activity, physical recreation. Sport leads to health and comfort. The Physical Recreation section of the Award encourages young people to participate in sport and other physical recreation for the improvement of health and fitness. This Section specifically aims to improve the performance, health, team skills, self-esteem and confidence of participants. Young people can choose team or individual sport. The aim is to encourage healthy behaviours and be responsible to the health.

Voluntariness. All life is about giving and getting something. Voluntariness is the way how we can give and get simultaneously. Participants get to know new people, they learn empathy, tolerance and patience. They learn to be more responsible and useful for the society.

Adventurous expedition. The Adventurous Journey section encourages a sense of adventure and discovery whilst undertaking a team journey or expedition. As part of a small team, participants plan, train for and undertake a journey with a purpose in an unfamiliar environment. The journey can be an exploration or an expedition but must be a challenge. The aim of this Section is to provide participants with the opportunity to learn more about the wider environment (homeland), as well as to develop their self-confidence, team work (in particular outdoor activities) and health. Participants are taken out of their comfort zone but kept within a safe and secure setting, achieved through suitable

training and supervision. (Guide book for leaders of "The Duke of Edinburgh´s International Award" programme, 2015).

Levels in DofE programme

The Duke of Edinburgh´s International Award programme should be a real challenge for the young and that is why it is inevitable and important to state aims for each person individually. If the aim is very easy for participant he will not be as satisfied as he expected. On the other hand, very difficult challenges should be demotivated. That is why the programme stated three levels with different difficulty – bronze, silver and gold. You can start with the level which is easy (the bronze) but you can start with silver or gold one.

Bronze level- for those aged 14+ years. Participants are joined into 4 sections (timescales, spheres): volunteering section (lasts 3 months), physical section (lasts 3 months), skill section (personal development- lasts 3 months), and expedition section (lasts 2 days/1 night). Participant chooses one section which will represent the most difficult aim. This section will last 3 months longer than the others. 6 months are needed to achieve and gain the bronze level of The Duke of Edinburgh´s International Award.

Silver level - for those over 15 years old. Participants are joined into 4 sections (timescales, spheres): volunteering section (lasts 6 months), physical section (lasts 6 months), skill section (personal development- lasts 6 months), and expedition section (lasts 3 days/2 nights). If participant didn't do Bronze, he/she must undertake a further 6 months in either the Volunteering or the longer of the Physical or Skills sections. 6 months (minimally) are needed to achieve and gain the Silver level of The Duke of Edinburgh´s International Award if the participant did the Bronze and minimally 12 months for those who did not do Bronze and starts immediately with the Silver one.

Gold level - for those aged 16+ years. Participants are joined into 5 sections (timescales, spheres): volunteering section (lasts 12 months), physical section (lasts 12 months), skill section (personal development- lasts 12 months), expedition section (lasts 4 days/ 3nights) and residential section (undertake a shared activity in a residential setting away from home for 5 days and 4 nights). If participant didn't do Silver, he/she must undertake a further 6 months in either the Volunteering or longer of the Physical or Skills sections which will be represented by more difficult aim. 12 months (minimally) are needed to achieve and gain the Gold level of The Duke of Edinburgh´s International Award if the participant did the Silver level and minimally 18 months for those who did not do Silver and starts immediately with the Gold one.
(Guide book for leaders of "The Duke of Edinburgh´s International Award" programme, 2015)

Implementation of the programme into university environment

As it was mentioned in the beginning of the article, our aim is to implement the DofE programme into the university environment and curriculum. It is not only about the university´s joining as the local centre what is common in the world. University students can become not only participants of the programme but they can educate and become leaders and supervisors of the expeditions thanks to the programme´s methodology.

Education of future leaders of DofE programme within the university education require another organization, methodology and procedures as in the present informal concept of the programme´s existence. The creation of new methods and procedures is necessary to acquaint applicants with important and needed knowledge and skills. They are necessary in all key spheres and sections including sport and adventurous expedition. Supervisors have to be able to think about safety risks and have to know participants´ skills over a period of the programme.

Matej Bel University in Banská Bystrica joined into the DofE programme through two ways. As the local centre and as the realizer (implementer) of the project „The Award goes to Universities". The university team consists of professionals and teachers of various orientation gained a grant for „The Award goes to Universities" project from The Duke of Edinburgh's International Award Foundation thanks to the cooperation with national company. Its aim is to create conditions and methodology for sustainable development and realization of DofE in the Slovak university environment. Benefit should be also a guide for university instructors as well as study materials for university students. Research monitoring of DofE benefits will be a part of the project addressed to participants and leaders. This method can be inspiring for other universities not only in Slovakia but also in foreign countries. From the historical point of view, Matej Bel University has highly-developed system particular key spheres which are noticed in DofE. For example, education and educational methodological procedures in

voluntariness (Brozmanová Gregorová et al. 2014). It is registered in whole-university subject Service learning which works and functions thanks to whole- university team.

Conclusion

Confirmed educational DofE programme with its history and philosophy focused on personal development of the young through informal education and it is beneficial for all society. Its basic success indicator is the statistics which is stated below in Table 1. Lack of knowledge, skills, attitude and lack quality of educational opportunities are the biggest barriers of the growth of the Slovak young people. Beneficial and important thing for our sporting community and formation of the personality of the young person is to use the means of sport and adventurous expedition in natural environment.

In the end of the article, we can summarize and define key benefits of the programme for the young:

- encourage the development of personal interests and practical and social skills thanks to which they find employment,
- ability to learn from own skills and experience,
- opportunity to gain something positive and constructive during the free time,
- chance to fulfil dreams, face to the challenge and surpass oneself,
- increase of self-confidence and self-belie,
- encourage independence and responsibility for myself and others,
- able to work in team,
- able to plan effectively and able to decide, be responsible and reliable,
- creation of active attitude to world around,
- finding new interests, friends and opportunities,
- social appreciation of made effort in the form of worldwide accepted certificate and its ceremonial sell

Results of DofE researches have shown that the participation in the programme improve compulsory education and success of the young, it develops lifelong interest for education, increase their employment, civil activity and tolerance to difference and it plays important role in prevention of asocial and criminal behaviour.

Denoted programme benefits can be tangible also for joined mentors and organization in Slovakia:

- opportunity to support personal skills thanks to worldwide confirmed programme with quantifiable results and international prestige,
- effective instrument for individual work with the young between 14-24 years,
- connection with prestige international sign – make it visible on Slovak web of the programme, status of local programme centre confirmed by prestige certificate,
- opportunity to use several activities in the programme which is in particular form leaded by organization or school,
- offer to young people educational aims which proceed from their own interests and on which they participate on,
- opportunity to organize free time of the young productively and support their personal and social responsibility
- chance to share own result satisfaction with the others,
- opportunity to improve organizational and professional skills thanks to the experience,
- possibility to create a group of active teachers/ volunteers participating on organization and following connection with similar "thinking" community which is joined in DofE in Slovak republic or abroad,
- possibility to improve cooperation with other organizations and schools,
- opportunity to participate on international projects of the programme,

University environment provides lots of future professionals into posts of programme leaders and supervisors of expeditions thanks to the variety of study fields. Alongside, it provides practice and demonstrability of achieved and gained skills thanks to university education. These personal competences and skills are foundation of development in sport sphere. Sport movement and its development is built on volunteering, natural leaders, mentors and personalities. DofE aims are very similar with athlete´s personality what is one of a few positive idols for Slovak children and teenagers in the present.

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