

# **SPORTS MEDICINE: PROBLEMS AND PROSPECTS**



MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
INTERNATIONAL HUMANITARIAN UNIVERSITY

# SPORTS MEDICINE: PROBLEMS AND PROSPECTS

Scientific papers



Odessa  
«Yurydychna literatura»  
2017

UDC 613.71/73(082)

BBK 75.0я43

S78

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Published for according to the decision of the Academic Council of the International Humanitarian University (*protocol № 4 of December 14, 2016*)

S78 **Sports medicine: problems and prospects : scientific papers / ed. in chief O. Romanchuk.** — Odessa : Yurydychna literatura, 2017. — 92 p. ISBN 978—966—419—288—7.

The scientific papers presented research sports medicine issues, revealing the social aspects of the development of diseases in low physical activity, the need for medical supervision to preserve the health of students, the influence of exercise on the female body. Important issues are discussed in the works devoted to methodological problems of research of athletes, as well features of the cardiovascular system in elite athletes and sports veterans.

The scientific papers will be useful to sociologists, sports physiologists, cardiologists, sports doctors.

**UDC 613.71/73(082)**  
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Scientific papers presented in the author's edition.

*На 1-й стор. обкладинки: професор Романчук Олександр Петрович проводить обстеження спортсменів збірної команди України з боксу (Professor Oleksandr P. Romanchuk is conducting a survey of athletes' team of Ukraine on boxing)*

ISBN 978—966—419—288—7

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# INTRODUCTION

In modern conditions the preparation of high qualification sportsmen is aimed at improving sports skills of a particular athlete, and to a large extent depends on the balanced interaction of many functional systems of the body that determine the nature of its adaptive capacity.

These adaptive characteristics include related functioning of the hemodynamic system, metabolism, immunological and hematopoietic values, the general profiles of which, according to the majority of the parameters, must remain within the limits of the statistical fluctuations corresponding to the same sex and age range of people, not deliberately engaged in a certain type of sports activity.

In other words, the optimal method of preparation of highly qualified athletes is the one allowing to achieve rapid growth of sportsmanship at the highest balance of individual performance and integrated level of functional systems that determine the adaptive reserves of an athlete while fully meeting the criteria of the population of people of practically healthy group of people of the same age and gender. However, the range of the variability parameters of homeostasis is much wider in athletes than in those who are not involved in sports; and rather often quite different values exceed the boundary population and can be treated as pre pathological and pathological. These changes reveal a higher adaptive capacity of an athlete.

It is completely obvious today that the diagnosis and correction of the functional state of athletes should be carried out taking into account the results of complex research methods and maximize personalized training plans, the amount and intensity of physical activity, the cycles of competition and recreation that in the future will relieve sport of the problems faced by coaches and doctors at the intensification of the training process.

That is, the diagnostic methods used in sports medicine should contribute to the early detection of conditions that can cause adverse effects of the impact of physical stress on the body, associated with the development of critical conditions and even deaths.

Therefore, an adequate diagnosis and assessment of the state of the body of people engaged in physical exercise seem extremely important area of sports medicine.



**La Rocca Gevisa**

Assistant professor, Faculty of Human and Social Science, University of Enna “Kore” (Enna, Italy)

## THE ITALIAN HEALTH COMMUNICATION FOR CHILDHOOD. AN ANALYSIS OF TWO DIFFERENT ADVERTISING CAMPAIGNS

*I like to move it, move it.*

### **Abstract**

This paper presents two different Italian campaigns against childhood obesity. Objective of the two companions is inciting movement the kids. This paper proceeds by identifying the phenomenon of obesity and analyzing two different communication strategies used by two Italian regions. The theoretical framework is represented by the public service advertising. The analysis model is taken from the work of Grisvolwd (1997) on cultural diamond and tools of analysis are those of advertising.

**Keywords:** *public service advertising, obesity, cultural diamond, language of advertising*

### **1. Introduction**

*I Like to Move It* is a song by American electronic dance duo *Reel 2 Real* (Erick Morillo), featuring ragga vocals by Trinidad and Tobago rapper *The Mad Stuntman* (Mark Quashie). Recently the song has used in *Madagascar* series of films.

It is with reference to the 2005 film *Magacascar*, that here we use the *incipit*: “I like it move”. The film’s characters are Alex, a lion, Marty, a male zebra, Gloria, a female hippo and Melman the hypochondriac male giraffe. They are four animals at the *Central Park Zoo* in Manhattan (New York), neighboring fence and inseparable friends, because the lion is peaceful, well-fed steaks by

veterinarians. Alex is also at the center of the zoo, since before the human, on a visit to his enclosure, performing and dancing is the star animal of the city, which is the king of New York City.

Like animals in the zoo, even the kids should move.

Childhood obesity is on the rise, in Italy, in Europe and USA.

Childhood obesity has more than doubled in children and quadrupled in adolescents in the past 30 years (Ogden, Carroll, Kit, Flegal: 2014).

The percentage of children aged 6–11 years in the United States who were obese increased from 7% in 1980 to nearly 18% in 2012. Similarly, the percentage of adolescents aged 12–19 years who were obese increased from 5% to nearly 21% over the same period.

In 2012, more than one third of children and adolescents were overweight or obese (National Institutes of Health: 2010).

Overweight is defined as having excess body weight for a particular height from fat, muscle, bone, water, or a combination of these two factors. Obesity is defined as having excess body fat (Krebs, Himes, Jacobson, Nicklas, Guilday, Styne: 2007).

Overweight and obesity are the result of “caloric imbalance”— too few calories expended for the amount of calories consumed — and are affected by various genetic, behavioral, and environmental factors (Daniels, Arnett, Eckel, *et al.*: 2005).

The problem is so socially relevant that in 1991 created the ECOG<sup>1</sup>. ECOG is a pan-European group of professionals dealing with childhood obesity and overweight. ECOG brings together experts from across the board including: paediatricians, psychologists, nutritionists, geneticists, physical activity experts, economists and many more. The group was founded in 1991 and its mission is to help the European community at large to understand fully the health, social, psychological and economic impacts of childhood obesity, and work together to take this growing problem off the menu in Europe.

The CDC – *Center for Disease Control and Prevention*<sup>2</sup> – suggest that childhood obesity has both immediate and long-term effects on health and well-being.

Immediate health effects:

- obese youth are more likely to have risk factors for cardiovascular disease, such as high cholesterol or high blood pressure. In a population-based sample of 5- to 17-year-olds, 70% of obese youth had at least one risk factor for cardiovascular disease (Freedman, Zuguo, Srinivasan, Berenson, Dietz: 2005);

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<sup>1</sup> See the website: <http://www.ecog-obesity.eu/>

<sup>2</sup> See the website <https://www.cdc.gov/healthyschools/obesity/facts.htm>

- obese adolescents are more likely to have prediabetes, a condition in which blood glucose levels indicate a high risk for development of diabetes (Li, Ford, Zhao, Mokdad: 2009).

Children and adolescents who are obese are at greater risk for bone and joint problems, sleep apnea, and social and psychological problems such as stigmatization and poor self-esteem (Daniels, Arnett, Eckel, *et al.*: 2005; Dietz: 2004).

Long-term health effects:

- children and adolescents who are obese are likely to be obese as adults 11–14 and are therefore more at risk for adult health problems such as heart disease, type 2 diabetes, stroke, several types of cancer, and osteoarthritis. One study showed that children who became obese as early as age 2 were more likely to be obese as adults (Freedman, Kettel, Serdula, Dietz, Srinivasan, Berenson: 2005);
- overweight and obesity are associated with increased risk for many types of cancer, including cancer of the breast, colon, endometrium, esophagus, kidney, pancreas, gall bladder, thyroid, ovary, cervix, and prostate, as well as multiple myeloma and Hodgkin’s lymphoma (Kushi, Byers, Doyle, Bandera, McCullough, Gansler, *et al.*: 2006).

Prevention strategies are mainly related to the change in lifestyle, today too sedentary; modification of diet and activity information about the risks linked to the consumption of foods too high in sugar and fat. In fact:

- healthy lifestyle habits, including healthy eating and physical activity, can lower the risk of becoming obese and developing related diseases;
- the dietary and physical activity behaviors of children and adolescents are influenced by many sectors of society, including families, communities, schools, child care settings, medical care providers, faith-based institutions, government agencies, the media, and the food and beverage industries and entertainment industries;
- schools play a particularly critical role by establishing a safe and supportive environment with policies and practices that support healthy behaviors. Schools also provide opportunities for students to learn about and practice healthy eating and physical activity behaviors.

## **2. Childhood obesity in Italy**

In Italy there is the OKkio monitoring system to HEALTH<sup>3</sup>, which began as a surveillance system on overweight and obesity in primary school children (6-10 years) and the related risk factors. Since 2007, the Ministry of Health/CCM has sponsored and funded the development and implementation over time of the

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<sup>3</sup> See the website: <http://www.epicentro.iss.it/okkioallasalute/>

surveillance system to OKkio HEALTH, coordinated by the National Centre for Epidemiology, Surveillance and Health Promotion Institute of Health and conducted in collaboration with the regions and the Ministry of Education, University and Research. This surveillance, like others, is the basis of Italian strategies for prevention and health promotion, such as the Government Program “Gaining health” and the National Prevention Plan and, internationally, participates in the project of the World Health Organization European Region “Childhood Obesity Surveillance Initiative (COSI)”. This project has the objective to describe the geographical variation and evolution over time of the weight status, dietary habits, levels of physical activity performed by children and school activities that favor healthy nutrition and exercise, in order to direct the implementation of useful and effective initiatives for the improvement of living conditions and health of children in primary schools.

The 2012 data confirms worrying levels of excess weight: 22.2% of children was overweight and 10.6% in terms of obesity, with higher rates in the regions of central and southern. However there was a slight decrease compared to the figure recorded in the previous collections.

The survey in 2012, confirming previous data, has highlighted the prevalence among children eating habits that can promote weight gain, especially if concurrent. In particular, it is found that 9% of children skip breakfast and 31% is not an adequate breakfast (i.e.: biased in terms of carbohydrates and proteins); 65% makes a hearty snack mid morning, while 22% of parents. He declares that their children do not consume daily fruits and/or vegetables and 44% consumed habitually sugary drinks and/or sodas. The survey in 2012, confirming previous data, has highlighted the prevalence among children eating habits that can promote weight gain, especially if concurrent. In particular, it was found that 9% of children skip breakfast and 31% is not an adequate breakfast (that is unbalanced in terms of carbohydrates and proteins); 65% makes a hearty snack mid morning, while 22% of parents said that their children do not consume daily fruits and/or vegetables and 44% habitually consume sugary drinks and/or sodas.

Even the values of physical inactivity and sedentary behaviors, although showing an improvement, are still high: 17% did not exercise the day before the survey, 18% practice sport for more than an hour a week, 44% have a TV in the room, 36% watch TV and/or playing with video games more than 2 hours a day and only one in four children goes to school on foot or by bicycle.

At this age it is crucial that the perception of the phenomenon have parents, or the adults who care for children. Parents do not always have an accurate picture of the weight status of their child: among mothers of children overweight or obese, 37% do not believe that your child is in the overweight and only 29% think that



amount of food he has chosen is excessive. In addition, only 40% of mothers of children less active physically believes that their child performs insufficient motor activity. These data are similar to those observed in previous surveys (2008, 2010).

We are in the presence of a socially relevant problem, of which he complains audience an actor to transform from “problem” in the “good issue”.

### 3. Good issues and actors

Several scholars of public communication have set themselves a number of questions about the importance of public communication, on why public institutions begin to “speak” and “to do” public communication and how this mode is paid is the development of the welfare state, to expansion of citizenship rights, increased interest and importance of the public sphere, understood as a vehicle and a place dedicated to the formation of public opinion (Lannon: 2008; La Rocca: 2015).

If you consider the social issues, we have to distinguish between: public service advertising and advocacy advertising. Between the public and private sectors. Among those who have more ability to use aggressive language and who has to be politically correct. In fact, the public body rightly deals with issues of social utility, however, does not promote particular interests, either commercial or social. In this sense it cannot promote a strong change that relates more purely advocacy advertising. Then:

- in *public service advertising* were to include topics designed to inform and educate. The goal is to change the public’s perception and raise awareness in relation to an issue or problem;
- *advocacy advertising* means a promoter and actively advocate the cause of someone else. Advocacy advertising is the use of strategic information and other resources (economic, political, etc.) To change collective and individual political decisions and behaviors in order to improve the condition of the community.

So, we have a substantial difference between the language and the communication activities carried out by the public administration that is in the public interest and that of players such as firms or ONG.

Objective of this work is the analysis of two communication campaigns “Stairs. Music for your health promoted by the Emilia Romagna<sup>4</sup> and “Health pills” promoted by the Lombardy<sup>5</sup>.

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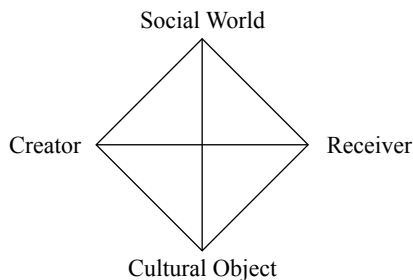
<sup>4</sup> See the website: <http://salute.regione.emilia-romagna.it/news/regione/le-scale.-musica-per-la-tua-salute>

<sup>5</sup> See the website: <http://www.pilloledisalute.com/eventi/item/786-obesity-day-2015-camminiamo-insieme>

To do this you need to locate the exact goals of public communication. In general, the objectives of social communication are as follows:

- inform/raise awareness, it is to bring to the attention of the target a particular topic of increased interest and sensitivity towards the themes addressed;
- educate/motivate, it is to propose to the target of the messages aimed at changing behavior considered harmful to themselves or to the community. In order to change the behavior of a subject you need to find solid arguments that motivate change;
- to call for action, you are achieved when the individual, the target, highly motivated shall implement the changes required by the social media message.

In achieving the objectives they play an essential role on claims makers or significant actors entitled to raise socially relevant issues (Loseke: 1999), our promoters. Applying the definition of good causes the cultural diamond scheme proposed by Griswold (1997) in which it has a creator of social phenomenon, a receiver, the social world and the cultural object, you can establish a parallelism where we have: a social problems, such as for example the phenomenon known as the childhood obesity is created by a combination of factors: the children and their way of life, the food industry and excessively products rich in sugar and fat.



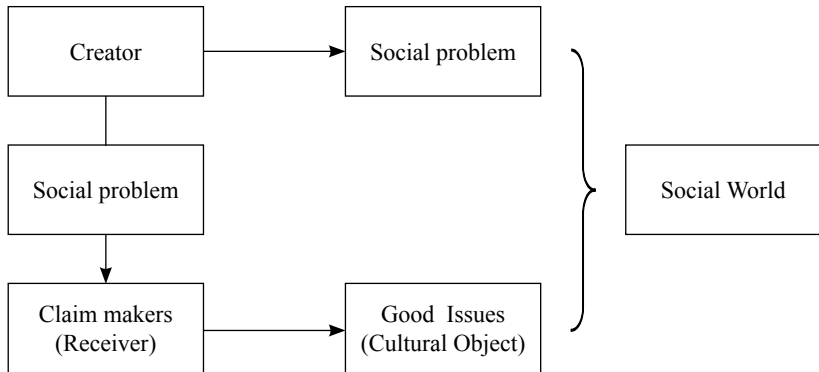
*Source: Griswold: 1994.*

Fig. 1 – Cultural diamond

Their creation takes place in the social world. As long as there's a receiver that will accept such problem and you get up to spokespersons of that instance it (the problem) is simply not a relevant question.

Are the promoters that transform the social problems in cultural objects by loading them with meaning, when there is this transformation is possible for

individuals to act and find a solution and that is because a problem is such that it always has a solution.



*Source: La Rocca: 2015.*

Fig. 2 – Model transformation of social problems in good issues

#### **4. Importance's reasons of advertising**

That publicity has an influence on consumption is obvious. It clearly follows the steps indicated through the years by the researchers of publicity and consumption. Starting from persuasive, mechanistic, suggestive and projective publicity, we move on to strong and weak theories on the effects it has on consumers. If we use the discriminating strong/weak proposed by Johns (1991), publicity has a decisive influence on the attitudes of consumers. According to the weak theory instead, publicity aims at strengthening the consumers' convictions, not at inoculating new ones.

The perspective changes when we no longer ask ourselves what publicity does to the consumer, but what use does the consumer make of publicity (Fabris: 1992). In our case, we are dealing, however, with a very young consumer: a children. It is therefore necessary to analyze the relationship between children and publicity. Children relate with television messages with a cognitive effort that sees them analyze the information transmitted, compare it with their own experience and knowledge, trying to understand, to be able to provide then an evaluation of what they have seen. The most used model to understand this process is the theory of stages elaborated by Piaget, according to which to children of different ages correspond different ways of thinking and solving problems.

The age group where obesity is more significant (8-12 year olds) falls in Piaget's third stage, that of concrete operational thought. In this stage children have developed the ability to distinguish fantasy from reality and to recognize the difference between television programs and publicity. They have also learnt to capture the sense and the incongruities of the stories narrated. Children prefer the publicity promoting products thought explicitly for them, using children as protagonists, adventurous settings, harmonic families, cartoons and symbolic formats. Publicity has characteristics which make it desirable to children. For example, its repetitiveness which facilitates memorization and makes the content more familiar; the shortness of its messages; the verbal iconic simplicity; the capability of the models proposed to attract; the playful and exhortatory aspects together with the sound (Laeng: 1984). A sum of elements which increase its capability of attracting young spectators. Publicity develops consumption abilities through goodwill:

A positive approach to the brand and all its products. Consumption socialization can be defined as the acquisition of abilities, knowledge and attitudes directly connected to consumption and to the product. In a first phase, defined as initial, the child exposed to publicity is able to select and recognize the information present in the ads. Later on, during the middle phase, the recognition of the ads' purposes and their positive or negative evaluation takes place (Word, Wockmann, Wartella: 1977). Children's role in the consumption choices of families has become more and more preponderant. This phenomenon can be divided and read following three directions: the influence of children on their parents, the power of parents over their children and the influence of peer groups. The power children have over their parents is the insistence with which they ask for the purchase of a good or for the money they need to buy the good directly themselves.

Yukl and Falbe in their study Influence tactics in upward, downward, and lateral influence attempts (1990) identify eight tactics children can use to obtain what they want from their parents. By playing up they are able to put "pressure". They can also call on the "authority" of one of their parents, claiming, for example, that one of them has already promised to buy the item. They can even claim that grandpa will buy it; in this case forming a "coalition" with another family member. The wish to have a certain toy can even bring them to promise good behavior or to perform small tasks in exchange. Sometimes these services are performed before the request is made, hoping to obtain "benevolence". They may even play the card of "seduction". It can be difficult to resist a well presented request, accompanied perhaps by a drawing that goes straight to a parent's heart. There are also "logical" argumentations or argumentations

which engage directly parents in the decision of purchase. The answers given by parents to the requests made by their children, can strengthen or weaken these behaviors. Parents' replies to such requests and the educational models about media fruition, make up the total of mediation variables through which the rational influence of educators on children's socialization to consumption is performed. Peer group socialization is an essential element. It is part of the informal and horizontal models of socialization. We can add, taking the definition from Dotson and Hyatt (2005), that it is "socially irrational", because it appeals to emotional aspects in contrast with the rational ones offered by the family and other educators. In particular, Dotson and Hyatt (2005) claim that the main factors of influence on the socialization of consumption should be identified, in addition to the socialization agencies (television, family, peer groups) and the individual and social aspects just described, in consumption behavior styles and in the brand. Children of the 21st century spend much more time in commercial contexts and they are surrounded by advertising messages not necessarily to be re-conducted to traditional television ads. Nor can we ignore the influence exercised by the brand itself, because its solid presence on the market through an extreme product diversification, brings to a stronger awareness and preference among precocious young children. Publicity is a distorting mirror (Pollay: 2004) which reflects and modifies social culture. Because of the need to communicate quickly, it has produced a high level of standardization in the ways of expressing oneself, in the situations and attitudes which have ended up producing what Goffman (1979) has defined as hyper-ritualization. It is without doubt a social reality construction tool (Giaccardi: 1995) capable of weakening, strengthening and transforming all the cultural objects it uses. The definition of cultural objects used in this paper recalls Griswold's lesson (1994), who claims that they are a shared meaning incorporated in a form. In other words, it is a significant, hearable, visible and tangible expression. A cultural object tells a story, the story of a product, of a genre, of a transformation from the way the object itself is created. The capability of human beings to generate cultural forms is implicit in the definition of culture given by Geertz (1977). He stresses how culture is meaning incorporated in symbols through which humans communicate and transmit habits and knowledge. Even though cultural objects are created by men, when they penetrate the circuit of human discourse, they become part of culture. It is in that moment that they are transformed in cultural objects (Griswold: 1994). For this reason all cultural objects have to have an audience that can receive, listen, read, understand, think and live them. It is not a passive audience, but – as Griswold highlights (1997) – a cultural recipient, that is an active producer of meanings. Both the cultural objects and the people

who receive them do not operate in a vacuum because they are anchored to a defined context: The social world. Linn in *Consuming Kids: The Hostile Takeover of Childhood* (2005), referring to an experience at a conference she participated to, suggests to reflect on the concept of “undeclared child”. This idea came to her during an training project with the aim of creating an ad for a little girl’s shampoo, whose claim was «“What”...to change!». The main idea is that the product’s target and the ad’s object refer to a period between childhood and adolescence. Hence, it will focus on products destined to teenagers, in which “older” models are presented in ads with more provocative tones. The mantra behind the planning of the ad and which is often repeated during the congress is that children in the marketing world are neither children nor teenagers. As a consequence, they need their own products and a specific advertising language.

## **5. An analysis of communication health for childhood**

An advertising communication campaign encapsulates phases, objectives and tools necessary to develop and propose to target a theme of social character.

The communication of good issues borrows from the commercial the established forms of the latter, one printed and the audiovisual spot. Therefore, there are the classic elements of communication: issuer, message, channel, receiver, feedback. Forms of advertising have their own internal organization of the messages. Posters and newspaper ads are standard size and generally maintain the established organization in commercial ads, the main elements are: headline, subheadline, body copy, packshot, visual, logo, trademark, pay off. These elements are arranged, then, in the manifest space or page according to their visual organization. Together with the layout elements just mentioned in a printed message must be considered also the format elements and vocabulary. The format is the deep part of the message, it is a structural-narrative model that you choose as the setting and represent the message.

The goal of the work proposed here is the analysis of the communication strategy adopted in the two different campaigns, in order to:

- identify the construction and mechanism of the advertisement,
- the effectiveness of the language used,
- the targeting and positioning techniques.

### **5.1 Stairs. Music for your health**

“Stairs. Music for your health” is an information campaign promoted by the Emilia Romagna region<sup>6</sup> in 2013, has cost 40 thousand euro. The campaign

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<sup>6</sup> See the website: <http://salute.regione.emilia-romagna.it/news/regione/le-scale.-musica-per-la-tua-salute>

“The stairs. Music for your health” is part of the “promotion of physical activity project”, contained in the Regional Prevention Plan. The project’s overall objective the strengthening of interventions aimed at people of all ages (children, adults, elderly), and in different settings (school, leisure, meeting places, health services). Reached, before its official launch, some of his purposes as it has contributed substantially to strengthening networks and alliances with: Municipalities and Provinces, fundamental to prevention interventions.

It has been activated, from the very beginning of the design, a regional table of overall coordination of the campaign, which was attended by representatives of municipalities, provinces and Region (Department for health policies). Provincial tables were also attended by representatives of the health authorities for physical activity, the latter was entrusted with the local coordination.

The printed poster presents a pentagram with hearts instead of the notes, and large and small people who climb to illustrate how the scales are “music” for health; this illustration has been entrusted and built by Ro Marcenaro<sup>7</sup>. The illustration is located above the slogan “The stairs. Music for your health “and this concept has been utilized both for the totems, and for posters, leaflets, made by the Region in collaboration with ANCI and UPI (associations of Municipalities and Provinces). The goal is to encourage the population to climb stairs, exercise muscle strengthening recommended by the World Health to maintain a good state of health.

The information campaign invites “to climb 90 steps a day, even doing some ramp at a time”, which prevention activities: numerous studies published in the international literature, in fact, have demonstrated the effectiveness of physical activity is enhancement (as, indeed , climbing stairs) and aerobic (such as walking for at least 30 minutes per day) for the prevention of many cardiovascular and metabolic diseases. Physical activity is in fact effective in the prevention and treatment of many diseases such as heart failure, obesity and diabetes, certain cancers, depression, and to counter the cognitive deficits of the older person.

In all printed media used for the communication campaign the benefits of this simple activity are succinctly explained, it must become a healthy daily habit.

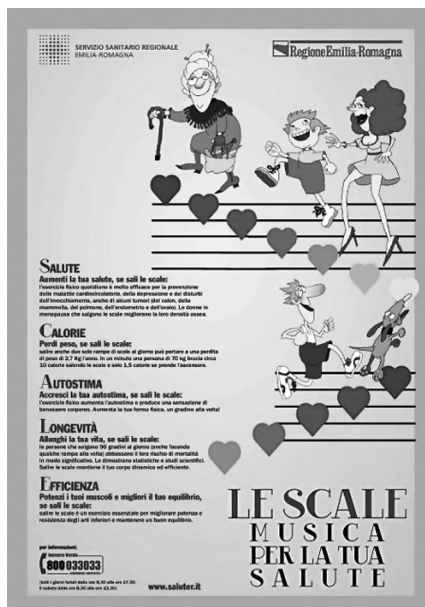
The word “stairs” contained in the headline synthesizes and presents in a funny way the objectives of the campaign, in fact: “s” stands for health (increases your health, if you go up the stairs); “C” for calories (you lose weight if you go up the stairs); “A” to self-esteem (Make your self-esteem, if you go

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<sup>7</sup> Ro Marcenaro is counted among the pioneers of the animated advertising board. See the website: <http://www.flashfumetto.it/artisti/professionisti/professionista/37/>

up the stairs); “L” for longevity (lengthen your life, if you go up the stairs); “And” as efficiency (powers your muscles and improve your balance, if you go up the stairs).

The colors are green and red. The format is a symbolic format, in which the figures are anthropomorphized and remember the cartoon characters. A very smart choice when you consider the main target: the kids.



The poster features a reading “Z”, following the natural inclination of the eyes to read from right to left, not requiring excessive effort of understanding. In the left corner, there is a toll free number to contact in case you want to receive more information.

Fig. 3 – Poster of Stairs. Music for your health

## 5.2 Health pills. Free evidence of movement

The Obesity Day<sup>8</sup> is a national day of awareness against obesity organized, annually, on October 10 by the ADI (*Italian Association of Dietetics and Clinical Nutrition*) in order to direct and orient the attention properly mass media, public opinion and also of those working in health care, to a vision Healthy, rather

<sup>8</sup> See the website: <http://www.pilloledisalute.com/>



than just aesthetics, obesity and overweight. The purpose of Obesity Day are: raise public awareness against Obesity; to publicize the activities of Dietetics Services inside and outside the health structure they belong; communicate a strong message on the role of services to the media, public opinion and management of Health companies.

The meeting is attended by two experts of ASL Lecco (Lombardy) – *Food Hygiene and Nutrition Service* (SIAN). Experts SIAN for more than 10 years participating of Obesity National Day with local initiatives and activities, in recent years, have been geared to emphasize the symbiosis between nutrition and physical activity in the fight against overweight and obesity.

The poster is divided into two areas, as if to be a book or a notebook. On the first page we find information about the obesity day. The main picture shows a boy in the first thin plane, which leaves behind his shadow obese. This is what happens when you start walking, to get moving, they leave behind the extra pounds. The second page is more descriptive and dedicated to the activity of walking. It seems to be cured by the Nordic Walking Spin, a group that deals with walks. In both pages the format chosen is symbolic, in fact we have the use of colors and images that take us to the world of comics. This choice can be explained considering that the primary targets are the guys. It is also a balance, because the poster is full of text. The images and colors, mostly pastel, have therefore the objective to attract the attention of kids.



Fig. 4 – Poster of Obesity day

## 6. Evidences and suggests

These two advertising campaigns manage to move the kids?

Let us analyze some elements.

Regards to format, both use a symbolic format that makes use of anthropomorphized figures. The colors are soft and the posters are full of text.

Although the drawings and the colors are turning to childhood it is evident how the messages is directed more to the secondary target: the parents, rather to the core target: the kids.

In fact, the primary goal is to make movement to children, but this is not possible if you do not sensitize adults to the problem. Awareness-raising is the goal we seek to achieve public actors. The public actors to her in spokesman for a social problem: the childhood overweight and communicates using soft tones, as befits it.

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**Khrystovaya Tetyana Yevgenivna**

*Doctor of Biological Sciences, Professor, professor of the department of theory and methodology of physical education and sports sciences, Melitopol State Pedagogical University named after Bohdan Khmelnytsky (Melitopol, Ukraine)*

## STATUS OF STUDENTS HEALTH: PROBLEMS AND THEIR SOLUTIONS

The health level of young people studying at different educational institutions under the educational process conditions in Ukraine, Russia, Belarus' has been analyzed. General tendencies of health state of students of the northwest to the Azov Sea regions have been systematized and their levels are studied. It has been found out that influence of unfavorable social-hygienic factors during the education period results in negative tendencies in students' health of different countries. Core factors of noninfectious diseases rate are over-nutrition, low physical activity, neuro-emotional stress, bad habits. The health status of students of the north-western Azov regions deteriorates. In particular there are up to 45% (of total number of cases) pathologies of the cardiovascular system, up to 26% – musculoskeletal system disorder. The increase of the nation health requires modern approach based on modern health paradigm. It implies design and implementation of state integrated public rehabilitation programs providing creation of conditions for leading a healthy lifestyle. The comprehensive rehabilitation program is proposed. It includes such components as units of diagnostic and organizational measures, informational and preventive measures, treatment and correctional activities, effectiveness evaluation of the taken actions. The program implementation will make it possible to improve the students health level, form firm healthy lifestyle motivation.

**Key words:** *health, students, rehabilitation program.*

**Problem statement, analysis of last publications and experiments.** The young generation health is one of today's global issues. It is integral to the human being matter, comes into existence together with a human being and modifies

according to human culture motion [18]. Health is a state of complete physical, mental and social well-being, but not merely the absence of disease or infirmity. This definition is given in the Preamble to the Constitution of the World Health Organization. One of the most important indicators of health status is the level of human body major adaptive systems functional development [3]. Health is a process of preservation and development of physiological, biological and mental functions of optimal labor and social activity within maximum duration of active creative life [5, 21].

The maximum level of human health is the goal achievement of which should be provided to each member of the society by the modern state. However, it is not a secret that the modern system of health protection and medical science are mostly aimed at the design of the newest treatment technologies [15]. But the number of sick people doesn't decrease; on the contrary, the epidemic of chronic non-communicable diseases grows in the world moreover among the population of the most active age. These diseases are major causes of death. This situation is also observed in Ukraine and is a threat to the national security [1]. It is the youth medico-social status that will determine the quality of the labor, economic, reproductive and defense potential of the country in future.

Today's formed notions about health person closely connected with harmonious overall developed personality. Healthy in all attitudes person can be named such as able to react adequately and to adapt to constantly changing conditions of ecological, biological and social environment; is able to self-improvement morally, to support highly personality capacity.

Ideas about health as the integrated system fulfils the main function of supporting vital and human life in the society generally can be used advisably on the present stage of research of health human problem. In this connection if it is the level of integrated health, the high level is characterized by functional balance of the organism with environment in the presence of condition of the physical, mental and social comfort.

Generalized analysis and systematization of scientific literature prove that the modern information paradigm of personal health of a healthy human is presented as the union of its components: physical, mental and social [5].

Health of a healthy human as informational problem consists, as minimum of three modules [3]:

- Module of informational knowledge field of basic subject spheres.
- Module of information technology research base.
- Module of information and organizational management tools.

The Ukrainian youth health is characterized with the high incidence morbidity and prevalence of disease, disability and death. Morbidity of 17-18

years old students in the period from 2009 to 2011 increased by 1,6 times and reached 8521,4 cases per 10000 population. Prevalence of disease in this very period grew by 1,8 times that makes 14900 for every 10000 young people [4].

The researchers note that study load increased, existing forms of physical education either are not applied or used inefficiently, there is widespread curtailment of the preventive direction due to lack of funding [9].

Various aspects of health of the students of different educational institutions have been subject of researchers' scrutiny [12, 14, 19]. Nevertheless nowadays there is a very small amount of comparative and generalizing works on the health status and self-preservational behavior of students of different countries. Investigation of the health status of students of the northwest to the Azov Sea regions hasn't been carried out.

These statements explain the relevance of the research topic that is related to the need of the necessity of young people health improvement in Ukraine. That is of great theoretical and practical importance.

The work is carried out according to the Melitopol State Pedagogical University named after Bohdan Khmelnytsky research work plan, the theme is: "Modern youth health-preserving technologies in an educational establishment by means of physical education and sports".

**Research objective** is to analyze the level of health status of youth in different educational institutions of Ukraine, Russia, Belarus.

The following tasks were solved:

to study literature and summarize data on students of higher education establishments of Ukraine, Russia and Belarus morbidity;

to study levels and systematize general tendencies of health status of students of the northwest to the Azov Sea regions;

to give scientific substantiation of comprehensive rehabilitation programme.

**Methods of investigation.** Theoretic-methodological basis comprises comprehensive use of scientific principles, systematic approach that caused the choice of research methods: general scientific (analysis, synthesis, classification, generalization of scientific and methodical literature); interdisciplinary (analysis of medical records to determine diseases structure (class); empirical: survey (questionnaire «Self-Health»); methods of mathematical statistics. Scientific and special methods were used for solutions of scientific research (table 1).

40 first – year and second – year students of Natural – Geographical Department of Melitopol State Pedagogical University named by Bohdan Khmelnytsky took part in forming experiment. Two homogenous groups of twenty students in every one were formed, an average age amounted  $18,57 \pm 0,59$  years. Students of the control group (CG) studied according

to general program “Physical Education” for students of Ukrainian higher educational establishments of the III and IV levels of accreditation. The training methods of girls of Experimental Group (EG) included using of the comprehensive rehabilitation program; its peculiarity was the differentiation of physical workload according to functional characteristic of students’ organisms in process of physical education by means of aerobics. This program was aimed to develop girls’ strength endurance and flexibility.

*Table 1*

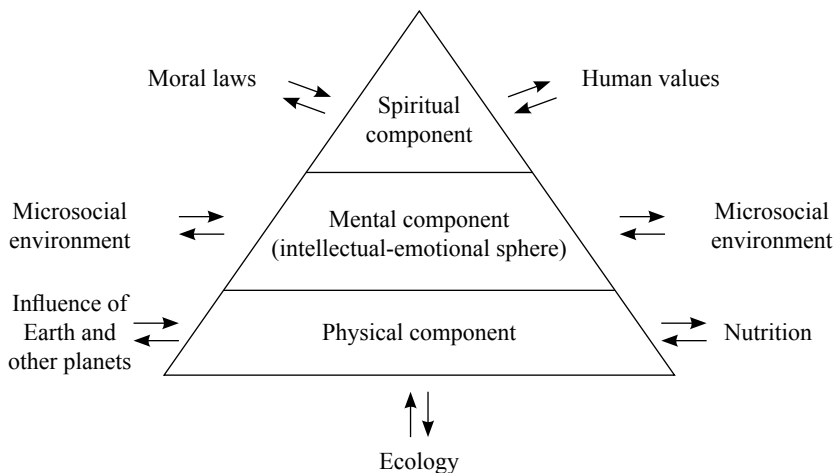
**Stages and methods of Research**

<b>Stages of research</b>	<b>Methods of research</b>	<b>Resources of information</b>
Study of morbidity and complex research of condition of students’ health.	Proportional typological selection. Copying of data from initial medical documents. Comparative analysis.	Medical cards of ambulance patients.
Social hygienic characteristic of ways and conditions of students’ life.	Questionnaire, methods of mathematical processing with using statistical programs.	Special devising questionnaires.
Study of students’ behavior according to preservation and strengthening of health, the level of youth health.	Questionnaire, questioning, methods of mathematical statistics.	Questionnaire “Self – appraisal of health”, estimation of the level of students’ physical health according to G.L. Apanasenko’s method.
Testing of the comprehensive rehabilitation program.	Experiment, dynamic observation, testing of the level of students’ physical readiness, assessment of functional condition of the organism.	Cards of dynamic observation, results of testing of the level of the students’ physical readiness and Assessment of functional condition of the organism.

**Basic material exposition.** Based on the modern health paradigm, we can say that health is a holistic multi-dimensional dynamical system having a definite structure. Health of the nation shows the level of life quality, determined by many parameters: physical, social, psychological and emotional, development of physical culture and sports. (picture 1).



Recent year's scientific publications analysis clearly shows that the problem of youth health is in the field of view of many scientists. For example, Russian researchers [2] point out that the prevalence of diseases of secondary specialized educational institutions students aged 15-21 makes 1445,2‰ according to consulting doctors level in 2010. In the fourth year, compared to the first, there is a veracious increase in doctor consulting level about diseases of the circulatory system by 2,4 times, the nervous system – 2,0 times, diseases of the digestive system – 1,8 times, the ear and mastoid process – 1, 5. Studying the college student's cardiovascular system the authors [10, 17] found out that during the three years of study the adolescents aged 15-17 show a tendency to tachycardia, development of hypotensive reactions, a decrease in muscle performance both at rest and during exercise. This is explained by the lack of material provision, low level of knowledge and skills in organizing their life, alternation of work and rest, rational organization of the daily routine and diet.



Picture 1. The structural model of human health.

Similar tendencies in health and disease are also observed among students of Belarus [7, 12]. Despite the high level of overall life quality index of the main components (social and emotional functioning, life satisfaction, health) about 30% of Belarus high educational institutions students are in the dispensary register. Such diseases as chronic gastritis, asthma, duodenal ulcer dominate. The study of the morbidity incidence of the students of the Belarusian State Medical University has shown that the first place in the structure of morbidity

take diseases of the respiratory system (33,4%), second – diseases of the nervous system and sensory organs (27,4%), the third –of the genitourinary system (10,3%). The share of diseases of the digestive, musculoskeletal systems and connective tissue makes for approximately 5,0 % per each.

It was found out [3, 6] that among university students in Ukraine the main factors contributing to the development of cardiovascular disease are over-nutrition, low physical activity, neuro-emotional stress, bad habits.

The study of the morbidity dynamics of full-time students of Melitopol State Pedagogical University named after Bohdan Khmelnytsky (MSPU) for the last 6 years has shown that the number of young people studying PE in the main group and allowed not to attend the lessons due to medical reasons grows steadily: 2009 – 17,4 %, 2010 – 22,0 %, 2011 – 22,9 %, 2012 – 31,1 %; 2013 – 34,0 %; 2014 – 35,9 %. This increment occurs mainly due to the younger students.

The results of the study allow to state that the prevalence of diseases among MSPU students during 2009–2014 was 585,9%. The study of morbidity patterns depending on the year of study has shown that the major part of diseases among freshmen is constituted by respiratory diseases, the second place is taken violations of the musculoskeletal system, followed by diseases of the digestive and nervous systems. Among the fifth-year students, on the contrary to first-year students, the first place is obtained by cardiovascular system diseases, the second – by violations of the musculoskeletal system, followed by excretory system diseases.

Generalized analysis of the nature of diseases among MSPU students for the last 6 years has shown that the first place is taken by the cardiovascular system pathologies: from 35 to 45 % (of the total number of cases). They are followed by changes in the musculoskeletal system (violation of posture, scoliosis, flat foot) which make 20–26 %. Almost at the same level over the years are excretory system (8–12 %), eyes (6-10 %) diseases. Incidence of other diseases fluctuates between 5–15 %. Morbidity incidence rises in the course of study process, and in the fourth year it is 1,4 times higher than in the first one.

The data obtained as a result of the study also indicate to the existence of negative dynamics in the health status of students of Melitopol State Pedagogical University from the first to the last year of study: 32,2 % of the first year and 22,6 % of the fifth year students are considered to be healthy. And if in the first year of study about one third of student suffer from chronic diseases, in the fifth year – more than one half. According to the MSPU students questionnaire their health self-assessment depends on the year of study. 56,5 % of the first-year students evaluated their health as good. Unlike junior students

senior ones made more negative assessment: 38,0 % of respondents evaluated their health as bad, 5,9 % – as good.

Irrational daily routine, big study load, examination session stress along with such factors as poor nutrition, lack of physical activity, unhealthy habits are pointed out to be the main causes of students' bad health. Their nutrition is not considered to be rational and balanced by 51,8 % of the first year students and by 68,3 % of the fifth year students of MSPU in spite of the fact that lack of money was mentioned as a main obstacle of regular nutrition only by the quarter of the respondents.

The main constituents of university students recreation in their spare time are characterized by a predominance of passive forms, only 12,5 % of young people do sports. However, 72,5 % of students noted that almost have no free time, and 88,2 % are not satisfied with the way of its spending. It should be recognized that students almost equally attributed their dissatisfaction as to the lack of money (40,3 %), as to their own laziness and lack of organization (33,5 %).

The major part of students (74,9 %) do sports only at PE classes. Among obstacles for more frequent physical exercise 77,6 % of recipients indicated lack of free time, 18,4 % – laziness and lack of organization. In the study of students physical activity it was found out that doing exercises on a daily basis is practiced by 9,5 % of the first year students and by 7,5 % of the fifth year students.

The most important feature characterizing attitude to health is having bad habits. The study of involvement into smoking has revealed that over 24,5 % of students smoke. Analysis of the smoking motives makes it possible to make a conclusion about significant contribution of psychological factors in the formation of bad habits. The majority of respondents are aware of the hazards of smoking to health (74, 8%). Approximately 4/5 of all respondents (from 75,5 % up to 82,0 %) are going to quit smoking in future. Among the reasons of readiness to quit smoking the following were called: «health problems», «the decision to become a parent», etc. Statistically significant differences in the prevalence of smoking in the years of study were identified: the proportion of non-smokers increases among senior students. The percentage of persons who had never tried smoking is 19,2 %.

High frequency of alcoholic beverages consumption by students has been registered. Alcoholic beverages are consumed by 87,1 % of the first year students and by 86,7 % of the fifth-year students. In the structure of types of beverages consumed by young people beer ranks first (about half of the students indicated to the use of it). It is followed by dry wines, champagne, alcoholic cocktails (they are consumed by 47,1 % of students), about a third of all respondents prefer hard liquors – vodka, cognac, fortified wines.

Analysis of the study results showed that in the contemporary socio-economic conditions students' health state is one of the most acute medical and social problems. Negative trends in health status are caused mainly by the behavior not contributing to its preservation and strengthening. The authors state that only 4,5 % of Ukrainian students are in the zone of safe health level. Average Ukrainian student is 5-7 years older of his/her biological age – an aging of Ukrainians phenomenon [4].

Scientific literature analysis shows that at the beginning of the XXI century the main threat to health constitute chronic no communicable diseases, which are major causes of adult population disability and mortality in Ukraine [1].

A superb way out was developed, theoretically proved and experimentally tested by the group of scientists [3, 8, 11], who were the first to show the functional dependence of physical activity on the health of the population. This vicious cycle can be easily broken by doing physical exercises based on age, sex, fitness, physical development and health status.

Application of the holistic approach to the problem of students health preservation helped us to work out a comprehensive rehabilitation program, that embraced the following components: the unit of organizational and diagnostic procedures (clinical, laboratory, functional diagnostics of diseases of different nosological forms), the unit of information and preventive measures (development and implementation of system informational support of teachers and students on healthy lifestyles and safe behavior), unit of treatment and rehabilitative activities (active means of rehabilitation – physiotherapy, hydrokinesotherapy, occupational therapy, work and rest, tempering, food, sleep hygiene), the unit of evaluation of the measures effectiveness. This program will promote improvement of the students' health and formation of the healthy lifestyle stable motivation.

Analyzing the results of division of students from the experimental and the control groups according to the level of physical health, the next facts were ascertained. The most numbers of students from the EG had the level of physical health – “below average”. The same situation was observed with girls from the CG.

General assessment of the health level of girls from the EG was matched as “low” level, and the CG – “below average”.

Students from both groups according to the body mass index were not identified reliable differences ( $p < 0,05$ ). This index among representatives from the EG amounted  $375,65 \pm 0,30$  conventional units (0 points), girls CG  $377,31 \pm 0,33$  conventional units (0 points).

Rates of life index among girls were not differed reliably ( $p < 0,05$ ): among girls from the EG –  $51,02 \pm 1,43$  conventional units (4 points); at students from

the CG –  $52,48 \pm 1,00$  conventional units (4 points). The health level to the ratio of the vital capacity of the lungs to body mass among students from both groups ( $p < 0,05$ ) was matched as the assessment “above average”.

Indicators of power index at students from the EG were ranged on the level  $40,02 \pm 1,74$  conventional units (0 points); at girls from the CG –  $52,05 \pm 1,54$  conventional units (2 points); ( $p < 0,05$ ). The ratio of dynamometry of the hand to body mass among girls from the EG were diagnosed the “low” level of health, and among girls from the CG – “below average”.

Robinson’s index at students from the EG was equaled to  $96,32 \pm 2,04$  conventional units (0 points) in average, and at girls from the CG –  $98,15 \pm 2,01$  conventional units (0 points); ( $p < 0,05$ ) The level of health “below average” was defined according to the ratio of heart rate and systolic blood pressure, among girls of both research groups. The time for heart rate recovery at girls from the EG was amounted  $140,49 \pm 6,66$  seconds (1 point); and at the CG –  $146,74 \pm 6,92$  seconds (1 point). Among girls from both groups were diagnosed the level of physical health “below average” according to the speed of recovery of normal cardiovascular system functioning after minor physical workload.

General assessment of physical girls’ health from the CG was amounted as  $3,28 \pm 0,19$  points (the “low” level), the EG –  $4,12 \pm 0,21$  points (the level – “below average”).

Reliable differences between rates of students of both groups were not noticed ( $p > 0,05$ ) in test results which were got in the beginning of academic year. The average result in hold the squat position at girls of the CG was amounted –  $17,92 \pm 2,25$  seconds; the EG –  $16,93 \pm 2,29$  seconds. Low results of students from both groups were recorded in flexion – extension of hands from push – up. This rate at girls from the CG was amounted  $5,14 \pm 0,94$  times, the EG –  $4,80 \pm 1,31$  times. Clients retention of the push-up position on forearms from the EG exceeded the girls’ result from the CG ( $38,67 \pm 4,62$  and  $36,05 \pm 5,05$  seconds accordingly). Results of twisting the torso didn’t have reliable differences between students’ indicators of both groups. The best result turned out girls’ results of the EG –  $16,75 \pm 2,95$  times and in the CG this parameter was equaled  $16,47 \pm 1,55$  times. The low results were fixed in hold the legs in position angle. Girls’ result of the EG was lower ( $5,93 \pm 0,93$  seconds), than the result in the CG ( $16,22 \pm 0,65$  seconds) The best result in test “Tilt toward, standing with the back to the wall” belonged to the girls from the CG and totaled  $16,28 \pm 1,77$  centimeters, and girls’ result of the EG was  $15,97 \pm 1,73$  centimeters. Girls’ result from both research groups were no different in tests “Wikrut ago with grip tape” and “Bending forward from a standing position”.

Statistic processing of data according to Student's t-criterion showed the high level of the significance of differences between both groups after training according to the proposed rehabilitation program for girls of the EG (table 2). As the result of experiment we were fixed, that at the tend of the study the health level among girls of the experimental group was defined from "low" to "above average". Among the representatives of this group revealed 10 % students with "low" general level of physical health, 15 % students with "below average" level; 50 % – with "average" and 25 % – "above average", among girls of the control group these indicators were equaled accordingly – 20 %, 25 %, 40 % and 15 %.

Generally after the experiment the number of students of the experimental group with the level of health "low" and "below" decreased to 25 %, and with "average" and "above average" – increased to 75 %. In the control group changes were less severe: 45 and 55 % accordingly.

Table 2

**Dynamics of the numbers of students (%)  
with different levels of physical health**

The levels of physical health	low		below average		average		above average	
	before	after	before	after	before	after	before	after
Stages of the experiment	the introduction of the experimental factors							
The control group	30±0,2	20±0,1	50±0,4	25±0,1	20±0,1	40±0,2	0	15±0,1
The experimental group	35±0,2	10±0,1	45±0,3	15±0,1	20±0,2	50±0,3	0	25±0,2

As the result of systematic aerobics practice the levels of indicators of the girls of the experimental group increased; the body mass index – from "average" to "above average"; Robinson's index – from "below average" to "average"; power index – from "low" to "average", recovery time of heart rate after 20 squats – from "below average" to "average". In the end of research the significant increase of indexes of students from the EG was observed in all tests. The relative increase of parameters of girls of the control group amounted on average 29,3 %, and from the experimental group – 67,1 %.

Thus, the systemic approach, based on the modern paradigm of health is needed for increasing the health level of the nation. It assumes to develop, to adapt and to implement the comprehensive rehabilitation programs to be

provided creation of conditions for realizing healthy way: fitness classes, malnutrition, hardening, giving up unhealthy habits, environmental protection from pollutions.

Preventive role in this direction plays screening of the population with the identification of “at risk” groups among healthy people, formation and implementation of healthy lifestyle, improving of the environment, working and living conditions of people. However, many of these activities require significant expenditures, expensive equipment, personnel special training. At the same time, sufficient physical activity aimed at combating physical inactivity and hyperkinesias, the widespread introduction of physical culture in the everyday life of the population, as it is shown by numerous medical and biological research papers [13, 16, 20], promotes human health, improves resistance of the body to a variety of environmental factors (temperature, pressure, air pollution and water, infections, etc.), as well as health conservation and restoration, prevents the development of early fatigue and overwork, promotes correction of psycho-emotional overload during professional activity.

### **Conclusions.**

1. Exposure to adverse social and hygiene factors during the study leads to negative tendencies in health of students from different countries. The main factors of students' morbidity with noninfectious diseases are over-nutrition, low physical activity, neuro-emotional overload, bad habits.

2. The health status of youth northwest of Azov regions deteriorates. In particular, up to 45 % (of the total number of diseases) constitutes pathologies of the cardiovascular system, up to 26 % – violation of the musculoskeletal system. By the end of training in high school, every second student obtains a chronic disease.

3. The efficiency of the proposed rehabilitation technology of using individual physical activities according to functional characteristics of the organism and the level indicators of students' physical fitness in the process of physical education by means of aerobics was proved experimentally. In the final part of the experiment the significant increase of the level of the level of the functional indicators of girls' physical health and their physical fitness ( $p < 0,05$ ) was fixed. In the end of the research the significant increase of the indicators among the students' from the experimental group was observed in all the tests. The relative increase of parameters among girls of the control group equaled in average 29,3 %, but of the experimental group – 67,1 %.

4. The nation's health improvement requires a modern approach based on the modern paradigm of health. It presupposes the development, adoption and

implementation of comprehensive state rehabilitation programs that provide conditions for leading the healthy lifestyle: doing fitness, good nutrition, hardening, avoiding of bad habits, nature protection from pollution.

**Further research prospective.** It is planned to develop computer programs for determining the health and physical development levels of youth northwest of Azov regions and to test and implement the comprehensive program of physical rehabilitation on the basis of a systematic approach.

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**Romanchuk Oleksandr Petrovich**

*Doctor of Medical Sciences, Professor, Head's assistant of the Medical Institute of International Humanitarian University (Odessa, Ukraine)*



**Pahleuanzade Alireza**

*Doctor of Medical Sciences, professor, Director of Research and Methodological Centre of International Humanitarian University (Odessa, Ukraine)*



**Dolgier Yevdokiia Volodimirivna**

*PhD in physical education and sport, Senior Lecture of the department of Health basics (Odessa, Ukraine)*

## THE IMPACT OF LONG-TERM AEROBIC EXERCISES ON PHYSICAL STATE OF MIDDLE-AGED WOMEN

***Abstract.***

***Aim:*** to study the influence of long-term aerobic exercises on physical state of middle-aged women.

***Materials and methods.*** The work presents the results of research of physical development and autonomic providing cardiac rhythm of 19 women, who were divided into two studied groups. The first study group consisted of 10 women who had experience of regular training (3 times a week) aerobic orientation from 3 to 5 years, the average age of this group of women was  $37,9 \pm 5,9$  years. The second study group consisted of 9 women with regular training

experience with aerobic orientation over 10 years, the average age of women –  $44,6 \pm 5,5$  years.

The estimation of physical development was conducted by means of the basic anthropometric measuring. The specific features autonomic heart providing were defined with using of the device – spiroarteriocardiography. According to data the measuring of sequences cardiac rhythm, systolic and diastolic blood pressure variability and data respiratory ventilation was conducted by Fourier's spectral analysis, which determines the capacity of regulatory influences on three frequency ranges: very-low-frequency (VLF,  $ms^2$ ), low-frequency (LF,  $ms^2$ ) and high-frequency (HF,  $ms^2$ ). Additionally there was a spectral method determined by data of sensitivity arterial baroreflex (SBR,  $ms/mmHg$ ) –  $\alpha$ -coefficient, what calculated in ranges high ( $SBR_{HF}$ ) and low ( $SBR_{LF}$ ) frequencies.

**Results.** The results of the analysis of women's physical state parameters shows more favorable influence of training aerobic orientation with the increase of experience on the component body structure. Research results of determination of heart rate variability and sensitivity arterial baroreflex of women demonstrate that increasing the term of training with aerobic orientation leads to changes which increased low-frequency (sympathicotonic), but decreased high-frequency (vagotonics) effect on cardiac rhythm.

**Key words:** *aerobic exercises, heart rate variability, physical state, middle-aged, women.*

## 1. Introduction

At the present time instead of the monotonous physical exercises new ways of physical activity which became a part of the man's image have come. Among many physical activities the expediency and efficiency of the use of aerobic orientation loading are proven. Currently, the most popular physical activity is fitness-aerobics training which has a stable positive motivation and a large number of trends [1,2]. Numerous studies convincingly testify that aerobic loading combined with a balanced diet and healthy lifestyle have a considerable influence on optimization of all functions of an organism: metabolic, homeostatic and behavioral. For woman's body the specific activities are characteristic, thus decisive role at all the above-mentioned levels aerobic possibilities and adaptation potential of organism play [3,4]. Cardiac rhythm (CR) is an integral adaptation criterion, in which genome and phenotypic information is encoded, it reflects the abilities of an organism and specifics of available influence of environmental factors on it [5,6].

## **2. Substantiation of research**

The study of the physical state of middle-aged women has a special interest to the gerontology for determining the role of regulatory mechanisms of the cardiovascular system acting while forming active longevity. At this age the changes in the functions of the organism take place, they create the foundation of the development of atherosclerosis, ischemic heart disease, and arterial hypertension, experiencing deterioration the respiratory function [7,8].

Recent studies make it possible to mark a positive impact of aerobic loads on the risk factors of diseases of the women cardiovascular system. So, the influence of 12 weeks combined course of training, which included dancing- and step-aerobics, strength exercises was studied by means of examining general cholesterol concentration, triglycerides, and lipoproteins of the high- and low-density and percentage of body fat. The study found a significant increase of lipoproteins of the high-density and reducing the percentage of fat in the women's body, but there was no significant effect on total level cholesterol, triglycerides and lipoproteins of the low-density. Thus, facilities of fitness-aerobics help to reduce the risk factors for diseases of the cardiovascular system, also the necessity of further research concerning optimal levels of intensity, duration and types of the combined aerobic training is found out for achieving the desirable effects [8]. It should be noted, that at this time there are differences in the results of some researches, that are connected with various facilities and methods used in modern aerobics, different criteria estimation, descriptions of the examined women and duration of the research [9].

In modern scientific researches we didn't find any publications which study the impact of long-term experience aerobic training on middle-aged women. Besides it was noted the absence of comparison in the dynamics of adaptive changes in the states of the cardiovascular system of this women group. In connection with the above-mentioned material and with the necessity of practical work there is a need to study heart rate variability (HRV) as an assessment criterion for regulatory changes in the organism middle-aged women with long-term regular training experience of aerobic orientation.

**3. Aim of research:** to study the influence of long-term aerobic exercises on physical state of middle-aged women.

## **4. Materials and methods of research**

The studies were conducted at the department of Theory and methodology of physical education, physical therapy and sports medicine of South Ukrainian National Pedagogical University n.a. K.D. Ushinsky.

The work presents the results of the examination of physical state and autonomic providing cardiac rhythm of 19 women, who had regular training of aerobic orientation in fitness club “Fit curves” (Odessa). They were divided into two study groups. The first study group ( $SG_1$ ) consisted of 10 women who had experience of regular training (3 times a week) of aerobic exercises from 3 to 5 years, the average age of this group of women was  $37,9 \pm 5,9$  years. The second study group ( $SG_2$ ) consisted of 9 women who had regular training experience of aerobic exercises over 10 years, the average age of women –  $44,6 \pm 5,5$  year old.

The estimation of physical state was conducted by means of the basic anthropometric measuring: lengths of the body (LB, cm) and the masses of body (MB, kg), body fat was determined by means of device OMRON (BF, %), body mass index (BMI,  $kg/m^2$ ) was calculated by correlation of masses of body (kg) to the lengths of the body ( $m^2$ ), vital capacity of lungs (VCL, ml) was determined by dry-air lung-tester. Research of hypoxia’s firmness of organism, were conducted by tests with a breath-holding on exhalation (Genchi, c) and inhalation (Shtange, c). Conducted measurements of heart rate (HR) and blood pressure were the basis for calculating of the Kerdoe’s vegetative index (KVI), adaptation potential of Baevsky (AP), coefficient of efficiency blood circulation (KEBC), level of physical state (LFS) of Pirogova and Skybinskaya’s index (SI). Study of aerobic capacity ( $VO_{2max}$ ) was conducted by system of estimation of somatic health level (SHL) of G.L. Apanasenko [13].

We defined the specific features autonomic heart providing, that was characterized on the basis of the analysis research HRV results. For this purpose it was used the special device – spiroarteriocardiorythmography (SACR), which in a simultaneous mode register defines the parameters of HR, systolic blood pressure (SBP) and diastolic blood pressure (DBP) for each heart reduction [10]. According to the data measuring sequences of cardiac rhythm (CR), systolic (SBP) and diastolic blood pressure (DBP) and data respiratory ventilation conducted Fourier’s spectral analysis, which determines the capacity of regulatory influences in different frequency ranges that are measured in the absolute values of power ( $ms^2$  – for CR,  $mmHg^2$  – for SBP and DBP,  $(l/min)^2$  – for spontaneous breathing). By the date of a lot modern authors very-low-frequency (VLF, 0-0,04 Hz) – characterizes activity of over-segmental structures on the CR, low-frequency (LF, 0,04-0,15 Hz) – activity in that range connecting with regulation of sympathetic branches of autonomic nervous system (ANS), high-frequency (HF, 0,15-0,4 Hz) – activity in that range connecting with regulation of parasympathetic branches of ANS, TP ( $ms^2$ ) – characterizes the total power of HRV and reflect of the general state of the ANS [10,11].

The study of women was conducted in the morning with an empty stomach in sitting position in one day after training. Duration of the registration was 2 minutes.

Additionally using the spectral method we determined the index of arterial baroreflex sensitivity (SBR, ms/mmHg) –  $\alpha$ -coefficient, what was calculated in high (SBR<sub>HF</sub>) and low (SBR<sub>LF</sub>) frequencies ranges [12,13].

$$SBR_{LF} = \sqrt{LF_{HRV}/LF_{SBPV}} \quad (1)$$

$$SBR_{HF} = \sqrt{HF_{HRV}/HF_{SBPV}} \quad (2)$$

Assessment of the received results was carried out with the help of STATISTICA program for Windows (version 10.0), Microsoft Excel 2012, MATLAB 2015a. The comparison of quantitative indices in studied groups was realized using non-parametric criterion of Mann-Whitney.

## 5. Results of researches

The results of the analysis of women's basic anthropometric parameters in the studied groups are presented in table 1, which shows, that the groups had great differences in the body masses (MB, kg) and body fat (BF, %), these indicators in SG<sub>2</sub> was lower. Substantially complement information about physical development of these groups of women indicators of measurement circumferences of the body, namely – the waist and thighs, which in SG<sub>2</sub> were less by decrease of fat on the lower limbs and trunk (waist). In this way, women with longer experience of regular aerobic exercises indicated significantly smaller contribution of fat in the structure of the component body.

*Table 1*

**Features of parameters physical development of women SG<sub>1</sub> and SG<sub>2</sub>**

Indicator	SG <sub>1</sub>	SG <sub>2</sub>
MB, kg	62,5 (54,0; 71,0)	55,0 (54,5; 62,0) *
LB, cm	163,0 (160,0; 165,0)	163,0 (162,0; 172,0)
Circumference of neck, cm	31,5 (30,0; 32,0)	32,0 (31,0; 33,0) *
Circumference of waist, cm	75,5 (70,0; 88,0)	73,0 (72,0; 75,0) *
Circumference of chest (pause), cm	86,0 (83,0; 91,0)	86,0 (84,0; 86,0)
Circumference of chest (inhalation), cm	91,0 (87,0; 93,0)	90,0 (87,0; 91,0)
Circumference of chest (exhalation), cm	84,5 (80,0; 88,0)	84,0 (82,0; 86,0)

Indicator	SG <sub>1</sub>	SG <sub>2</sub>
Chest's amplitude, cm	6,0 (5,5; 6,5)	6,0 (5,0; 7,0)
Circumference of thigh, cm	52,5 (49,0; 54,0)	51,0 (49,0; 52,0)*
Dynamometry (right hand), kg	23,5 (22,0; 24,0)	25,0 (24,0; 26,0)*
Dynamometry (left hand), kg	21,0 (20,0; 22,0)	20,0 (18,0; 22,0)
VCL, ml	3050,0 (2900,0; 3300,0)	3100,0 (3000,0; 3500,0)
BF, %	30,7 (27,0; 32,7)	23,6 (22,5; 28,2)*
BMI, kg/m <sup>2</sup>	23,7 (20,0; 26,8)	21,0 (20,8; 21,1)*
VCI, ml/kg	54,8 (40,3; 56,1)	50,0 (48,7; 57,7)
SI, %	36,9 (33,8; 40,7)	41,9 (37,3; 47,3)*

Note: \* – data probable differences,  $p < 0,05$

A similar trend was observed in indicators of carpal dynamometry, which in strength of right hand was significantly ( $p > 0,05$ ) greater in women SG<sub>2</sub>. That was confirmed by calculating the strength's index (SI), which in SG<sub>2</sub> significantly higher ( $p < 0,01$ ). Some attention, from the standpoint of the characteristics muscular component of the body structure and strength abilities studied groups of women, deserve indicators of neck's circumference that in women SG<sub>2</sub> significantly ( $p > 0,05$ ) higher too. This fact allows stating, more favorable influence of training aerobic orientation with the increase of experience on the component body structure.

Table 2 shows the characteristics of the basic routine parameters of activity cardiovascular and respiratory system, which showed more economic work of the first system at rest state, displayed a higher  $VO_{2max}$  (by the system of estimation of somatic health level (SHL)) [14], also the balanced state of autonomic regulation (by Kerdoe's vegetative index) in women of SG<sub>2</sub>. But it is necessary to keep in mind that women in both groups were mainly in a satisfactory adaptation state considering adaptation potential of Baevsky (AP). Data of calculation of Pirogova's LFS are complement information about physical state and witnessed about higher LFS of women SG<sub>2</sub>. Fully logical were reliable ( $p < 0,01$ ) differences in data KEBC, which in SG<sub>2</sub> was greater. To assess the tolerance of the organism to physical loading (as part of the physical state) we considered the speed of recovery of the cardiovascular system after standard exercise – 20 squats in 30 seconds (Martine's test). Table 2 shows, that in SG<sub>2</sub> time of restitution is significantly lower ( $p < 0,05$ ), confirming improved tolerance because of long-term regular aerobic exercises and it was quite expected.

Table 2

**Differences of data cardio-respiratory systems of women SG<sub>1</sub> and SG<sub>2</sub>**

<b>Indicator</b>	<b>SG<sub>1</sub></b>	<b>SG<sub>2</sub></b>
HR, min <sup>-1</sup>	79,4 (71,3; 89,2)	73,9 (72,6; 78,5)*
SBP, mmHg	110,0 (108,0; 120,0)	100,0 (98,0; 104,0)*
DBP, mmHg	70,0 (60,0; 80,0)	70,0 (66,0; 72,0)
Time of the restitution, s	105 (60; 120)	85 (60; 90)*
A sum of marks by system of estimation SHL	7 (6; 9)	11 (7; 13)**
KVI	0,06 (-0,33; 0,17)	-0,03 (-0,06; 0,03)*
Baevsky's AP	2,25 (1,96; 2,43)	2,14 (1,77; 2,32)
Pirogova's LFS	0,443 (0,356; 0,478)	0,526 (0,394; 0,673)*
KEBC	3120,0 (2640,0; 3600,0)	2100,0 (1980,0; 2160,0)**
SI	1820,4 (1208,3; 2497,2)	1589,7 (1454,5; 3091,7)
Shtange's test, s	40,5 (25,0; 57,0)	40,0 (32,0; 53,0)
Genche's test, s	25,0 (20,0; 40,0)	30,0 (24,0; 32,0)

Note: \* – data probable differences,  $p < 0,05$

The smallest difference between the groups SG<sub>1</sub> and SG<sub>2</sub> were in data of the functional state of the respiratory system. Recall, that we weren't registered reliable differences in data of VCL and VCI (table 1). Analogical results we got from the analysis of data hypoxia's firmness – Shtange and Genchi. The last found a reflection in absence of reliable differences between the calculation of data of SI, which between of the studied groups didn't differ and for the qualitative characteristic proved satisfactory and well state of cardio-respiratory system in both groups of women (table 2).

However, today evaluation of activity of regulatory influences on cardiovascular system uses greatly researches of HRV. According to its indicators it can be found not only activity and prevalence of individual units of ANS, but also to identify the main mechanism of influence on CR taking into account various components of power HRV – very-low-frequency, low-frequency and high-frequency. Table 3 presents differences in HRV indicators in the experimental groups of women. Judging by the data from table 3 possible difference in HRV parameters are observed only for high-frequency (HF) components of HRV power spectrum, which are in SG<sub>2</sub> significantly ( $p < 0,05$ ) lower. The latter is reflected in the possible ( $p < 0,05$ ) differences in the ratio



LF/HF, which is used to describe the prevalence of activity of sympathetic and parasympathetic parts of ANS. In this case, we can speak that women from SG<sub>2</sub> had a tendency to a slight predominance of sympathetic influences and women from SG<sub>1</sub> had predominance of parasympathetic 0,81 (0,36; 1,44) influences.

Table 3

**Differences of HRV indicators of women from the studied groups**

<b>Indicator</b>	<b>SG<sub>1</sub></b>	<b>SG<sub>2</sub></b>
TP, ms <sup>2</sup>	1775,6 (1036,8; 2601,0)	1267,4 (882,1; 1944,8)
VLF, ms <sup>2</sup>	307,2 (225,0; 384,2)	285,6 (282,2; 967,2)
LF, ms <sup>2</sup>	605,5 (228,0; 789,6)	237,2 (228,0; 681,2)
LFn, n.u.	43,2 (24,3; 57,5)	54,1 (41,3; 69,8)
HF, ms <sup>2</sup>	877,0 (453,7; 1714,0)	368,6 (94,1; 900,0) *
HFn, n.u.	55,7 (41,1; 72,7)	43,5 (27,7; 55,9) *
LF/HF	0,81 (0,36; 1,44)	1,21 (0,81; 2,56) *

Note: \* – data probable differences,  $p < 0,05$

As for the other components of the power spectrum HRV, it should be noted that possible differences are absent, but there is a certain tendency that proves reduction of general and all constituents of power spectrum HRV in SG<sub>2</sub>. The latter requires more careful analysis with taking into account age-old features of HRV in women.

With this aim the indicators of women in the studied groups were analyzed taking into account the results of population studies which had been done before [7]. Figure 1 presents limits of the 1st (25%) and 3rd (75%) quartiles indicators TP (ms<sup>2</sup>) of women aged 30, 45 to 58 years old in comparing to the data which were got from the women of the experimental groups (SG<sub>1</sub> and SG<sub>2</sub>), results of which are presented as limits of the 1st, 2nd (medians) and 3rd quartiles. It's necessary to recall, that the average age of SG<sub>1</sub> women was  $37,9 \pm 5,9$  years old and SG<sub>2</sub> women –  $44,6 \pm 5,5$  years old. First of all it is necessary to pay attention that in certain age ranges there is reducing of regulatory values of TP (ms<sup>2</sup>) that is characterized of decrease with age limits of the 1st and 3rd quartiles. Thus, value of the 1st and 3rd quartiles indicators TP (ms<sup>2</sup>) in experimental groups clearly fall into the relevant age limit. It means that, the tendency to reduction of this indicator marked earlier demonstrates its age-old character. Founded on it we can do supposition about positive influence of experience aerobic training under 5 years, in which women have the indicator of TP (ms<sup>2</sup>) similar to limits

30 year old women. At the same time, in women of SG<sub>2</sub> the values TP fully correspond their age. It doesn't allow speak about positive influence of training aerobic orientation on reserve possibilities regulation of cardiac rhythm in comparing to the population of this age women.

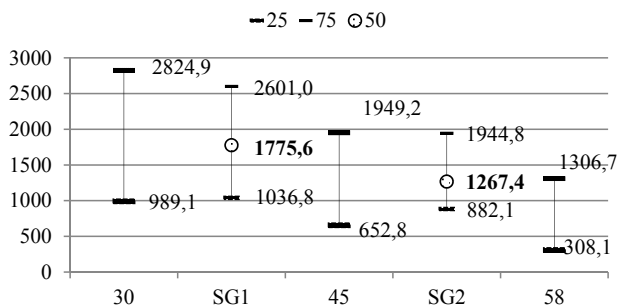


Fig. 1. Absolute values of limits of 1st (25%), 2nd (50%) and 3rd (75%) quartiles of indicator TP (ms<sup>2</sup>) in women of SG<sub>1</sub> and SG<sub>2</sub> compared with the values of 1st (25%) and 3rd (75%) quartiles of 30, 45 and 58 year old women.

Similarly, the total power spectrum HRV changes with age power in very-low (VLF, ms<sup>2</sup>) frequency range (fig. 2), the limits of quartiles of which diminish from 220,5–764,4 ms<sup>2</sup> at 30 year old age to 60,1–340,4 ms<sup>2</sup> at 58 year old age. At the same time age 45 year old the absolute values limits of quartiles occupy an intermediate place – 105,1–517,5 ms<sup>2</sup>. As shown in fig. 2 in women of SG<sub>1</sub>, values of VLF-component HRV are in rather narrow limits which get in the normative limits of all age-related groups of women. At the same time in women of SG<sub>2</sub> the range of changes of components at the 1st and 3rd quartiles is wide enough, and getting by median values in the limit of normative age-old values, at the half of women substantially increases. Taking into account physiological characteristics of women of this age, it should be noted, that in the SG<sub>2</sub> there were 4 women in menopause and they had high values of VLF-component. Perhaps, hormonal changes in a woman's body have influence on the increase of activity regulatory of over-segmental effects on the CR.

However, the limits quartiles of indicator VLF (ms<sup>2</sup>) women of SG<sub>1</sub> and SG<sub>2</sub> even taking into account age-old physiology features tendencies to the decline are not observed in women when there is the increase of training experience aerobic orientation. The last supposition requires certain confirmation with the use other methods of research.

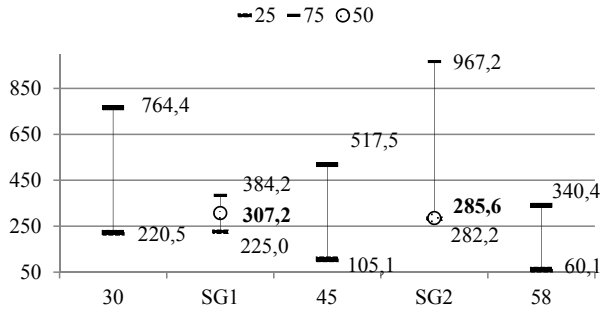


Fig. 2. Absolute values of limits 1st (25%), 2nd (50%) and 3rd (75%) quartiles indicator VLF ( $\text{ms}^2$ ) in women of SG<sub>1</sub> and SG<sub>2</sub> compared with the values of 1st (25%) and 3rd (75%) quartiles of 30, 45 and 58 year old women.

As shown in fig. 3 when women are getting old activity in low-frequency (LF,  $\text{ms}^2$ ) range of spectral power HRV diminishes. However, substantial reduction is marked at the age 58 year old. At the same time, in women in the age of 30 and 45 year old these differences are insignificant. But if to analyze the data of women with long-term training experience aerobic orientation (SG<sub>1</sub> and SG<sub>2</sub>), we can see, that activity in LF-range has the clearly expressed tendency to the decline when there is the increase of training experience comparing to the women of SG<sub>1</sub>. However, the results are not credible. Therefore, having regard to the physiological features of women of this age, we can assume, that training aerobic orientation although leads to the decrease in activity of the sympathetic part of the ANS, but it doesn't determine its influence to the CR, which can be related with hormonal alterations in the organisms of women.

Figure 4 shows the results of analysis of indicator HF ( $\text{ms}^2$ ), which is associated with the activity of the parasympathetic part of ANS. It also decreases with age like other components of the power spectrum HRV. The same dynamics is observed in experimental groups of women, who differ by age. Thus reduction of regulator influences in HF-range with the increase of training experience is reliable. At the same time, ranges of limits of quartiles indicator HF in SG<sub>1</sub> and SG<sub>2</sub> are significantly higher than these in population's age groups of women. It's possible to assert regarding absolute values HF, that in SG<sub>1</sub> they are significantly higher, than in 30, 45 and 58 year old women, but in SG<sub>2</sub> they have a tendency to the increase in comparing with the 45 year old women and don't differ significantly from women of 30 years old.

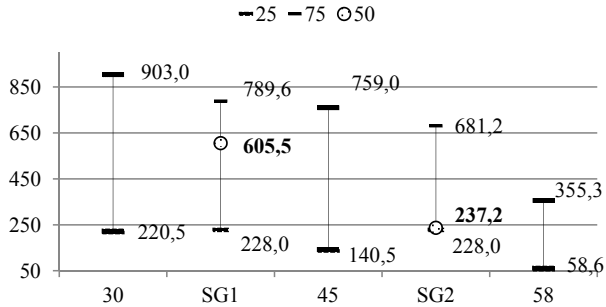


Fig. 3. Absolute values of limits of 1st (25%), 2nd (50%) and 3rd (75%) quartiles indicator LF ( $\text{ms}^2$ ) in women of SG<sub>1</sub> and SG<sub>2</sub> compared with the values of 1st (25%) and 3rd (75%) quartiles of 30, 45 and 58 year old women.

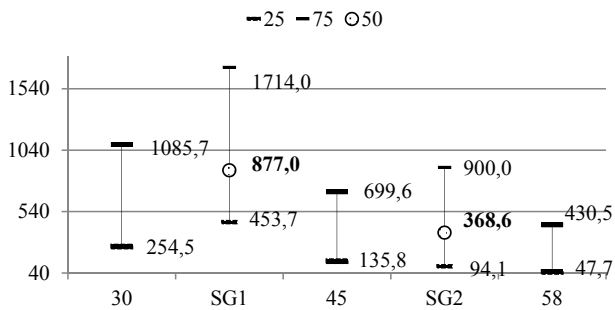


Fig. 4. Absolute values of limits of 1st (25%), 2nd (50%) and 3rd (75%) quartiles indicator HF ( $\text{ms}^2$ ) in women of SG<sub>1</sub> and SG<sub>2</sub> compared with the values of 1st (25%) and 3rd (75%) quartiles of 30, 45 and 58 year old women.

We should keep in mind that, estimation of autonomic providing of CR can be carried out both by HRV and SBP and by indicator of SBR which defines a mechanism of maintaining homeostasis in the vascular system and is the indicator of autonomous control [3].

Figures 5 and 6, shows the results of determination of  $\text{SBR}_{\text{HF}}$  and low  $\text{SBR}_{\text{LF}}$  in women of SG<sub>1</sub> and SG<sub>2</sub> in comparing with the population's data, which show, that with age autonomous control over the heart activity is reduced. Thus more clearly it is determined by indicator of  $\text{SBR}_{\text{LF}}$  (fig. 5). Less expressed, but clearly directed, this tendency is by indicator

of  $SBR_{HF}$  (fig. 6). Without going to interpretation of this mechanism, it should be noted, that in ontogeny of a woman's body there is a series of significant changes during certain the marked period of life. However, men have the same tendency [7]. Therefore we can assume that this mechanism is generally biological. In our case it is important to estimate how long-term trainings of aerobic orientation affect on realization of this mechanism.

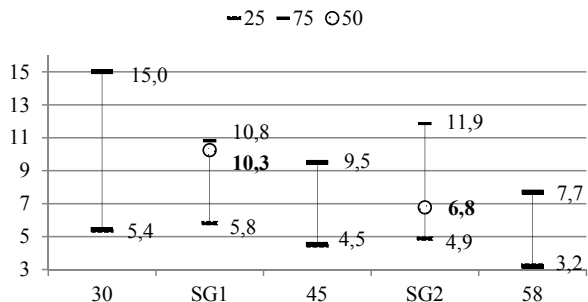


Fig. 5. Absolute values of limits of 1st (25%), 2nd (50%) and 3rd (75%) quartiles indicator  $SBR_{LF}$  (ms/mmHg) in women of  $SG_1$  and  $SG_2$  compared with the values of 1st (25%) and 3rd (75%) quartiles of 30, 45 and 58 year old women.

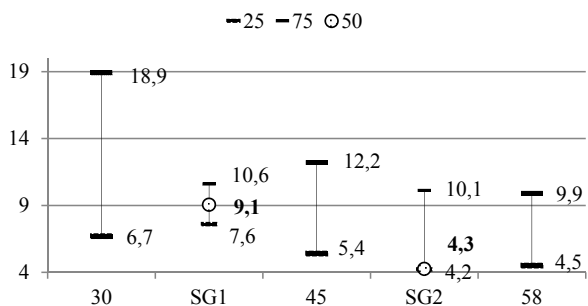


Fig. 6. Absolute values of limits of 1st (25%), 2nd (50%) and 3rd (75%) quartiles indicator  $SBR_{HF}$  (ms/mmHg) in women of  $SG_1$  and  $SG_2$  compared with the values of 1st (25%) and 3rd (75%) quartiles of 30, 45 and 58 year old women.

First of all, analyzing the data presented in figures 5 and 6, we can assert that for the lower limit of normative values SBR, which are located at 1st quartile, women of different age groups were not significantly different, except of 58 year old women. However, the range of standard values, which is determined by the 3rd quartile, decreases with age. So, from 30 to 58 year old its value for  $SBR_{LF}$  (ms/mmHg) decreases from 18,9 till 9,9, it means almost twice. But at the age of 45 year old these indicator have intermediate values.

From these positions results determination SBR of women with consideration of experience training aerobic orientation should be described as those which demonstrate a positive impact of training on the mechanisms of autonomic regulation, first of all, with consideration of  $SBR_{LF}$ , which has a tendency to the increase comparing to the group of women of the same age. On the other hand, autonomous regulation in the high-frequency range significantly reduced with long-term experience.

Thus, it can be asserted with a certain degree of probability that activity of regulatory influences with consideration of autonomous control of the heart with increasing the term of training with aerobic orientation leads to increasing low-frequency (sympathicotonic) influences and decreasing high-frequency (vagotonics) effect on CR.

## **6. Discuss of the results of research**

The studies of modern scientific researches shows appropriateness and effectiveness of aerobic exercises for middle-aged women, but some aspects concerning selection and impact, combining with other types of exercise had not been studied and require clarification. There were absences of publications, which study of the impact of long-term experience aerobic exercises on middle-aged women.

Research of physical development using of data basic anthropometric measuring showed, that women with experience of training over 10 years compared to women with experience of 3-5 years, had characteristic of the reliable changes that can be connected with influence of longer experience of aerobic exercises. Namely, lower body weight, body fat percentage, circumference of waist and limbs, as well as higher values of absolute and relative strength of hands and neck circumference, which, by our opinion, show the development of the trunk and neck muscles specifically. Absence of differences in data of VCL and chest's amplitude appeared enough informing. The shown differences of physical development give possibility to assume reduction risks of origin cardiovascular diseases, among the basic factors development of increase masses of body and percentage of body fat.

Fully logical were differences at activity of the cardiovascular system with consideration of the training experience. Women with experience of training more than 10 years had in the state of calmness less indicators of HR and SBP, thus last on the lower limit of age-old normative values and also more rapid renewal of organism after standard physical loading that witnessed economization functions of systemic hemodynamic. Similarly, changing all indexes, that includes of heart rate and blood pressure in the formulas of calculating. Analysis of SHL by system of G.L. Apanasenko allowed assuming a higher aerobic capacity of women with longer experience of training. There was also informing absence of differences in the results of hypoxia's firmness of organism and Skybinskaya's index, that witnessed about age-old firmness of the respiratory system with longer training experience of aerobic exercises.

The studies which were conducted revealed, that by the common activity of regulatory effects on the CR, women with experience of training of aerobic orientation under 5 years ( $SG_1$ ) and more than 10 years ( $SG_2$ ) doesn't differ from the women of the same age in a population. Women in  $SG_2$  have, unreliable, but a significant increase in activity of regulatory impacts in very-low-frequency range that in our opinion could be predefined by physiological characteristics of an organism at the age of women of  $SG_2$ . It is shown that in women of  $SG_2$  the autonomous heart control of the heart in low-frequency (LF) range increases. The biggest changes come from the activity of regulatory influences in the high-frequency (HF) range. Namely, limits of the 1st and 3rd quartile values HF ( $ms^2$ ) of women of  $SG_1$  and  $SG_2$  are significantly more than in the population. Besides, with increasing the term of training there is probable decrease in activity regulation in HF range. The last confirmed probable decrease in autonomous control for the indicators of SBR in a HF range.

## **7. Conclusions**

1. The studies of modern scientific researches revealed the absence of information about impact of long-term experience aerobic exercises on middle-aged women and comparison in the dynamics of physical development, adaptive changes in the states of the cardiovascular system of this women group. In connection with the above-mentioned there is a need to study heart rate variability as an assessment criterion for regulatory changes in the organism middle-aged women with long-term regular training experience of aerobic exercises.

2. Research of physical state shown that with increase of experience aerobic exercises decrease risks of origin cardiovascular diseases, that can be confirmed by data of more rapid renewal of organism after standard physical

loading, analysis of SHL by system of G.L. Apanasenko, Skybinskaya's index, adaptation potential of Baevsky (AP), Pirogova's LFS that witnessed economization functions of systemic hemodynamic.

3. The studies which were conducted revealed, that women in second study group have, unreliable, but a significant increase in activity of regulatory impact in very-low-frequency range, that in our opinion could be predefined by physiological characteristics of an organism at the age that group of women. The biggest changes come from the decrease in activity of regulation in high-frequency range with increasing the term of training. The latter is confirmed by probable decrease in autonomous control for the indicators of sensitivity arterial baroreflex in a high-frequency range.

4. Results of research, showed a positive effect of long-term training of aerobic orientation on the physical state of middle-aged women, however, for more complete analysis of changes in the women's body, necessary to make a number of additional instrumental, biochemical, immunological, genetic research, which would allow to characterize changes in autonomic, endocrine, immune and other systems of women under influence of long-term aerobic exercises, which determines the issue for further research in this area.

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**Mikhalyuk Yevgen Leonidovich**

*Doctor of Medical Sciences, Professor, Head of the department Physical rehabilitation, sports medicine, physical education and health, Zaporozhye State Medical University (Zaporozhye, Ukraine)*

## UNIFICATION OF SPORTS TERMINOLOGY IN MODERN SPORTS MEDICINE

**Summary.** This article consistently addresses issues related to medical examinations of athletes, sports terminology, first of all, such as “untrained person”. Emphasizes, that the trained or untrained can only athletes in different periods of the training process. In the examples, the absurdity of comparing the functional state of the runners on the distance of 800 meters with the sports aerobics, sports gymnastics with the sports game, etc., recommendations aimed at the correct comparison of the studied parameters among representatives of different kinds of sports.

The author gives examples, in accordance with which is not quite right to divide the athletes at the “achievers” and “not achievers” in the sport only because of their performance in the competition, without taking into account the dynamics of a sports result.

Separately presented a vision of the author on appropriateness and features of research at the former athletes, who stopped his career and lead different lifestyles in terms of physical activity.

**Key words:** *sport medicine, sports terminology, veterans of sports.*

Currently there are many inconsistencies in the formulation of some concepts that relate to teaching, didactic, medical and sports formulation found in modern sports and medical literature in Ukraine. This often disorients scientists in the discussion of the results of their research. This article is aimed at the unification of terminology in the modern sports medicine.

**Aim of the work** – to draw the attention specialists and researchers of sports medicine, trainers to the problem of the concept of training, graduation

of athlete on the basis of successful and unsuccessful in sport and relevance of research in veterans of sports.

**Materials and methods.** In article used sources of special scientific sports and medical literature, own observations and research for active athletes and those, who terminated their sport activities, i.e. veterans of the sport.

**Results and discussion.** At the beginning of the development of medical monitoring for engaged physical culture and sports (because before the 70 years of XX century in the Soviet Union was called Sports Medicine) conducted medical examination and comparison of the results between the athletes of all specializations. Most often in the comparison groups were athletes different kinds of sport, and sometimes different genders, which, to determine the effect of physical activity on the body engaged in physical culture and sports, compared persons not involved in sports. In spite of this, some researchers have called and called the latter as “untrained person.” Unfortunately, in the textbook “Physical rehabilitation, sports medicine,” published in 2014 [10] also used this term.

Similar formulation, currently, is not reasonable, because ignored sports terminology, when authors forget that only athletes [5] can be trained or untrained. By us, the concept of trained persons implies a state of an athlete, is in good sports form (often in the competitive period), and untrained – a state of an athlete at the beginning of the preparatory period or after the compelled rest period, associated with injury or illnesses. Incidentally, the confirmation of this is the definition of well-known experts in pedagogy of high performance sport A.N. Bleer et al. [1], indicating that the “training – it’s a state of the body, which determines the level of physical preparedness an athlete, which is a the result of the training”.

It is known, that one of the sections of the sports doctor work is the question of admission to sport and, consequently, qualified recommendations, concerning the exactly how kind of sport it is advisable to engage a particular person, on the basis of its morphological and functional data. Sometimes the doctor error in resolving this issue could lead, at best, to the wrong choice of kind of sports and the loss of time, and at worst – to the emergence of diseases, and sometimes life-threatening disease, etc. Thus, the doctor of sport medicine must have not only high medical qualifications, but also be widely knowledgeable in of sport medicine, and especially, know specifics of some of kinds of sports, requirements for the body due to this specificity. That’s why in program of postgraduate medical education on medical physical culture and sports medicine there is a section, devoted to the theory and practice of physical training and sport. Future specialists are invited to explore issues, relating to

sports training exercises, learn the special formulation, allows you to talk with the coach on the “same language”. Sometimes, in conversation with some doctors or colleagues-scientists, feel the lack of understanding of the seemingly common sports terms. The same applies to the concept of “untrained person”.

Later, after proposed A.G. Dembo et al. in 1966 [3] classification of kinds of sport, in which all sports were considered from the point of orientation of the training process, for development of certain physical qualities and physiological patterns, used in training exercises are the same, there are scientific works which take into account these recommendations. At the same time, we met the scientific work, in which the author [11], compares the data of representatives of sports aerobics high class (IMS, MS, CMS), practicing 18 hour per week for several years, with students engaged in physical culture in the volume academic program for 2 hours a week, and thus judges about impact of physical activity on functional state of athletes, noting their superiority.

In addition, there are reports, that compare data, received from representatives of gymnastics with the sports games, single combat with the heavy lifting, representatives of sports aerobics with runners at the distance of 800 meters, etc. In the latter case, the author [2] compares the data of athletes, doing exercises sports aerobics, causing deep functional changes in the body of an athlete and accompanied by arrhythmic breathing, with run on 800 m, is an example of extreme physical activity in the zone of mixed (aerobic-anaerobic) energy supply. We think that is not quite correct to compare the data of athletes acyclic and cyclic kind of sport only for the duration of the competitive movement, which is about 2 minutes. Similar comparisons of performance in athletes with persons, who are not involved in sports or athletes, who are in training process developing various physical qualities, it seems, is not correct.

In recent years, studies, in which some authors have carried out a comparison of the results from athletes, who “successful” in sport and “unsuccessful”. We think, that in this case, researchers must, first of all, analyze the results for the sports competitions. In this plan significant research, conducted by I.A. Kuznetsova and S.I. Kudinova [4]. The authors took into account performances of athletes at competitions during two winter competitive season with the indicators of heart rate variability (HRV), showing, that at successful athletes before competitions some parameters of HRV were higher, than at less successful athletes.

It is known, that for assessing the success of an athlete, it is necessary to fix the original athletic performance, conduct relevant studies of the functional state in the training period, for example in the preparation, and then received a performances of the parameters in the competitive period, to carry out a

similar repeat examination, ie, traced in the dynamics occurring changes of the functional state of the athlete.

It should be clear, that at the start of the preparatory period, sports results at absolute number of athletes will be at relatively low levels, and this is not surprising. Then, under the influence of training loads, continuing in various sports from 3 to 9-10 months, occurs, most frequently, improving the functional state of athletes, physical qualities (parameters of strength, speed, endurance, etc.), technical of conditions, which should, in certain conditions, lead to improved of sports results. Under certain conditions we mean the absence of injury, illness, infringement of a mode, effects of overtraining and overexertion.

But the fact, that the normally delivered training process, improves the functional state of all athletes, leading to an increase of sports results, is an established, but the division of the athletes on the “successful”, that is, improve athletic performance and “unsuccessful”, that is, not improve athletic performance, without giving specific results of the competition – obviously far-fetched notion.

Then, just a question, in which of the proposed groups (“successful” or “unsuccessful”) include the athlete, who in the competition showed the same or even worse result, than in the preparatory period, but won at major competitions?

It is unclear which group may include cases where the athlete, despite the fact that they are in a good “sports form”, made unsuccessfully in the competition due to the fact that “burned out” in psychological terms.

Separately should stay on the study of the functional state in veterans of sports. Our studies have shown [6-8], that correct can be comparisons at veterans of sports with persons of the same age, who have never engaged in sports, to study positive and negative effects on the human body of physical activity of a particular kind of sport. Received interpretation of persistent changes of the functions in veterans of sports can contribute to the clinical assessment of these changes in practicing athletes. There are comparisons between group same kind of sport and gender at veterans of sports, who have stopped active sports, but continues engaged in physical exercises in the maintenance mode, with a group of veterans of sport, leading inactive way lifestyle. Finally, relevant comparison between veterans of sports and active athletes, who have the same personal sports performance [9]. Such comparisons are useful information, when they are carried out only in kinds of sports, where there are sports results, expressed in meters, centimeters, seconds, kilograms, ie, in athletics, swimming, rowing, heavy athletics, etc.

Thus, we believe, that the comparison of the studied parameters in athletes can be by age, length of service activities a particular kind of sport, sports

qualification, gender, length (in representatives of game sports), body weight (in combat sports, weightlifting, representatives of weight sport, separate types of rowing), period of the training process, and in sport games is also by type (forward, goalkeeper etc.).

Since investigations in sports medicine, to a greater degree, directed to the development of sports, i.e. for coaches and, of course, for the doctors of sports teams, then it is time to study the parameters in the individual disciplines of athletics, such as running on a short, medium or long distance, jumps – in height, throwing – spear and others. In swimming, in addition to distance and even the style, for example – front crawl, butterfly, etc. As one option, and very important, the ability to compare performance in athletes, developing the same physical qualities, such as endurance in marathon runners and representatives of road cycling, or speed, in athletes-sprinters and swimmers-sprinters, etc.

Regard to research at veterans of sport, the most important, we believe, is the comparison of the studied parameters between the former athletes particular kind of sport and of the same gender, leading active and inactive lifestyles, and with persons, never involved in sports in terms of benefits, or vice versa, damage employment of particular kind of sport at young age.

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**Polianska Oksana Stepanivna**

*Doctor of Medical Sciences, Professor, Professor of the department of internal medicine, physical rehabilitation, sports medicine and physical education, Higher State Educational Establishment of Ukraine “Bukovinian State Medical University” (Chernivtsi, Ukraine)*



**Gulaga Olga Igorivna**

*PhD in Medical Sciences, Assistant Department of internal medicine, physical rehabilitation, sports medicine and physical education, Higher State Educational Establishment of Ukraine “Bukovinian State Medical University” (Chernivtsi, Ukraine)*



**Moskaliuk Inna Igorivna**

*PhD in Medical Sciences, Assistant Department of internal medicine and Infectious Diseases, Higher State Educational Establishment of Ukraine “Bukovinian State Medical University” (Chernivtsi, Ukraine)*

## FUNCTIONAL STATE OF THE CARDIO-VASCULAR SYSTEM WITH VARIOUS PHYSICAL LOAD

**Summary.** The article deals with electrocardiogram peculiarities in sportsmen with various physical load. 35% of children going in for sport have been found to have changes on ECG increasing up on 10% after physical activity. ECG changes before physical exercise are found more often among track and field athletes, football players and basketball players, whilst ECG changes among weightlifters are found twice as frequently after physical activity. Before physical load ECG of track and field athletes and football players detects disorders of impulse formation prevailing, and after physical



load disorder of impulse conduction becomes three times as much. Peculiarities of ECG changes among weightlifters before physical load are prevailing disorders of impulse formation found by 20% more than among track and field athletes, and after physical activity disorder of impulse conductivity becomes twice as much, and disorders of repolarization processes increase five times as many. ECG of basketball players detects prevailing disorders of impulse formation, and after physical load disorder of impulse conductivity decreases almost twice as much which is indicative of functional changes available.

*Key words: electrocardiogram, sportsmen, physical load.*

### **Problem statement in general and its connection with important scientific and practical tasks.**

Over the last several years, sudden deaths of trained athletes, usually associated with exercise, have become highly visible events fueled by news media reports. Interest in these tragic events has accelerated owing to their increased recognition, awareness that underlying, clinically identifiable cardiovascular diseases are often responsible, and the availability of treatments to prevent sudden death for high-risk athlete-patients.

In modern sport with its high achievements the training process and competitive activity lead to maximal mobilization of functional reserves and compensatory-adaptive human possibilities [1,3, 7]. Under the influence of considerable physical and psychoemotional stress instrumental heart examination fixes certain deviations of indices behind the limits of normal values. In spite of certain achievements in the treatment of heart diseases, elaboration of new diagnostic technologies, the problem of sudden cardiac death (SCD) even in the developed countries remains unsolved. A great number of Ukrainian and foreign authors consider that sportsmen belong to the high risk group of the development of cardio-vascular pathology and SCD. Annually 1 out of 200 000 young sportsmen dies of SCD, although only 20% of SCD cases are registered during sport training. According to the data of the International Olympic Committee the cause of more than 90% of SCD of a non-traumatic character are cardio-vascular diseases.

### **Analysis of the latest studies and publications.**

Today we tend to find more publications in literature concerning description of death cases of sportsmen directly during training or competitions, or immediately after them. Analysis of sudden deaths happened due to the diseases of the internal organs because of acute physical

overload both among sportsmen and those who do not go in for sport, is indicative of the fact that in the majority of cases the main cause of death is heart diseases occurred before physical load and as a result of physical overload [4,9]. High physical and psychoemotional stresses peculiar for modern children sport are found to have a negative effect on the ability to reproduce optimally the skills and physical qualities obtained earlier. This effect initiates the development of a number of particular overexertion syndromes and formation of relevant pathology, among which a leading place is occupied by secondary sport immune deficiency in the form of various disorders associated with the condition of the immune system; acute and chronic stress, from acute desynchronosis with sleep disorders and wake to biological rhythms breakdown of all the systems providing physical ability to work [10,18].

The researcher Corrado, estimating the frequency of SCD rate among the population of athletes and non-athletes (age from 12 to 35) in the Italian region of Veneto demonstrated that competitive sport activity increases the risk of SCD among juvenile and young athletes by 2,5 times. In this study young athletes who died suddenly had asymptomatic cardio-vascular diseases manifested by cardiomyopathy, untimely diseases of the coronary arteries and congenital defect of the coronary vessels. Thus, SCD frequency due to different causes in this research was 2,3 (2,62 among men and 1,07 among women) per 100 000 of athletes a year, and 2,1 per 100 000 of athletes — due to cardio-vascular diseases. It should be noted that European findings are higher than those in the USA. The Polish scientist B. Halawa [13] investigated 16 SCD cases and proved that its risk among sportsmen is 5-6 times higher than among people who do not go in for sport. American scientists found out that 85% of SCD cases among sportsmen depended on heart diseases, 15% – do not depend, therefore regular ECG enables to make timely diagnostics of pathological conditions with irrational physical load.

In many foreign publications the following terms can be found: «heart strain»; «cardiac fatigue»; «myocardial dystrophy»; «overtraining heart», as well as complete rejection of sport cardiac pathology existence. Numerous works indicate the necessity to organize the system of comprehensive and screening medical examination of sportsmen before competitions [12, 14]. Nowadays there are algorithms of cardiologic screening of sportsmen. Some experts consider that the questionnaire containing 12 points elaborated by the American Heart Association is maximally close to practical use. It enables to distinguish a group of sportsmen requiring comprehensive examination. It is important to admit that the authors recommend to interview a young

sportsman with his parents present. International practical work widely uses the questionnaire elaborated by the European Society of Cardiology (known also as «Lausanne Recommendations»). Electrocardiography (ECG) is an important method to diagnose cardio-vascular pathology of a sportsman. The European Society of Cardiology and International Olympic Committee recommend the algorithm of cardiologic screening of young sportsmen where ECG is its main part.

Dr. Prutkin (Washington University, Seattle) described new ECG criteria as improved ECG criteria. Both sets of the criteria do not focus their special attention on ECG changes associated with physical load being of certain clinical value among middle aged individuals and absolutely normal for sportsmen including pre-cardiac ectopic activity: isolated QRS voltage changes typical for left ventricular hypertrophy (LVH); J-wave availability; elevation of ST segment and some other signs of early repolarization. The criteria are focused on approximately ten ECG parameters instead, suggesting possible high risk of cardiac pathology, including inverted T wave, ST segment depression, signs of right ventricular hypertrophy, ventricular pre-excitation, shortening and prolongation of QT interval.

It is functional reserves of the circulatory apparatus that are found to be a frequent factor restricting sport achievements, and on the other hand, cardio-vascular disorders are one of the first signs of irrationally organized training process. The main causes of SCD of young athletes are severe heart rhythm disorders. One of the most difficult practical issues of children sport cardiology is interpretation of the functional state changes detected in cardiohemodynamics and vegetative nervous system requiring further investigation in this direction [8,10].

With the aim to study functional state of the cardio-vascular system of young sportsmen we have examined 100 sportsmen aged from 18 to 22 including 25 track and field athletes, 25 weightlifters, 25 football and 25 basketball players. Sport experience of the examined sportsmen was 5 years. For all of them ECG was made in twelve leads before and after physical load on the apparatus “Cardio +” on the basis of the Regional Physiotherapeutic Dispensary. The following ECG readings were analyzed: P, T waves, P-Q intervals, R-R distance before and after physical load on bicycle ergometer (BEM) [5, 6].

The following changes were found after ECG analysis: disorders of impulse formation in the form of sinus bradycardia, sinus arrhythmia, ventricular extrasystole and paroxysmal tachycardia, conductive disorders in the form of incomplete or complete His right bundle-branch block; occurrence of WPW syndrome and Lown-Ganong-Levine syndrome; disorders of repolarization

phase. Abnormalities on ECG were found among one third of the examined individuals, and after BEM they increased to 60%.

According to the data delivered by certain authors [3,6] in 60% of sportsmen ECG changes are found (separate or combined) as follows: sinus bradycardia, sinus arrhythmia, atrioventricular block of the 1<sup>st</sup> degree, early repolarization; incomplete His right bundle-branch block; left ventricular hypertrophy. The degree of these changes depend on nationality, age, sex, major subject and professional level. Regular long sport training (minimum 4 hours every week) is reflected on ECG by a series of signs among which increased tonus of the vagus and enlarged volume of heart chambers are basic ones. These are normal adaptive processes, their manifestation does not require qualifying examinations and they are not dangerous for health.

About 55% of sportsmen, especially young, have sinus arrhythmia – increased rhythm during inspiration and its decrease during expiration. This normal phenomenon should be differentiated from dysfunction of the sinoatrial junction, therefore the authors suggest to draw attention to the electric axis of P wave. In case of physiological adaptation to sport load it remains stable, at the same time some exercise is enough to accelerate heart rate and make it normal eliminating arrhythmia. Early repolarization earlier detected only in cases of ST elevation, not is diagnosed in cases of J-wave available. It is found in 35%-91% of trained people prevailing among young ones and representatives of black race. Ectopic pre-cardiac rhythm is characterized by a special morphology of P wave and differs from the usual sinus one.

In case of atrioventricular block of the 1<sup>st</sup> degree PR interval becomes longer to 200 milliseconds and more, but its duration is stable. This phenomenon disappears with accelerated heart rate. 2<sup>nd</sup> degree block (Mobitz 1) is manifested by a growing elongation of PR interval up to disappearance of P wave and QRS complex changed by short PR interval. It is more serious disorder of the atrioventricular junction, but it is temporary in athletes and in the course of physical training it disappears. Potassium containing agents as restorative or medical means are contraindicated for sportsmen with atrioventricular block, as it can transfer into more severe block.

Incomplete His right bundle-branch block (rSR complex present in V1 lead with QRS duration no more than 120 milliseconds) is found in 12%-32% athletes and it is caused by delayed stimulation of the right supraventricular crest and right ventricular hypertrophy as the result of continuous physical load. This kind of block does not require therapy, but the dynamics of behaviour should be observed. Enlarged ventricular size provoke less changes on ECG. First of all, it is the criterion of left ventricular hypertrophy found in approximately 45% of

men and 10% of women going in for sport. There are several definitions of this criterion, but Sokolov-Lion definition is used more often. In case other signs are absent (except potential level) such hypertrophy is considered as normal physiological adaptation.

His left bundle-branch block in sportsmen is rarely found and its is detected in case of organic heart injuries. Detection of this block requires complete cessation of training and competitions, additional examination must be carried out to find underlying disease.

WPW syndrome is found more frequently in sportsmen than those who do not go in for sport. The cause of this syndrome is more often congenital pathology of the conductive system and organic heart injuries. The main danger in case of WPW syndrome is susceptibility to paroxysmal tachycardia, development of hemodynamic disorders. Sportsmen with WPW syndrome should leave big-time sport and go in for moderate physical culture. In case there were attacks of paroxysmal tachycardia in anamnesis he must be forbidden to go in for sport.

Sportsmen with Lown-Ganong-Levine syndrome are susceptible to paroxysmal supraventricular tachycardia. Their ability to go in for sport is evaluated after a comprehensive deep examination in the clinic and medical-pedagogical observations during training. Excessive load on the myocardium of sportsmen which can be both physiological (physical load) and pathological (different heart defects) results in the formation of hypertrophy of various myocardial parts. On initial stages of hypertrophy development coronary circulation completely makes up energy loss of hypertrophied myocardium. In case of considerable enlargement of myocardial mass there is an inequality between its requirements and blood supply, myocardial hypoxia develops resulting in metabolic disorders and formation of pathologic hypertrophy. In sportsmen this kind of hypertrophy develops rarely as the heart of a sportsman possesses increased compensatory possibilities, it is found only with irregular training process and as a result of organic heart injury.

In sports medicine timely detection of transmission into pathological stage is of a special value. At the beginning of transformation “ $TV1 > TV6$ ” syndrome is found. This syndrome is characterized by prevailing amplitude of T wave in V1 lead as compared to V6 lead, with positive T wave available in all the thoracic leads. “ $TV1 > TV6$ ” syndrome is more often found in sportsmen of speed-power kinds of sport in the period of the most intensive training.

In track and field athletes ECG changes are found in  $\frac{1}{4}$  of the examined, and after physical load ECG changes increase to 30%. In weightlifters ECG changes are found initially only in 16%, although after physical load this index increases twice as much as compared to the same index in track and field athletes. Among

football players changes on ECG are found in the half of sportsmen, and after physical load these changes are found in 70%. In basketball players ECG changes are found in  $\frac{1}{4}$  part of sportsmen, and after BEM deviations from the norm are found in the half of the sportsmen examined. On ECG of track and field athletes the most frequent changes are disorders of impulse formation, although this index decreases after BEM which is indicative of a functional character of these changes. Although after physical activity disorders of conductivity increase 3 times as much which can be indicative of irrational use of physical exercises with SCD risk in such sportsmen. Pathology with disorders of impulse formation also prevails among weightlifters. It should be noted that after physical load the number of disorders detected on ECG increases 5 times as much, especially in the form of repolarization phase disorders with T wave inversion. It may be indicative of the risk of metabolic cardiomyopathy occurrence with progressing cardiac failure[3,14, 16].

On ECG of football players there are changes in the form of disorders of impulse formation as it is found in all the previous groups. They decrease after physical load and are of a functional character. Although, after physical load analogically to the group of track and field athletes, the index of conductive disorders increases twice as much which is indicative of cardiac muscle injury due to inadequate physical load. In the group of basketball players prevailing of separate pathology on ECG is not found. After BEM the index of conductive disorders decreases twice as much which is indicative of functional changes in the myocardium.

In all the sportsmen before physical load there are disorders of impulse formation, but only in the group of track and field athletes and football players this index decreases after physical load which is indicative of their functional character. In addition, in the group of track and field athletes, football and basketball players there are disorders of conductivity in the form of complete and incomplete His right bundle-branch block, although after BEM in the group of track and field athletes and basketball players this index increases twice as much which is an unfavourable prognostic criterion. After physical load in all the four groups of sportsmen disorders of repolarization phase are found five times as much. It should be noted that only in 3% of sportsmen normalization of T wave is found after physical load.

Syndrome of focal myocardial changes is caused by disorders of coronary circulation. Coronary circulation disorders in sportsmen are also possible due to changes in the coronary vessels. These changes are more often found among middle-aged and elderly people going in for sport. Excessive load is defined not so much by load itself but the degree of tolerance to it when its amount exceeds

the level acceptable for the given person. It occurs when effect of the load is combined with negative influence of the environment (high, low temperature, high humidity, highlands etc.), as well as in persons with chronic foci of infection in acute period of disease, in the period of rehabilitation after disease. Therefore, dosage of physical load should be strictly individual considering the results of a comprehensive examination and anamnestic data with continuous dynamic control.

Proper evaluation of negative T waves is especially important as they occur within the norm in childhood and are associated with peculiarities of repolarization processes in the right ventricle. Negative T III waves and two-phase T and aVF waves are frequently found in children of pre-school and early school age, which corresponds to the age norms. Deep negative T waves (to 6 mm) can be found in healthy children at the age from 6 to 12 in V1-3 leads. Such waves are considered to be juvenile T. They are characterized by a gradual decrease of a negative phase from the first thoracic leads to V4 where they are negative in the norm. juvenile T waves are not accompanied by depression of S-T segment.

Basically [9, 12], structural and functional myocardial changes in sportsmen depend on the variant of genetic polymorphism angiotensin converting enzyme (ACE). In sportsmen with DD genotype much higher level of diastolic arterial pressure, bigger index of myocardial mass and lower signs of its function are found than in those with the genotypes II and ID. Parameters of physical ability are not found to be associated with genotype variants of the genes examined. The majority of scientists consider that genes of ACE and NO-synthase (eNOS) play a certain role in the development of cardio-vascular complications. Athletes with D/D genotype on ACE gene are able to run short distances and weightlifting, while athletes with I/I genotype on ACE gene are more able to run middle and long distances. The scientist Monthomer proved that people with D/D genotype of ACE have higher risk of myocardial infarction, ischemic and dilation cardiomyopathy which is an independent factor of SCD. Intensity of truly hypertrophic changes of disadaptive character is considered to be a risk factor of SCD. Although it is connected not only and not so much with the influence of physical load on the heart, but with the influence of physical load on the constitutional-determined mechanisms in the heart of those who go in for sport but have genetic predispositions for the development of disadaptation. This statement is based on the analysis of the Lausanne Recommendations (Sudden cardiac death in athletes: the Lausanne Recommendations). According to the British Association of Sport and Exercise Sciences (BASES) the lack of strict criteria

to select individuals wishing to go in for professional sport is a negative factor concerning monitoring of the state of health of sportsmen.

High level of physical exercise peculiar for sport has a considerable effect on the system of active oxygen forms (AOF) causing a complex of changes in the enzymatic systems. These changes may be of a positive, compensatory character, and in a number of cases lead to decompensation, inhibition of antioxidant mechanisms activity, AOF accumulation in the tissues with the development of injuries. In recent years more evidence has appeared to prove direct AOF involvement in the processes to regulate adaptation to physical load, and due to this fact the practice to administer antioxidant medicines becomes not so much unique [2, 11, 15]. A moderate level of oxidative stress with physical load is useful, as free radicals released during destruction of the muscular tissue are important regulators of reparative processes, which is the basis of muscular tissue adaptation to physical load. AOF in the range of concentrations from low to moderate modify signal cellular ways and regulate expression of a number of genes including those coding enzymes of the antioxidant system defense, heat-shock proteins, enzymes of DNA system reparation and enzymes of the respiratory chain [2, 17].

Oxidative stress is one of the factors leading to erythrocyte damage directly during and after physical load. Elevated level of AOF results in disturbance of contractile ability of the muscular cells which may be one of the factors promoting peripheral weakness. AOF effect leads to the modulation of expression of a considerable amount of genes and might be associated with cysteine oxidation in the domains of transcription factors binding or signal molecules. Genes activated by AOF include the genes of primary response, the genes coding heat-shock proteins, the genes coding enzymes of the antioxidant system defense. These genes are activated by both short and long physical load.

Therefore, all sportsmen require special control during preventive examinations before and after physical load, which must be individual, controlled and dosed considering gene polymorphism.

### **Conclusions:**

In 35% of children going in for sport changes on ECG are found becoming 10% as many after physical load.

ECG changes are found before physical load more frequently among track and field athletes, football players and basketball players, whilst ECG changes among weightlifters are found twice as frequently after physical activity.

Peculiarities of ECG changes before physical load among track and field athletes and football players are prevailing disorders of impulse formation, and after physical load the index of conductive disorders increases 3 times as much.



Peculiarities of ECG changes among weightlifters before physical load are prevailing disorders of impulse formation found by 20% more than among track and field athletes, and after physical activity disorder of impulse conductivity becomes twice as much, and disorders of repolarization processes increase five times as many.

Peculiarities of ECG changes among basketball players are prevailing disorders of impulse formation, and after physical load the index of conductive disorders decreases twice as much, which proves functional changes available.

### **Perspectives of further studies.**

Investigation of polymorphism of NO-synthase genes is planned to be conducted in sportsmen to detect the markers of vascular instability and prognosis of life-threatening complications.

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**Mikhalyuk Yevgen Leonidovich**

*Doctor of Medical Sciences, Professor, Head of the department Physical rehabilitation, sports medicine, physical education and health, Zaporozhye State Medical University (Zaporozhye, Ukraine)*

## THE IMPACT OF MOTORING ON SOME INDICATORS OF CARDIOVASCULAR AND AUTONOMIC NERVOUS SYSTEMS IN VETERANS OF SPORTS

**Summary.** In recent years, the interest in the veterans of the sport has come thanks to an active veterans' movement in many countries and the participation of former athletes in the Championships of their countries, of Europe, and of the World.

There are research works in which sports doctors study the echocardiographic indices of the veterans of the sport, the features of central hemodynamics in the process of ontogenesis.

**The aim** is to study and compare the parameters of the cardiovascular, autonomic nervous system and physical performance in sports' veterans who continue to lead an active lifestyle after the sports career and have stopped playing sports and leading a sedentary lifestyle.

**Materials and methods.** The study included 31 male sports' veterans at the age of 32 to 75 years, mean age of  $50,3 \pm 1,85$  years, athletics training length  $11,4 \pm 0,83$  years in the past at a distance runners from 100 to 400 meters, with sports qualifications from the I category to master of sports of international class (MSIC).

Our study has shown that sport veterans (high class runners at a distance of 100-400 meters), that continue active exercises and do not differ from sport veterans, who lead a sedentary lifestyle by age, length of employment on the selected kind of athletics and body length have some advantages. This is primarily a smaller BMI, more common bradycardia, the absence of people with tachycardia, prevalence of parasympathetic effects ANS, hypokinetic TC and the lack of individuals with hyperkinetic TC, the large value of the relative value of the index  $PWC_{170}$  and functional

state. These results confirm the conclusion of many researchers that highly skilled athletes after the cessation of their professional activity in the prevention of cardiovascular events show continuation of physical activity in maintaining mode.

**Key words:** *veterans of sports, male, athletics, electrocardiographic, heart rate variables, central hemodynamics, functional state index.*

The problem of the health level and functional status of high class athletes, who have ceased active sports due to such reasons as a decrease in athletic performance, lack of motivation, serious injuries, etc., is always concerned by sports doctors. The first who conducted medical monitoring for former athletes and published the results of their observations were N.D. Graevskaya [8], V.K. Velitchenko and R.E. Motylyanskaya [3], E.L. Mikhalyuk [14,15,16], F.A. Jordanskaya [9], G. D. Sheliya [25], W. Bringmann [26], S.Israel [28], and others.

In recent years, the interest in the veterans of the sport has come thanks to an active veterans' movement in many countries and the participation of former athletes in the Championships of their countries, of Europe, and of the World. Scientists, mostly pedagogues, recommended approximate plans and characteristics of sports training in weightlifting [17], judo [19], cycling [7], and technical and tactical training of athletes in martial arts [1], the application of interval hypoxic training in the preparation of swimmers-veterans [10]. Some authors propose the optimal motor activity for basketball players [4], as well as the study of the age of age-regression of physical qualities and psychomotor functions [20].

There are research works in which sports doctors study the echocardiographic indices of the veterans of the sport [21,22,23], the features of central hemodynamics in the process of ontogenesis [5,6].

For many generations of athletes who are actively involved in sports, sooner or later there comes a time when they due to their age, have to stop regular training and performances in competitions. Athletes very painfully, and sometimes even dramatically, experience the retirement, believing that it was the best period of his life when they were young and healthy [24]. Speaking about the regularities of the adaptation process among the veterans of sport, some researchers propose to interpret the changes occurring in the body of an athlete with a sharp cessation of sporting activity, from the viewpoint of the theory of stress [5]. The authors believe that the stressor

may be not only athletic training with her physical and emotional impacts, but also an abrupt shutdown from the training process. The termination of sport activities creates a need to adapt to the new environment with a significantly lower motor mode, unusual mental and social factors that often turn out to be unsafe to the health of veterans.

Sports longevity as an important social and cultural phenomenon in recent years has increasingly become the object of scientific research. It is difficult to imagine the existence of more convincing arguments about the importance of healthy lifestyle and, as an illustrative example that can serve as sporting and professional achievements of the veterans of sports [10].

Concern about the health and motor activity of persons who have ceased sports activities should be an important national priority. Therefore, the study of all body systems and, in particular of the circulatory system in a remote period of the training process, is very important [9,16,28].

In most cases the basic indicators of hemodynamics in former athletes are within the lower limits of the age norms of persons who were not engaged in sports [9,27]. In particular, the main manifestations are tendency to lower values of blood pressure (BP), reduced heart rate, peripheral resistance at high values of the stroke and minute blood volume.

In individuals who have discontinued sports, but, however, carry on active motor mode showed the significant differences in the settings of cardiodynamics that characterize the favorable changes in the activity of their hearts [25,26].

Sports in case history have positive impact compensatory abilities of the cardiovascular system with the development of atherosclerosis and coronary heart disease (CHD) in athletes and help to improve clinical course and prognosis of treatment of CHD [12,13], have a positive impact on the prevention of the development of heart disease and overall life expectancy [29]. There is evidence showing that the veterans of the sport, who ceased active sports, revealed a high degree of the development of cardiovascular diseases (26%), while those who continued occupation revealed 4,5% [21].

Peculiarities of hemodynamics arising under the influence of training of athletes core-throwers according to our data [16] persist in individuals who have ceased active sports in a period of 5 to 25 years, though they are much lesser extended. However, such peculiarities remain not only in former athletes who continue to be engaged in physical activity but also in sports' veterans, leading a sedentary lifestyle, although in latter their expression is diminished. The persistent hemodynamic features can be considered as a factor that reduces the risk of developing of hypertension [16].

**The aim** is to study and compare the parameters of the cardiovascular, autonomic nervous system and physical performance in sports' veterans who continue to lead an active lifestyle after the sports career and have stopped playing sports and leading a sedentary lifestyle.

**Materials and methods.** The study included 31 male sports' veterans at the age of 32 to 75 years, mean age of  $50,3 \pm 1,85$  years, athletics training length  $11,4 \pm 0,83$  years in the past at a distance runners from 100 to 400 meters, with sports qualifications from the I category to master of sports of international class (MSIC). Among them, the finalists and participants of the Olympic Games, the finalists of the World and European championships, winners of international competitions, the champions of the Soviet Union and Ukraine. In order to clarify the influence of the motor mode after an active workout, we have formed 2 groups: the first (I) group included veterans ( $n=17$ ), mean age of  $49,9 \pm 2,64$  years, length of employment on the selected kind of athletics  $12,1 \pm 0,96$  years, length and weight, respectively  $178,3 \pm 1,36$  cm and  $79,9 \pm 2,40$  kg, which continue to lead an active lifestyle, using 3-4 times per week cross jogging, mini-football, basketball, volleyball, swimming. The second (II) group ( $n=14$ ), mean age  $50,6 \pm 2,65$  ( $p > 0,05$ ), length of employment on the selected kind of athletics  $10,6 \pm 1,43$  ( $p > 0,05$ ), length and body weight, accordingly  $174,5 \pm 1,61$  cm ( $p > 0,05$ ) and  $81,6 \pm 2,46$  kg ( $p < 0,05$ ). This group of veterans stopped playing sport and was leading a sedentary lifestyle. The groups for analysis of the studied parameters in veterans did not differ statistically in age, in the number of athletes who have qualification of the category I, Candidate Master of Sports (CCM), Master of Sport (MS) and MSIC. To assess the differences in the reliability of consent used  $\chi^2$  test based on the conventional method of determining the difference between the errors. The value of  $\chi^2$  criterion was 2,103, the relationship between the factor and effective signs was absent, the level of significance was  $p > 0,05$ .

Study of the bioelectric activity of the myocardium was performed by means of ECG in 12 leads to a state of relative calm. For the analysis of the autonomic regulation of cardiac activity mathematical methods of analysis of HRV were used. The following characteristics were singled out: modes (Mo, s), mode amplitude (AMo, %), variation range (D, s). The number of derived indices was counted: the index of vegetative balance (AMo/D, %/s), vegetative indicator rhythm (VIR,  $1/c^2$ ), the index of adequacy of regulation processes (IARP, %/s), tension index (TI, c.u.). Analysis and evaluation of frequency components of the heart rhythm was performed by examining the spectral parameters of the autocorrelation functions: total spectral power TP ( $mc^2$ ), power in the range of

very low frequency VLF ( $\mu\text{c}^2$ ), power in low frequency LF ( $\mu\text{c}^2$ ) and high HF ( $\mu\text{c}^2$ ) frequencies, LF and HF in normalized units (LFn, %, HFn, %), ratio of LF/HF (c.u.).

Central hemodynamics was studied by automated tetrapolar rheography on W. Kubiček et al. (1970) in the modification of Yu.T. Pushkar et al. (1970). The stroke and minute blood volumes were counted (SV, MBV), stroke and cardiac indices (SI, CI) were calculated, general and specific peripheral vascular resistance (GPVR, SPVR) were considered. Determination of physical capacity was performed by the standard technique on the Ergometer using a submaximal test  $\text{PWC}_{170}$  [11] and the calculation of the relative value of physical performance, i.e.  $\text{PWC}_{170/\text{kg}}$ . Functional state index (FSI) was calculated according to the formula proposed and patented by us [18].

The results were statistically processed using “Statistica 6.0 for Windows” program with parametric methods. Values are given as mean values  $M \pm m$ . Taken statistically significant differences in the figures for the value of the significance level of  $p$ , which does not exceed 0,05. Correlation between the variable was evaluated using Spearman’s correlation coefficient (R) for variables with abnormal distribution and Pearson’s for normal distribution [2].

**Results of the study.** After anthropometric research of sports’ veterans, as well as collecting data from the questionnaires, we noted that veterans of both groups during the period of their active sports activity, did not differ in body mass index (BMI), respectively  $23,10 \pm 0,53 \text{ kg/m}^2$  and  $23,01 \pm 0,45 \text{ kg/m}^2$  ( $p > 0,05$ ), whereas in the present time, the veterans of the first group BMI amounted  $25,09 \pm 0,62 \text{ kg/m}^2$  and was significantly less than the veterans of the second group –  $26,86 \pm 0,64 \text{ kg/m}^2$  ( $p < 0,05$ ).

Electrocardiographic data demonstrated that the veterans of the first group showed 94,1% of sufficient voltage and 5,9% of the reduced voltage. The representatives of the second group possessed reduced voltage in 21,4%. Electrical axis of the heart in the first group was not rejected in 64,7% and declined to the left in 35,3%, while the veterans of the second group, respectively, and 78,6% and 21,4%.

Bradycardia was revealed in 58,8% of veterans of the first group, heart rate was in the range of 61-79 beats/min in 41,2%, among the veterans of the second group it was 57,2% of cases with heart rate in the range of 61-79 beats/min, and 35,7% of cases with 80 beats/min or more and bradycardia was detected in only one veteran (7,1%).

The veterans of the first group showed ECG changes which were detected in 52,9% mainly it was SERV (29,4%), AV blockade of the I degree was

founded in 11,7% and 5,9% of incomplete blockage of right bundle branch block (IBRBBB) and incomplete blockade of the anterior branch of the left bundle branch block (IBLBBB). Among the veterans of the second group ECG changes were recorded in 35,7%, 14,4% with the syndrome of early repolarization of ventricles (SERV), and in 10,65% of patients with AV blockade of the I degree and the combination of CRBBB and AV blockade of I degree. It should be noted that most of the observed changes in the ECG in sports' veterans of both groups are a feature of the ECG of athletes. In sports' veterans with CRBBB and IBLBBB according echocardiography revealed no pathological changes.

HRV data showed that the Mo component, pointing to the dominant level of functioning of the sinus node, the veterans of the first group compared with the veterans of the second group was significantly higher, respectively, with  $0,941 \pm 0,03$  and  $0,804 \pm 0,03$  to ( $p < 0,05$ ), which indicated an increase in the tone of the centers of the parasympathetic innervation of the heart. The indicator of the rate of adequacy of regulation processes (IARP) reflecting the level of correspondence between the sinus node function and sympathetic activity was significantly smaller in the veterans of the first group compared with veterans of the second group, respectively  $54,45 \pm 3,45$  %/sec and  $67,52 \pm 6,47$  %/sec ( $p < 0,05$ ), which also indicates an increase in parasympathetic influences of the autonomic nervous system (ANS). Among other temporary HRV comparisons between the studied groups no significant differences were found. Thus, the analysis of time parameters of HRV indicates the prevalence of parasympathetic effects of the ANS in veterans, leading an active lifestyle after professional sports.

The spectral analysis of HRV have shown that total spectral power (TP), which reflects the total activity of the autonomic influence on heart rate was prevalent in veterans of the first group, respectively  $2887,9 \pm 324,1$   $ms^2$  and  $1946,0 \pm 413,4$   $ms^2$  ( $p < 0,05$ ), which indirectly may indicate the predominance of the parasympathetic ANS in sports' veterans of the first group. The confirmation of the above, with respect to the enhancement of the parasympathetic, is the presence of bradycardia in veterans of the first group ( $57,8 \pm 1,50$  beats/min) compared to the mean values of heart rate among the veterans of the second group ( $70,4 \pm 2,16$  beats/min,  $p < 0,01$ ).

Comparison of central hemodynamic parameters showed that the integral index SI was significantly smaller in the veterans of the first group, respectively  $2,607 \pm 0,08$  l/min/m<sup>2</sup> and  $3,170 \pm 0,09$  l/min/m<sup>2</sup>,  $p < 0,01$ , and it corresponds to a hypokinetic type of blood circulation (TC) and eukinetic TC in veterans of the second group. Veterans of the first group had such the percentage of



TC: 70,6%:29,4%:0%, when the representatives of the second group had: 7,1%:71,5%:21,4%, respectively hypokinetic, eukinetic and hyperkinetic TC, i.e, veterans of the first group prevails mostly hypokinetic TC and no former athletes with hyperkinetic TC, while in the second group persons have eukinetic TC and hyperkinetic TC. Among the variables of GRPV and HIPS no significant differences were found.

Analysis of the relative magnitude of the values of physical performance ( $PWC_{170}/kg$ ) of the surveyed showed that veterans who continue active physical exercise, the value  $PWC_{170}/kg$  was significantly greater than that of the second group, respectively up to  $18,57 \pm 0,77$   $kgm/min/kg$  and  $13,14 \pm 0,93$   $kgm/min/kg$  ( $p < 0,01$ ). The index of the functional state of the veterans of the first group was  $6,788 \pm 0,44$  rel. units and corresponded to “below average” assessment, while veterans of the second group had this value as  $4,355 \pm 0,43$  rel. units ( $p < 0,01$ ) and corresponded to a “low” estimation.

Individual analysis of the FSI has shown that veterans of the first group of “low” and “medium” rating was, respectively, in 6 people (35,3%), and “below average” – in 5 (29,4 %), where as the veterans of the second group “low” rating was in the 11 (78,6%) and “below average” – in 3 (21,4%). These individual analysis data confirm the average scores for groups.

Our study has shown that sport veterans (high class runners at a distance of 100-400 meters), that continue active exercises and do not differ from sport veterans, who lead a sedentary lifestyle by age, length of employment on the selected kind of athletics and body length have some advantages. This is primarily a smaller BMI, more common bradycardia, the absence of people with tachycardia, prevalence of parasympathetic effects ANS, hypokinetic TC and the lack of individuals with hyperkinetic TC, the large value of the relative value of the index  $PWC_{170}$  and functional state. These results confirm the conclusion of many researchers that highly skilled athletes after the cessation of their professional activity in the prevention of cardiovascular events show continuation of physical activity in maintaining mode.

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**Guziy Oksana Volodimirivna**

*PhD in physical education and sport, Assistant professor,  
Assistant professor of the department of Health, Lviv  
State University of physical culture (Lviv, Ukraine)*

## DIFFERENTIATION OF HEMODYNAMICS OF TOP ATHLETES DEPENDING ON HEART RATE VARIABILITY AFTER TRAINING

**Introduction.** The study of central hemodynamics of athletes is one of the important areas of sports medicine, aimed at identifying the characteristics of the body that trains and diagnosis of preparedness. Body preparedness determines the level of fitness and characterizes the readiness of athlete to achieve high sports results. It develops under the influence of systematic and targeted sports, and its level depends on the balanced interaction of many functional systems that determine the nature of adaptive capacity, hemodynamics being among the most important ones [1]. To determine the functional condition and adaptive capacities heart rate variability, blood pressure, and central hemodynamics of athletes are recently taken into consideration [2,3]. Such techniques are applied in sports medicine practice when it is primarily necessary to identify prepathological changes in the body of athletes, to prognose athletic performance, which is only possible with a clear understanding of applied and adaptive mechanisms that develop in the body under the influence of training activity [4,5, 6]. Recognition of these mechanisms can not only determine the tolerance towards physical exercises, but also adjust training process purposefully with the use of various kinds of exercises. Determining the mechanisms of adaptation allows to monitor the impact of training loads on objective criteria of cardiorespiratory system at all times. At present the main methods of monitoring the impact of training process on the cardiovascular system remain routine: heart rate (HR) and blood pressure (BP) controls. This is due to the failure to use modern methods of instrumental diagnostics in terms of the training process.

**Materials and Methods.** Modern semi-unctional method of research of cardio-respiratory system (Spiroarterycardiorhythmography (SACR)) is used to study the hemodynamic features of athletes. It allows to simultaneously register interconnected indicators characterizing the activity of the heart (first part of electrocardiogram), vessels (peripheral systolic (SBP) and diastolic (DBP), blood pressure in the middle phalanx of a finger using Penaza method, and respiratory system (according to ultrasound spirometry) [7]. The method allows to determine the volume of the influence of autonomic nervous system on heart rate (HR), blood pressure (BP), spontaneous breathing (SB). According to the data of testing HR, SBP and DBP sequences for each heartbeat and lung ventilation spectral Fourier analysis was applied, which determines the capacity of regulatory influences in different frequency ranges related to general activity, activities of suprasedgmental structures and parasympathetic and sympathetic branches of vegetative nervous system (VNS) [8]. Spectral analysis is conducted in three frequency ranges: very low frequency (VLF, 0-0.04 Hz), low frequency (LF, 0.04-0.15 Hz) and high frequency (HF, 0.15-0.4 Hz), measured in absolute values of power ( $\text{ms}^2$  – for HR;  $\text{mm Hg}^2$  – for SBP and DBP;  $(1 / \text{min})^2$  – for spontaneous breathing). The ratio LF / HF is used to describe vegetative balance [9]. Baroreflex sensitivity (BRS) indicators defined by spectral method and called  $\alpha$ -factor were analyzed.  $\alpha$ -factor was measured separately within the range of high ( $\text{BRS}_{\text{HF}}$ ) and low ( $\text{BRS}_{\text{LF}}$ ) frequencies [10].

$$\text{BRS}_{\text{LF}} = \sqrt{\text{LF}_{\text{HR}} / \text{LF}_{\text{SBR}}} \quad (1)$$

$$\text{BRS}_{\text{HF}} = \sqrt{\text{HF}_{\text{HR}} / \text{HF}_{\text{SBR}}} \quad (2)$$

The data of central hemodynamics were determined on the basis of the first part of electrocardiogram by means of method of double-phase reconstruction proposed by Kim T.N. [11].

To assess the research results we have used the distribution-free method of statistical analysis, using which we can evaluate the Wilkoxson criteria, and also percentile method analysis based on determining the individual assessments of each indicators that take into consideration falling in appropriate limits of percentile ranges. [12,13]. The assessment of individual performance was conducted as follows: the range of <5% – expressed decrease; the range of 5–25% – moderate decrease; the range of 25-75% – normative; the range of 75–95% – modest increase; the range of > 95% – expressed increase.

**Findings and discussion.** 32 qualified water polo male athletes aged  $20,6 \pm 3,0$  years were examined in regards of the impact of trainings on their bodies.

The research included the study of physical parameters, routine methods of HR and BP and the study of cardiorespiratory system using SACR before and after training in state of relative relax. The training lasted for 2 hours and involved sessions in the pool, which was aimed at developing speed endurance. It was conducted within the period of annual training cycle of preparing for competition.

The characteristics of the main parameters of physical development of athletes are presented in Table 1.

*Table 1*

**Parameters of physical development of the studied group of athletes**

<b>Body mass, kg</b>	<b>Body length (upright), cm</b>	<b>Lungs vital capacity, ml</b>	<b>Fat, %</b>
83,9±7,4	188,3±3,0	5536,4±494,2	15,7±4,1

The data of cardiorespiratory system recorded before and after the training are presented in Table 2–5.

As shown in the Table 2, significant changes in terms of HR, SBP, PBP and RR (respiratory rate) occur after training, confirming the well-known data on the activation of the function of cardiorespiratory system caused by exercise. The values of heart rate variability (HRV) before and after the training are presented in Table 3, showing likely decrease in the variability in all ranges ( $p < 0,05$ ), which is characterized by expressed ( $p < 0,01$ ) decrease in overall power and increase in low-range and high- range components of HRV. The latter happens due to the increasing influence of the sympathetic part of VNS on heart rate [14].

*Table 2*

**The data of cardiorespiratory system of the studied group of athletes before and after the training**

<b>Parameter</b>	<b>before</b>	<b>after</b>
HR, min <sup>-1</sup>	65,7±8,1	93,3±11,7***
SBP, mmHg	121,8±6,4	132,5±7,2**
DBP, mmHg	82,0±5,2	85,9±6,4
PBP, mmHg	39,8±2,6	45,7±5,6*
RR, min <sup>-1</sup>	15,6±4,2	19,3±5,2*
Vtid, l	0,637±0,195	0,684±0,228

\*  $p < 0,05$ , \*\*  $p < 0,01$ , \*\*\*  $p < 0,001$

Table 3

**Changes of HRV impact on training load**

<b>Parameter</b>	<b>before</b>	<b>after</b>
TP, ms <sup>2</sup>	4160,3 (1984,7; 9239,7)	879,3 (349,7; 1781,7)**
VLF, ms <sup>2</sup>	566,4 (280,6; 1125,7)	178,3 (83,8; 292,6)*
LF, ms <sup>2</sup>	1218,0 (482,4; 2986,5)	430,6 (169,4; 877,0)*
HF, ms <sup>2</sup>	1730,6 (630,9; 3041,5)	173,0 (63,2; 735,1)*
LF/HF, ms <sup>2</sup> /ms <sup>2</sup>	0,81 (0,57; 1,57)	2,11 (1,11; 3,81)*

\*  $p < 0,05$ , \*\*  $p < 0,01$

To estimate the results of research of variability of heart rate of athletes using SACR a method of percental analysis was also used. It is based on the determination of individual assessments of individual features considering relevant limits of percental ranges designed for qualified athletes (Table 4) [13].

Table 4

**Boundaries of percentile distribution of HRV parameters in qualified athletes**

<b>Parameter</b>	<b>&lt;5</b>	<b>5-25</b>	<b>25-75</b>	<b>75-95</b>	<b>&gt;95</b>
TP, ms <sup>2</sup>	<1017,6	1017,6-2450,3	2450,4-7225,0	7226,1-15700,1	>15700,1
VLF, ms <sup>2</sup>	<77,4	77,4-207,4	207,5-812,3	812,4-2152,9	>2152,9
LF, ms <sup>2</sup>	<201,6	201,6-552,3	552,4-2116,0	2116,1-7885,4	>7885,4
HF, ms <sup>2</sup>	<265,7	265,7-835,2	835,3-3481,0	3481,1-7551,6	>7551,6
LF/HF, ms <sup>2</sup> /ms <sup>2</sup>	<0,13	0,13-0,37	0,38-1,47	1,48-5,53	>5,53

The analysis of individual parameters of HRV revealed that the effect of training is accompanied by expressed and moderate decrease of TP (respectively, in 54.8% and 25.8% of cases), VLF (respectively, in 29.0% and 41.9% of cases), LF (respectively, in 25.8% and 32.3% of cases,) and HF (in 58.1% of cases) and a moderate increase in LF / HF (in 48.4% of cases) see. Figure 1 (a-e).

That is, the research results presented above make it possible to conclude that in response to training the reaction of a cardiorespiratory system is accompanied by a number of regulatory alterations. Rather informative looks e decrease of autonomic regulatory impacts on HR after training, which can be explained by turning on the regulatory mechanisms with maximum involvement of inotropic function of



the heart during exercises, inacting hemodynamic mechanisms ensuring physical activity. It is obvious that such a mechanism of HR adaptation during exercises is associated with the reduction of influence of all (suprasegmental, sympathetic and parasympathetic) regulatory parts of VNS. An the same time, during a period after exercise activity VNS impact on HR begins to increase, primarily due to the activation of the parasympathetic division. According to our data, 38,7% of athletes reached the optimal level of HF and 32,3% the best level of autonomic balance.

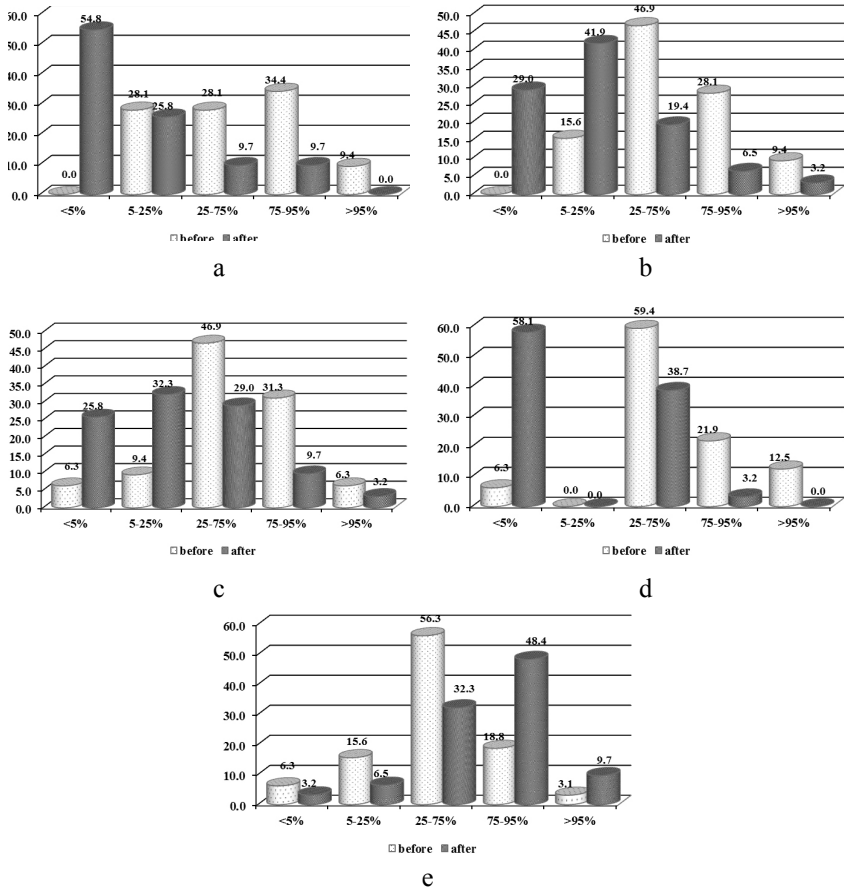


Figure 1. Distribution of HRV parameters (%) within the boundaries of percentile ranges in athletes before (light column) and after (dark column) the training load: TP (a), VLF (b), LF (c), HF (d), LF/HF (e).

In general, the analysis of individual changes of HRV parameters under the influence of training revealed the following: moderate and expressed decrease in general volume of HRV (TP, ms<sup>2</sup>) due to larger variety of options: moderate and expressed decrease in VLF (from 15.6% before to 70.9% after training), moderate and expressed decrease in LF (from 15.7% before to 58.1% after training), expressed decrease in HF (from 6.3% before to 58.1% after training) and moderate and expressed increase in ratio LF/HF (from 21.9% before to 58.1% after training). The of the greatest interest in this case are changes of HF-components: 58.1% of athletes were observed to have a decrease to less than 265,7 ms<sup>2</sup>, and some athletes (38.7%) remained within the optimal (835,3-3481,0 ms<sup>2</sup>) range [15].

The results prompted us to investigate how the mentioned athletes can be differentiated according to hemodynamic provision of their bodies. 2 groups were formed: the first group (EG<sub>1</sub>) consisted of 17, the second (EG<sub>2</sub>) of 15 athletes.

The characteristics of the main parameters of physical development of EG<sub>1</sub> and EG<sub>2</sub> are presented in Table 5.

*Table 5*

**The parameters characteristics of physical development  
of athletes from the studied group**

<b>Parameter</b>	<b>EG<sub>1</sub></b>	<b>EG<sub>2</sub></b>
Body mass, kg	72,0 (70,0; 76,0)	79,5 (76; 85,5) *
Body length (upright), cm	184 (181; 190)	186 (184; 189)
BMI, kg /m <sup>2</sup>	21,4 (20,8; 22,4)	22,4 (22,1; 22,9) *
Shoulder diameter, cm	41 (40; 42)	41,5 (40; 43)
Neck circumference, cm	38 (37; 39)	38 (36,5; 39)
Abdominal circumference, cm	77 (74; 80)	79 (76,5; 84)
Chest circumference, cm	96 (94; 99)	97 (94; 100)
Thorax mobility , cm	8 (7; 9)	9 (7; 10,5)
Mid-arm muscle circumference (relaxed), cm	29 (28; 29)	30 (29,5; 31) *
Mid-arm muscle circumference (tense), cm	33 (32; 34,5)	35 (32,8; 35,5) *
Forearm circumference , cm	28 (27; 28)	28 (26,5; 29)
Hip circumference, cm	52 (48; 56)	54 (50,5; 56,5)

<b>Parameter</b>	<b>EG<sub>1</sub></b>	<b>EG<sub>2</sub></b>
Tibia circumference, cm	36 (34; 37)	38 (37; 39) *
Lungs vital capacity, ml	4900 (4400; 5600)	5200 (4850; 5250)
Fat, %	9,8 (8,1; 13,5)	12,4 (8,9; 17,9)

\* –  $p < 0,05$

First of all, analyzing the data presented in Table 5, it should be noted that the differences in the changes of HRV HF-components after training are associated with the physical development of athletes, such as anthropometric and componential elements. This primarily refers to body mass (BM), circumferential size of the arm, leg, the absolute values of which are marked by probable differences, which are characterized by their increase in EG<sub>2</sub> and percentage of fat (Fat, %), the difference of which in EG<sub>1</sub> and EG<sub>2</sub>, though not probable, however, suggests an increase in these anthropometric parameters in EG<sub>2</sub> due to fat content. But probably it could be argued that the optimization of changes of HRV HF-components after training within a population range is characteristic for the athletes with more contours size of limbs.

Table. 6 shows comparative parameters of central hemodynamics of EG<sub>1</sub> and EG<sub>2</sub> athletes.

*Table 6*

**Parameters of central hemodynamics of athletes from the studied group**

<b>Parameter</b>	<b>EG<sub>1</sub></b>	<b>EG<sub>2</sub></b>
EDV, cm <sup>3</sup>	92,5 (87,0; 107,6)	116,3 (107,1; 118,8)**
ESV, cm <sup>3</sup>	27,1 (22,4; 33,7)	37,2 (33,9; 39,2)**
SV, cm <sup>3</sup>	64,9 (61,6; 77,1)	78,7 (72,5; 79,8)*
CO, l	4,4 (4,0; 5,1)	4,8 (4,5; 5,4)*
PVR, dyn×s×cm <sup>-5</sup>	1731,7 (1545,2; 1872,1)	1739,3 (1428,4; 1785,3)
CI, l/m <sup>2</sup>	2,32 (2,14; 2,63)	2,45 (2,26; 2,59)

\*\* –  $p < 0,01$ ; \* –  $p < 0,05$

Figure 2 presents the data on median and procental limits of stroke volume index (SVI ml / m<sup>2</sup>), the values of which are different for the studied groups of athletes, but not necessarily obvious.

The analysis of the types of central hemodynamics revealed that the vast majority of EG<sub>1</sub> athletes are noted by hypokinetic type of blood circulation

(88.2%), while the EG<sub>2</sub> athletes' hypokinetic type of blood circulation was observed only in 64% of cases. None of the groups possessed hyperkinetic type of circulation..

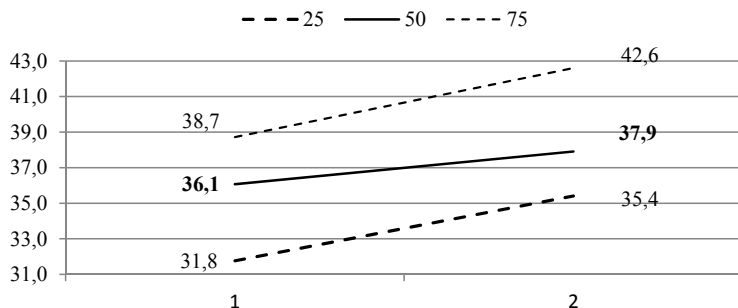


Fig. 2. Median and procental (25% and 75%) values of SVI (ml/m<sup>2</sup>) for the studied groups of athletes. Where 1 is EG<sub>1</sub> and 2 is EG<sub>2</sub>.

The comparative analysis of other indicators of central hemodynamics pointed to the likely differences in some of them. First, it is necessary to pay attention to the indicators of central hemodynamics, which speak of the size of the left ventricle, namely end-diastolic volume (EDV, cm<sup>3</sup>) and end-systolic volume (ESV, cm<sup>3</sup>), which is significantly higher in EG<sub>2</sub>, than in EG<sub>1</sub> group (p<0.01). A stroke volume (SV, cm<sup>3</sup>) was more likely (p <0.05) to be observed in EG<sub>2</sub> group.

Table 7 shows the results of calculation of  $\alpha$ -factor that characterizes baroreflex sensitivity. It is worth reminding that the values of the last prognose the effectiveness of the regulation of cardiac pump functioning in changing conditions of any type of the activity including training. Given the differences in values of BRS<sub>LF</sub> and BRS<sub>HF</sub> of the studied group it is possible to suggest that they are related to the size of the circumferential limbs and size of the left ventricle of athletes who are likely to be larger in EG<sub>2</sub> group. However, besides the characteristics of physical development and central hemodynamics, we can state that the response to training has clearly defined determinants of baroreflex sensitivity, the value of which at rest predicts reactivity of autonomic nervous system, namely its parasympathetic level in the aftermath of the training that can be used for evaluation of recovery mechanisms of athletes.

Table 7

**The parameters of arterial baroreflex sensitivity  
of athletes from the studied group**

Parameter	EG <sub>1</sub>	EG <sub>2</sub>
BRS <sub>LF</sub>	10,7 (8,7; 17,5)	19,8 (17,3; 22,1)**
BRS <sub>HF</sub>	12,8 (8,9; 24,9)	25,4 (17,0; 29,7)**#

\*\* –  $p < 0,01$  між значеннями в EG<sub>1</sub> та EG<sub>2</sub>; # –  $p < 0,05$  між значеннями показників в EG<sub>2</sub>

For further characteristics of features providing hemodynamics of athletes with different variants of HRV response to training an analysis of changes in the cardiovascular system of sportsmen of these groups was carried out in response to a standard exercise in a 20 sit-ups in 30 seconds (Table 8-10), which is widely used in the practice of medical control and allows to characterize the type of response to exercise (Martine Test).

Table 8 presents the data of the surveyed athletes at rest and after the Martine Test after 1,2 and 3 minutes of recovery. It should be mentioned here that the registration of parameters of the cardiovascular system of athletes during this test is performed by routine methods: pulsometry for 10 seconds with further conversion to 1 min. and measurement of blood pressure using a sphygmomanometer to within 2 mmHg.

As shown in the Table 8, in the initial state EG<sub>2</sub> athletes were more likely to reach higher value of SBP 126 (120, 130) mmHg against 118 (110, 120) mmHg in EG<sub>1</sub> group ( $p < 0.05$ ) and PBP 42 (40, 60) mm Hg compared to 40 (38; 42) mm Hg in EG<sub>1</sub> group ( $p < 0.05$ ) with almost identical values of HR and DBP.

That is, higher values of SBP and PBP at rest in EG<sub>2</sub> group at the background of the same values of HR and DBP can be associated with a higher baroreflex sensitivity and circumferential dimensions of the limbs that characterize the optimal level of influence on heart rate in the HF-range after training.

Table 8

**Averaged parameters of heart rate and arterial blood pressure  
in athletes from the studied groups while conducting the Martinet test**

Parameter	EG <sub>1</sub>	EG <sub>2</sub>
HR rest, min <sup>-1</sup>	66 (54; 78)	66 (60; 72)
SBP rest, mmHg	118 (110; 120)	126 (120; 130)*

<b>Parameter</b>	<b>EG<sub>1</sub></b>	<b>EG<sub>2</sub></b>
DBP rest, mmHg	80 (70; 82)	80 (76; 82)
PBP rest, mmHg	40 (38; 42)	42 (40; 60)*
HR restitution (0'00''), min <sup>-1</sup>	96 (96; 102)	96 (90; 108)
HR restitution (0'50''), min <sup>-1</sup>	66 (60; 72)	60 (54; 78)
SBP restitution (1'), mmHg	130 (128; 140)	150 (146; 154)*
DBP restitution (1'), mmHg	70 (60; 76)	66 (60; 70)
PBP restitution (1'), mmHg	70 (50; 80)	90 (80; 92)*
HR restitution (1'00''), min <sup>-1</sup>	66 (60; 66)	60 (54; 60)
HR restitution (1'50''), min <sup>-1</sup>	60 (54; 66)	60 (54; 60)
SBP restitution (2'), mmHg	130 (120; 140)	140 (136; 150)*
DBP restitution (2'), mmHg	70 (68; 80)	70 (66; 76)
PBP restitution (2'), mmHg	50 (40; 70)	70 (64; 80)*
HR restitution (2'00''), min <sup>-1</sup>	60 (54; 66)	60 (54; 60)
HR restitution (2'50''), min <sup>-1</sup>	60 (54; 66)	60 (54; 60)
SBP restitution (3'), mmHg	120 (110; 140)	140 (136; 144)*
DBP restitution (3'), mmHg	74 (70; 80)	72 (68; 76)
PBP restitution (3'), mmHg	50 (40; 60)	72 (70; 80)*

\* – p < 0,05

There were no probable differences in the values of heart rate immediately after exercise and within 3 minutes of recovery. At the same time, changes in blood pressure were characteristic and were related to SBP and PBP, which was reflected in a substantial credible increase in absolute values in response to stress and probably slower recovery within 3 minutes after exercise in EG<sub>2</sub> athletes compared to EG<sub>1</sub> group. That is, from the standpoint of economization of the function of the cardiovascular system the parameters registered in EG<sub>1</sub> group proved to be more favorable.

At the same time, while analyzing the data presented in Table 9, which shows the growth of the parameters of the cardiovascular system in response to a standard load, it should be noted that the only likely differences were observed in terms of QRI (p<0.05).

Table 9

**The growth of the performance of the cardiovascular system of athletes from the studied groups in response to load, %**

Parameter	EG <sub>1</sub>	EG <sub>2</sub>
growth HR, %	64,1±20,6	61,0±18,0
growth SBP, %	17,6±5,2	15,4±3,2
growth DBP, %	-12,2±9,3	-16,9±5,3
growth PBP, %	72,6±26,7	60,8±16,6
QRI, c.u.	0,83±0,36	1,03±0,30*

\* –  $p < 0,05$

The latter allows to suggest that the main hemodynamic response to a standard exercise in athletes from EG<sub>1</sub> and EG<sub>2</sub> is defined by baseline of their performance that in terms of SBP and PBP is significantly higher in EG<sub>2</sub> group. However, the percentage of PBP increase was higher than the percentage of HR in athletes from EG<sub>1</sub>, while they are the same in group EG<sub>2</sub>. To make quantitative analysis of these changes Kushelevskiy and Ziskin offered Quality Reaction Index (QRI), the fluctuations of which are normally within 0.5–1.0. At the same time, EG<sub>2</sub> group's average data of this index go beyond the upper limit, which indicates a certain discrepancy in chronotropic and inotropic functions of the heart due to the impact of training in this group.

Table 10 presents data of changes in the cardiovascular system at the end of the recovery after standard load comparing with baseline data.

Table 10

**The growth of performance of the cardiovascular system of athletes from studied groups at the 3d minute of recovery comparing with baseline data, %**

Parameter	EG <sub>1</sub>	EG <sub>2</sub>
growth HR, %	-2,5±3,6	-3,0±5,1
growth SBP, %	9,4±5,4	6,9±1,3
growth DBP, %	0,3±5,1	-9,9±4,0*
growth PBP, %	25,0±18,2	30,5±7,0

\* –  $p < 0,05$

The adequacy of response to standard exercise is determined by gradual recovery of the parameters of cardiovascular system, especially the heart rate, to the third minute of the period of restitution, revealing the level of tolerance of an athlete to physical activity.

According to the data presented in Table 10, heart rate significantly restored to the original level and even lower in both groups of athletes to the end of the third minute after a standard load. At the same time, SBP and especially PBP figures were higher than original. Likely reduce of DBP is noteworthy here comparing to baseline data in EG<sub>2</sub> group unlike EG<sub>1</sub>, which according to ordinary data reached almost 10%.

Registered by us differentiation of changes in HRV HF-components of water polo athletes in pre-contest period of annual training cycle (after training to develop speed endurance) revealed that it is determined by certain features of physical development and response of the cardiovascular system to a standard exercise. The latter can be used as prognostic criteria for fitness of athletes during current and phased control in annual training cycle.

First, it is necessary to point out the differences between the athletes of studied groups while undergoing medical control traditionally. The research results of EG<sub>2</sub> athletes comparing with athletes from EG<sub>1</sub> revealed that HRV HF-component optimization at the population level after training is characterized by a greater percentage of fat and significantly larger body size and circumferential arm and leg in comparison with athletes who are noted for an expressed decrease in HRV HF-component. The study of parameters of the cardiovascular system at rest and after a standard load revealed that HRV HF- component optimization after training is associated with significantly higher levels of SBP and PBP in the initial state and within the dynamics of 3 minutes of recovery after standard load and greater decrease in DBP at the end of the period of restitution, which reached almost 10% in comparison with the original level. At the same time, quantitative characterization of response to standard exercise (QRI) suggests that HRV HF-component optimization (EG<sub>2</sub>) after training mismatches reactions of chronotropic and inotropic cardiac functioning.

Rather informative were the values that indicate the size of the cavity of the left ventricle (EDV, cm<sup>3</sup> and ESV, cm<sup>3</sup>), which after exercise were significantly higher ( $p < 0.01$ ), significantly higher ( $p < 0.05$ ), were defined as SV (cm<sup>3</sup>) and cardiac minute output (CO, l) in the athletes with optimal values of HF (ms<sup>2</sup>).

In general, the research revealed that the mentioned features of changes in heart rate variability in the high-frequency range after training have rather accurate determinants in hemodynamic securing an athlete, which in turn can



be used to predict and adequately assess the state of the athlete in the recovery period after the competition.

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# CONTENT

Introduction	3
<i>La Rocca, G.</i> THE ITALIAN HEALTH COMMUNICATION FOR CHILDHOOD. AN ANALYSIS OF TWO DIFFERENT ADVERTISING CAMPAIGNS	4
<i>Khrystovaya T. Ye.</i> STATUS OF STUDENTS HEALTH: PROBLEMS AND THEIR SOLUTIONS	20
<i>Romanchuk O., Pahleuanzade A., Dolgier Ye.</i> THE IMPACT OF LONG-TERM AEROBIC EXERCISES ON PHYSICAL STATE OF MIDDLE-AGED WOMEN	33
<i>Mikhalyuk Ye. L.</i> UNIFICATION OF SPORTS TERMINOLOGY IN MODERN SPORTS MEDICINE	49
<i>Polianska O. S., Gulaga O. I., Moskaliuk I. I.</i> FUNCTIONAL STATE OF THE CARDIO-VASCULAR SYSTEM WITH VARIOUS PHYSICAL LOAD	55
<i>Mikhalyuk Ye. L.</i> THE IMPACT OF MOTORING ON SOME INDICATORS OF CARDIOVASCULAR AND AUTONOMIC NERVOUS SYSTEMS IN VETERANS OF SPORTS	66
<i>Guziy O.</i> DIFFERENTIATION OF HEMODYNAMICS OF TOP ATHLETES DEPENDING ON HEART RATE VARIABILITY AFTER TRAINING	76

У збірнику наукових праць представлені дослідження проблем спортивної медицини, що розкривають соціальні аспекти розвитку захворювань в умовах низької фізичної активності, необхідності проведення лікарського контролю для збереження здоров'я студентів, впливу занять фізичними вправами на жіночий організм. Важливі питання розглядаються в роботах, присвячених методологічним проблемам проведення досліджень спортсменів, а також особливостям серцево-судинної системи у висококваліфікованих спортсменів і ветеранів спорту.

Збірник буде корисний соціологам, спортивним фізіологам, кардіологам, спортивним лікарям.

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Формат 60×84<sup>1/16</sup>. Ум. друк. арк. 5,35.  
Тираж 300 прим. Зам. № 7 (2).

Видавництво і друкарня  
«Ю р и д и ч н а л і т е р а т у р а»  
(Свідоцтво суб'єкта видавничої справи  
ДК № 4284 від 23.03.2012 р.)  
65009, м. Одеса, вул. Піонерська, 7  
Тел.: (048) 777-48-79



Провідні фахівці зі спортивної медицини України (The leading specialists in sports medicine Ukraine). Зліва направо, верхній ряд: Ромаскевич Юрій Олександрович, д. мед. н., професор (м. Херсон), Неханевич Олег Борисович, д. мед. н., доцент (м. Дніпро), Кляпчук Василь Васильович, д. мед. н., професор (м. Запоріжжя), Михалюк Євген Леонідович, д. мед. н., професор (м. Запоріжжя); нижній ряд: Дорофєєва Олена Євгенівна, д. мед. н., доцент (м. Київ), Дудар Лариса Вікторівна, д. мед. н., професор (м. Київ), Романчук Олександр Петрович, д. мед. н., професор (м. Одеса), Кришень Валерій Павлович, д. мед. н., професор (м. Дніпро), Абрамов Віктор Васильович, д. мед. н., професор (м. Дніпро), Родинський Олександр Георгійович, д. мед. н., професор (м. Дніпро)

*From left to right, the upper row: Romaskevich Yuriy Oleksiiovich, DM, Professor (Kherson), Nekhanovich Oleg Borisovich, DM, Ass. Professor (Dnipro), Klapchuk Vasil Vasilovich, DM, Professor (Zaporozhye), Mikhalyuk Yevgen Leonidovich, DM, Professor (Zaporozhye); lower row: Dorofieieva Olena Yevgenivna, DM, Ass. Professor (Kyiv), Dudar Larysa Viktorivna, DM, Professor (Kyiv), Romanchuk Oleksandr Petrovich, DM, Professor (Odessa), Abramov Viktor Vasilovich, DM, Professor (Dnipro), Rodinskiy Oleksandr Georgiiovich, DM, Professor (Dnipro)*