

EFFICIENCY OF THE CARDIOVASCULAR SYSTEM AND FACTORS AFFECTING ON ITS QUALITY

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Abstract

Aim of the survey: To assess the influence of risk factors such as smoking the cigarettes, alcohol consumption, diet, level of physical activity and the incidence of mental stress on the efficiency of the cardiovascular system.

Methods: In our survey were participated 93 probants aged 18-25 years. Cardiovascular efficiency was assessed using Ruffier test. Based on its outcome were probants divided into three groups (A - good to excellent cardiovascular efficiency, B - average cardiovascular efficiency, C - below average circulation efficiency). There was used the questionnaire consisting of the questions directed on the lifestyle and incidence of the risk factors for the cardiovascular insufficiency. Incidence of various risk factors were compared in each group.

Results: In group C was the largest representation of abstainers (30.55%) and non-smokers (80.55%). The probants in this group also fared best in an effort to respect the principles of healthy eating. While the largest representation of (42.31%) probants with low levels of physical activity was in group A, the largest representation of probants with high levels of physical activity was in Group B.

Conclusion: We were unable to confirm the negative impact of selected risk factors for cardiovascular efficiency. It should be thing to realize, that the incidence of a risk factor does not immediately mean a deficiency of the cardiovascular system. Only continuous exposure to various risk factors leads to cardiovascular deficiency. The cardiovascular deficiency should be prevented by preferring a healthy lifestyle.

Key words: Cardiovascular system, Ruffier test, Cardiovascular efficiency, Proband

Introduction

In order that the vital functions of the organism can go on optimally it is necessary that the cells of the body are adequately supplied with oxygen and nutrients circulating in the blood. The basis function of the cardiovascular system (CVS) is therefore ensuring the blood perfusion of all tissues and cells of the body, thereby receiving oxygen in then, energetic substances, vitamins, minerals, hormones and water. Carbon dioxide, waste products and excess water from metabolism are then consequently discharged from the tissues. We can say that CVS is involved in the stability of the inner environment [1].

Cardiovascular efficiency

Cardiovascular efficiency is the most important indicator determining the overall fitness of the organism. It is given by the ability of the heart and the vascular system to transport enough oxygen and nutrients to the working muscular via blood. These parameters greatly affect regeneration and remodelling ability of the organism especially in the field of angiogenesis and vasculogenesis. If these mechanisms are not sufficiently activated it can mean for body deficit manifested by fatigue, respiratory insufficiency and pain in the muscles due to muscle acidosis after work on oxygen debt. High cardio-respiratory efficiency significantly reduces the risk of a cardiovascular disease. Savvy and powerful heart and vascular system are less prone to develop various disorders and are able to deal with them easier. From external factors which are capable of significantly positively influence on the characteristics mentioned above include the exposure of the body by hyperbaric oxygen. Recent studies show that hyperbaric oxygen therapy leads to activation of the synthesis of Placental Growth Factor (PIGF) which is a key molecule for angiogenesis and vasculogenesis [2-4].

Among the basic tests to assess the quality of the cardiovascular fitness we include the measurement of the heart rate after an exercise, Ruffier test and Step-Up test. In the physiotherapy of cardiac diseases also the training heart rate is usually counted. All these tests are based on measuring heart rate, which is the outer manifestation of cardiac activity and peripheral arteries [1]. In addition to the above, electro-diagnostic methods are often used in clinical practice. An electrocardiogram or various forms of stress tests may be used with the help of an electrocardiogram (ECG) we get diagnostic results, such as ischemic heart disease, conduction abnormalities of agitation, hypertrophy of ante-ventricles and ventricles or disturbance of agitation impulses [5]. Among the stress ergonomic tests pursuing changes in CVS (particularly heart rate, blood pressure and ECG changes) we can include tests using dynamic and static load. Graded workload that increases oxygen consumption enables to determine coronary reserve of the patient and allows to assess to which extent the defect of the blood regulation during exercise is manifested [6]. A stationary bike and walking are the most preferred in practice as a dynamic load.

Ruffier test

Ruffier test assesses the ability of the cardiovascular system. It sufficiently determines the functional state of CVS and the readiness of the organism for the load. It consists of 3 parts. The first part follows the room heart rate (we measure is a sitting position for 15 second = TF1) in the second part the heart rate is measured after a standard dynamic load (30 squats performed for 45 seconds) and consequently we measure the pulse rate (time 15 seconds = TF2) followed by the third part which is the relaxation of the body in the sitting position for the period of 1 minute and consequently the heart rate is measured again (for the time of 15 second = TF3). Individually obtained numerical valves are substituted in the formula for calculating the so-called Ruffier index.

$$RI = \frac{(4 \times TF1 + 4 \times TF2 + 4 \times TF3) - 200}{10}$$

The original version of the test is based on the pulse frequency (number of counts for 15 seconds) multiplied by four which are added to the minute valve. However, it is possible to use a modified method in which instead of every four time palpation of the measured valves a minute frequency measured by a digital tone -metre or a sport-tester is substituted [2].

The evaluation index of the Ruffier test is different. Professional literature describes two methods of evaluation. Both divide the result of the Ruffier test in five groups, but they differ in each interval. Both methods of evaluation are reported in Table 1. The first method of evaluation is stated for example by Bartůňková at al. [7] or Važan [8]. The second way to assess is used for example by Flemr [9], Bukovian [10], or the website of the Regional Public Health Authority in Trenčín [11]. Non-uniformity of evaluation could lead to a misinterpretation of the results of the scientific work. We should therefore always observe which method of evaluation has been used by the authors in their work. We have followed the second way of assessment in our survey, which we have encountered in professional and scientific literature more frequently.

Table 1 Assessment of the results of the Ruffier test

Mode 1		Mode 2	
Functional condition	Valve	Functional condition	Valve
Excellent	$i < 3,0$	Excellent	$i < 0$
Good	$3,1 < i < 7,0$	Very good	$0 \leq i < 5$
Average	$7,1 < i < 12$	Good	$5 \leq i < 10$
Poor	$12,1 < i < 15$	Average	$10 \leq i < 15$
Very poor	$i > 15,1$	Below average	$15 \leq i$

The rule is valid that the more the persons trained the smaller are the changes of the pulse frequency, caused by the kinetic load and the faster there changes return back to the base, quiet condition [2]. Among the main advantages of the Ruffier test belong its simplicity, it is without a major risk of heart occurrences and it doesn't require the presence of a doctor [12].

Factors influencing negatively the efficiency of the cardiovascular system

In professional literature there are often described different factors which negatively influence the quality of the cardiovascular system. Some of them we can influence (life-style components), others we can't (genetic inclinations, age sex and others). Probably the most frequently stated are: smoking, consumption of alcohol, fatty and salty meals, insufficient moving activity and long-term, possibility frequent exposures to stress situations. These consequently lead to the change of the blood pressure and also often have influence on biochemical parameters (for example the level of cholesterol or glucoses in blood), this way the overall efficiency of the circulation system is lowered. Due to the activity of several factors of jeopardy, the risk of the creation of the circulation insufficiency increases and the quality of the circulation efficiency decreases. We were interested in the fact to which extent the below stated factors of jeopardy that can be influenced, influence the cardiovascular efficiency.

Smoking

Smoking is the most important factor of jeopardy with cardiovascular diseases. It leads, to the increase of the concentration of cholesterol in blood, it increases the level fibrinogen and thrombocytes which leads to the condensation of blood, the creation of atherosclerosis and to the creation of thrombs. Just one cigarette a day substantially increases the cardiovascular risk. That's why most smokers suffer from heart and vascular diseases. Nowadays an increasing risk of coronary diseases is proven even with passive smokers [13-15]. According to Ochaba [14] smokers who consume more than 20 cigarettes a day have a twofold higher occurrence of the ischemic disease of the heart in comparison with non-smokers and a twofold or threefold higher risk of the creation of the myocardial heart-attack. If at the same time an increased level of cholesterol and hypertension is present, the risk of the myocardial heart-attack creation increases by eight times. Smokers also run an even six times higher risk of the creation of periphery blood vessels. Vráblik [15] states, that in the case of giving up smoking the risk of the

myocardial heart-attack falls by half during the first year of non-smoking and in ten years of non-smoking this risk is the same as the risk of a human who has never smoked.

Alcohol

The fact that alcohol negatively influences our organism has been known since long ago, but several studies have confirmed that abstinence isn't suitable, first of all what cardiovascular system is concerned. That doesn't mean that we should often drink alcohol and in big quantities. Alcohol contains substances which prevent cell damaging, it also prevents creation of inflammatory or tumour cells, it positively effects decreasing blood pressure and coagulating of blood. A lot of epidemiological studies have proven a positive link of alcohol to the figures of blood pressure [6], of a serious degree and thin blood. If you successively restrict alcohol beverages or you yet a teetotaler your blood pressure decreases or even gets back to normal. It has been found out. Apart from the above stated alcohol itself contains a lot of calories. Standardly it is stated that 1 g of an alcoholic drink contains 7 kcal. These figures show that a regular use of alcoholic beverages leads indirectly to the increase of a body weight and this consequently leads to hypertension [16].

Eating habits mistakes

We should be careful with our eating habits during several diseases, not only during cardiovascular. Nutrition of muscular is very important for movement. They get it from the blood circulation and it gets there from the nutrition we eat, that's why we should have healthy eating habits.

He results of the studies confirm that an increased intake of cooking salt exceeding the need of the organism leads to the keeping of liquids and this way blood pressure increases. That's why patients with hypertension are recommended to restrict the consumption of cooking salt [6]. It is stated that a sufficient amount of salt per day is about 2-5 grams [16]. Apart from salt, an excessive amount of food rich in fats also negatively influences the quality of CVS. The level of fatty substances in blood (and thus the creation of cardiovascular diseases) is influenced mostly by cholesterol saturated and unsaturated acids. In fact, cholesterol is a part of everybody cell it serves for the creation of some hormones vitamin D and gall acids. The organism itself creates it in the liver and in a gut wall in the amount of 800 mg daily. Daily supply of cholesterol via food represents only a third of the overall amount in body. The source is the bowels, eggs and other animal food. A daily intake of cholesterol in food shouldn't exceed 300 mg [17]. The higher the level of sugar in blood, the higher the risk of the creation of atherosclerosis and also myocardial heart-attack. Animal fats containing a great amount of saturated fatty acids and cholesterol lead to an increased level of blood sugar. That's why animal fats are not suitable for those who move excessively. An increased consumption of vegetable oils contains a high concentration of higher unsaturated fatty acids. These acids protect blood vessels and lower the blood pressure. These vegetable oils also contain linol acid, which can decrease cholesterol in blood. This way two factors of jeopardy can be effectively influenced at the same time [16].

Hypokinesia

During an exercise load the main task of the organs of blood circulation is the transport of oxygen from the lungs to working muscles and eliminating carbon dioxide and other waste products of energetic metabolism, washing away hormones, removing warmth and others. Owing to the fact that muscles get nutrition they help us create movement that is important for life [18]. In professional literature we often meet the description of the influence of kinetic activity on the health of an individual. Changes as a consequence of decreased mobility, even inactivity are visible in all system and thus also in the cardiovascular system. A decreased activity of moving leads to slowing down of perfusion and as result of weakening the „venous pump“ it comes to blood stagnation in veins. It is often described as so called local-static collapse, caused just as a consequence of a disturbed circulation efficiency. Chaloupka [19] describes the relationship between physical activity and the creation of hypertension. They claimed that with patients with light hypertension it comes after an exercise to the decrease of the period of 8-12 lessons after the exercise. Or the other hand, physical inactivity leads to lowering the volume of circulating blood and to the increase of the jeopardy of the creation of thrombs as a consequence of weakened fibrinolytic activity. Similarly, with people working predominantly in a sedentary position and thus with restriction of an active movement an increased activity of thrombocytes after an acute load was found out, which disappeared or at least decreased with obese individuals but physically active in comparison with individuals who have a normal body weight, though they have insufficient movement and a low energetic outsource. Nowadays we often encounter insufficient level of the kinetic activity. The shortage of kinetic activity is almost always accompanied with unsuitable eating habits, which goes hand in hand with overweight, almost obesity. They are already three factors of jeopardy impairing the efficiency of CVS. From the viewpoint of the prevention of CVS diseases it is suitable to move in the range corresponding with 30 minutes of a fast walk daily. It is important that the activity goes on without interrupting. The choice of a type of a kinetic activity depends on the associated illnesses, possibilities and naturally on personal preferences [15].

Stress

The impact of psyche on the individual processes occurring in the human body is emphasized in physiotherapy. In the field of internal medicine and cardiology, in turn, the influence of psyche on the activity of CVS is emphasized. It is even often said that people who exposed to stress long-term have a greater risk of the inception of a coronary heart disease and myocardial heart attack. Especially long-term, respectively often repetitive stress is a burden for the cardiovascular system. The long-term stress leads to vascular damage, heart, heart, blood pressure increases and metabolic processes change, which may result in diabetes mellitus, a metabolic disorder of cholesterol and various other diseases [15]. A great stride in medicine was the knowledge that the major factor in the rise or triggering a disease is a slow accumulation of stress. If during chronic stress a new stressful event occurs, the brain commands the pancreas to stop producing insulin. Stress triggers insulin resistance. Diabetes has, at the same time the most three fold share on the heart disease of men. If a stressful situation occurs frequently it leads to fatigue and subsequent damage of the heart and other major systems. Since stress is part of our lives ne cannot be surprised that cardiovascular diseases has been found with people of young and middle age [20].

Aim of the survey

The aim of the survey was to determine to which extent the above mentioned risk factors affect the cardiovascular fitness. We watched effects of smoking, alcohol consumption, diet, and level of physical activity and the presence of mental stress on the ability of the cardiovascular system.

Methodics

The survey was conducted during the period December 2013 to April 2014. It consisted of carrying out Ruffier tests for each subject. Based on the results we set Ruffier test subjects were divided into three groups (Group A - C). Group A consisted of subjects with good to excellent cardiovascular efficiency, group B consisted of subjects with an average cardiovascular fitness and group C consisted of subjects with below-average cardiovascular efficiency. These three groups have subsequently followed by questionnaires and compared the occurrence of individual risk factors affecting the quality of CVS. The questionnaire included six closed questions. Subjects were asked about their alcohol consumption in relation to smoking, healthy eating, we watched their level of physical activity, a sense of frequent mental stress (stress) and frequent feeling of fatigue.

Research sample

The entire group consisted of 93 subjects. The age group ranged from 18 to 25 years. All participants were students of the Faculty of Health Alexander Dubcek University in Trenčín. Having made Ruffier tests, we found that the greatest frequency, had the subjects with below-average efficiency (n = 36, 39%). The subjects with average efficiency were 31 (33%) and subjects with good efficiency were 22 (24%). Only one subject had on the basis of the results of the Ruffier test an excellent efficiency of the cardiovascular system and 3 subjects had very good fitness. Based on the results of the Ruffier test, the subjects were divided into three groups:

- Group A (subjects with good to excellent cardiovascular fitness): 28% (n = 26)
- Group B (subjects with average fitness of the circulation): 33% (n = 31),
- Group C (subjects with below-average cardiovascular fitness): 39% (n = 36).

Results and discussion

In the group of subjects with below-average cardiovascular efficiency was the largest representation of abstainers (30.55%) and non-smokers (80.55%). The subjects in this group also did best in their try order to respect the principles of healthy eating. Up to 91.67% of trial subjects with below- average fitness of the cardiovascular system said they tried to eat healthily. While the biggest representation of subjects (42.31%) with low levels of physical activity were in group A (good to excellent cardiovascular efficiency), the largest representation of subjects with high levels of physical activity were in group B (mean cardiovascular efficiency). Convenient processing of results and comparison of the different groups A-C is recorded on Figure 1.

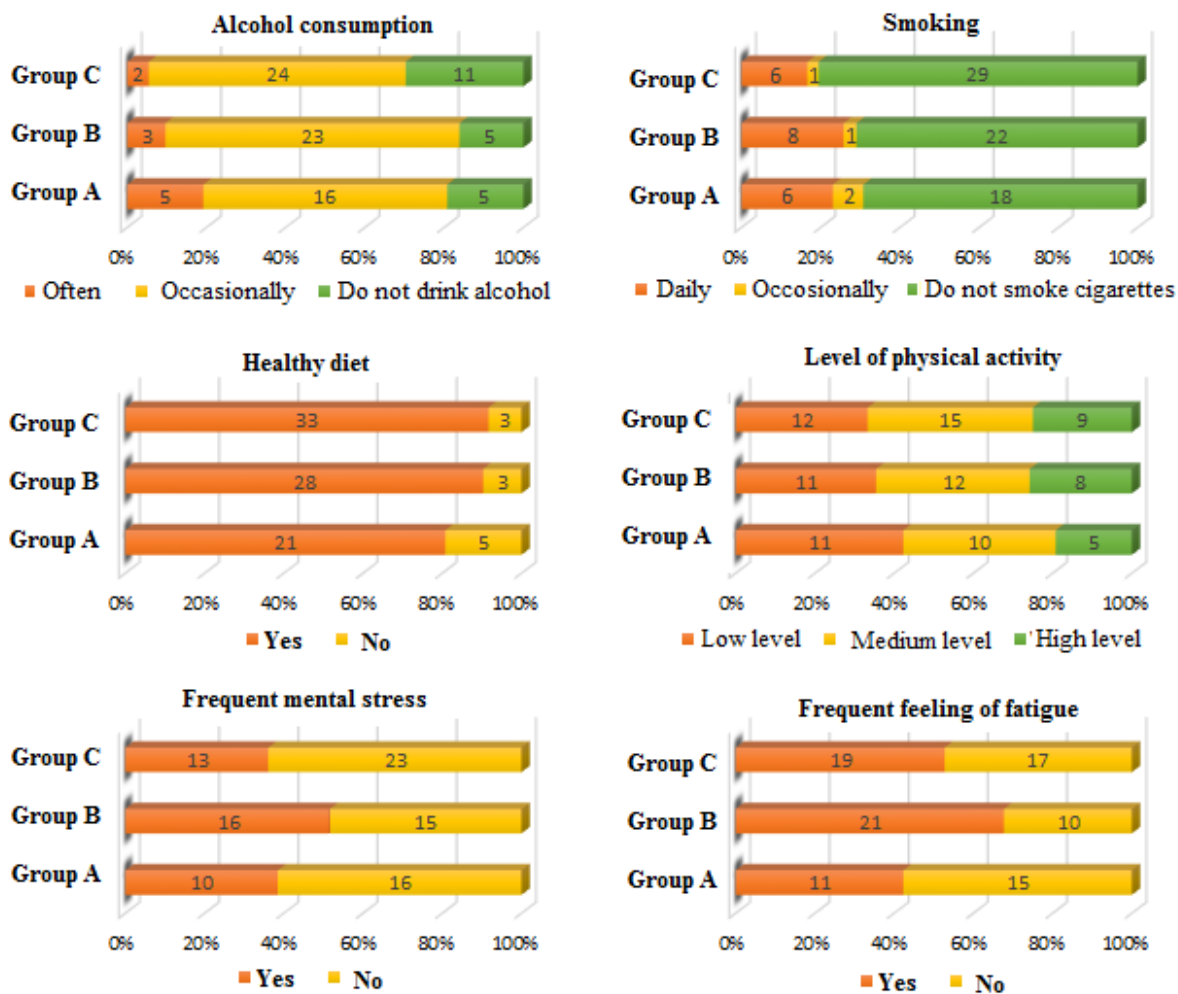


Figure 1 Survey results

In the studies we often meet so called risk factors for cardiovascular diseases. Some of them are components of lifestyle that we can influence, others (genetic predisposition, age, gender and others) aren't. From the modifiable the most often mentioned are alcohol consumption, smoking, errors in diet (fatty and salty it), lack of physical activity and stress. All of the abovementioned have the according to the professional literature affect the quality of CVS and that's why these factors have been the object of our monitoring. Our results, however, are not always in line with the Panel's literature. For example, most drinkers were in the group with below average cardiovascular efficiency while in the group with good to excellent cardiovascular efficiency were the most subjects frequently consuming alcohol (at least once a week). Similar results were also during smoking. In all three groups non-smokers dominated. Most non-smokers, however, were in the group with below-average efficiency, while in the group with good to excellent cardiovascular efficiency the most were daily smokers. The situation was similar also with other risk factors. We could not therefore confirm the negative effect of selected modifiable risk factors on the cardiovascular efficiency. Based on our results, the question arises why the results of our survey are not in accordance with the available literature. The arguments in the literature are scientifically sound. There are numerous studies describing the negative impact of smoking on the heart and blood vessels and long-term negative effects of alcohol consumption on the CVS. Similarly it is in the case of insufficient of physical activity, inappropriate diet and stress. There are even experimental studies on animals exposed to stressful environment in which stress-induced tachycardia and subsequent myocardial infarction was induced. Despite all these facts and experimental studies, our results did not follow the technical and scientific literature. We believe that our subjects were apparently not long enough exposed to various risk factors, and so far no changes in the constitution of the cardiovascular system have appeared. It should be noted that the presence of risk factors can also mean just cardiovascular insufficiency. Only long-term exposure to various risk factors leads to malfunction. It can also be one of the reasons why in our survey individual risk factor occur in such significant amounts, even in the group of subjects with good to excellent cardiovascular efficiency. So we ask, „What is considered a long-term impact of risk factors?“ Or „How long must a risk factor operate to cause changes in the cardiovascular system? This is individual for each factor. Year of regular smoking leaves different traces on the cardiovascular system than for

example a year spent under stress. Our sample consisted of subjects in the age limit from 18 to 25 years and thus individual risk factors might not only had the opportunity to express themselves on the quality of the cardiovascular system. However, if the lifestyles of our patients don't change, the consequences will sooner or later follow.

Conclusion

It is known that year by year, the percentage of people with obesity increases. This means that people forget to exercise and eat healthily, reducing the ability of individuals and circulation. A lot of works already deal with little activity in the population and its impacts on individual body systems. We in our work decided to watch the efficiency of the cardiovascular system and the factors affecting it. The results of our work show that most subjects (39%) were placed in the group with below-average levels of cardiovascular fitness on the basis of Ruffier test. Since in this group to 94% of subjects weren't diagnosed with any cardiovascular disorder and they didn't even feel sick, it is highly likely that the formation of a below average level of fitness of the circulation can be just the presence of individual risk factors. It should be noted, however, that the presence of a risk factor does not just mean a deficiency of the cardiovascular system. Only continuous exposure to various risk factors leads to malfunction. However, this should be avoided. Preventive measures for cardiovascular diseases are a prerequisite to success. We reiterate that only 39% of young people under 25 are, already covered by Ruffier test results in the category of below-average levels of cardiovascular fitness. We assume that with a persistent lifestyle of these people, this percentage will increase. What happens after 30 years? It is already proved that ischemic heart disease and myocardial heart-attack affects an ever and younger age groups. Will there be a sufficient capacity of beds in internal unit departments?

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References

- [1] BÉDER, I. at al. 2005. Fyziológia človeka. Bratislava, 2005, ISBN 80-223-2028-5.
- [2] ENVIROEXPERIMENT. 2013. Funkční testy oběhové soustavy. [online] [cit. 02.05.2014] available on: <<http://www.enviroexperiment.cz/biologie-stredni-skola/funkcni-testy-obehove-soustavy>>
- [3] STEENBLOCK, DA. [s.a.] Hyperbaric Oxygen Therapy – HBOT [online] [cit. 27.01.2015] available on: <<http://strokedoctor.com/hyperbaric-oxygen/>>
- [4] BAŇÁROVÁ, P. – PETRIKOVÁ ROSINOVÁ, I. at al. 2015. Meranie funkčnej sebestačnosti u pacientov po cievnej mozgovej príhode v IV. štádiu motorickej obnovy podľa brunnströmovej. In: Zborník abstraktov. V. medzinárodný neurorehabilitačný kongres NeuroRehab 2015. Bratislava: Statis, 2015, p. 16-18., ISBN 978-80-85659-84-9.
- [5] GÚTH, A. at al. [s.a.]. Vyšetrovacie metodiky v rehabilitácii pre fyzioterapeutov. Liečreh Gúth [s.a.], ISBN: 80-88932-13-0.
- [6] ŠPINAR, J. at al., 1999. Hypertenze diagnostika a léčba. Grada publishing 1999, ISBN 80-7169-736-2.
- [7] BARTŮŇKOVÁ, S. at al. 1996, Praktická cvičení z fyziologie pohybové zátěže. Praha: Karolinum, 1996, ISBN 80-7814-274-5.
- [8] VAŽAN, R. 2009. Telesný a funkčný profil študentov 1. ročníka na LF UK v Bratislave. [online] [cit. 04.01.2015] available on: <<http://www.fmed.uniba.sk/index.php?id=4564>>
- [9] FLEMR, L. - NĚMEC, J. at al. 2014. Pohybové aktivity ve vědě a praxi. Karolinum Press, 2014, ISBN 9788024626215.
- [10] BUKOVIAN, J. 2011. Ruffierova zkouška. [online] [cit. 04.01.2015] available on: <<http://www.pohybspaja.eu/strategie/item/136-ruffierova-zkou%C5%A1ka-jednoduch%C3%BD-test-ob%C4%9Bhov%C3%A9-zdatnosti>>
- [11] REGIONAL PUBLIC HEALTH AUTHORITY IN TRENČÍN [s.a.]. Zisťovanie stupňa telesnej zdatnosti. [online] [cit. 04.01.2015] available on: <http://www.ruvztn.sk/sport/_ots.html>
- [12] BACQUAERT, P. 2014. Test de Ruffier-Dickson, [online] [cit. 12.05.2015] available on: <<http://www.irbms.com/test-de-ruffier-dickson>>
- [13] BACKER, GG. 2008. Risk factor and prevention of cardiovascular disease: a review. In: Dialogues in Cardiovascular medicine. Vol. 13, No.2, 2008, ISSN 1272-9949.
- [14] OCHABA, R. 2010. Fajčenie a kardiovaskulárne ochorenia. In: Kamenský, G., Pella, D.: Zdravý životný štýl. Cesta k prevencii ochorení srdca a ciev. Bratislava: Akadémia vzdelávania, 2010, ISBN 978-80-88880-88-2.
- [15] VRÁBLIK, M. 2014. Kardiovaskulární rizika. [online] [cit. 28.04.2014] available on: <<http://www.vasesrdce.cz/kardiovaskularni-rizika>>
- [16] MIDEKKE, M. at al. 1994. Jak snížit krevní tlak bez léků. Praha, 1994, ISBN 80-85612-65-8.

- [17] JURKOVIČOVÁ, J. 2010. Správna výživa a zdravé potraviny v prevencii srdcovo-cievnych ochorení. In: Kamenský, G., Pella, D.: Zdravý životný štýl. Cesta k prevencii ochorení srdca a ciev. Bratislava: Akadémia vzdelávania, 2010, ISBN 978-80-88880-88-2.
- [18] KOLÁŘ, P. at al. 2010. Rehabilitace v klinické praxi. Galén. 2010, ISBN 97880-7262-657-1.
- [19] CHALOUPKA, V. at al. 2003. Pohybová aktivita u nemocných s kardiovaskulárním onemocněním. In: Kardiologická revue, 2003, č. 1, str.16 –19, ISSN 2336-2898.
- [20] TOMKOVÁ, M. 2007. Stres a zdraví. Praha: Portál s.r.o., 2007, ISBN: 978-80-7367-211-9.