

CURRENT INFECTIOUS THREATS ASSOCIATED WITH THE DEVELOPMENT OF CIVILIZATION AND PROGRESS IN MEDICINE - METHODS OF PREVENTION AND EDUCATION

**Maria Koziół-Montewka^{1,2}, Anna Pańczuk¹, Małgorzata Tokarska-Rodak^{1,2},
Jolanta Paluch-Oleś^{1,2}, Iwona Gładysz¹, Agnieszka Sikora², Aneta Filipek-Czerska¹,
Edyta Kawka¹, Emilia Pawłowicz¹, Beata Kosińska¹, Maciej Montewka^{1,2}, Aneta Skrzek²,
Małgorzata Koziół², Anna Gózd-Barszczewska², Piotr Barszczewski², Stanisława Spisacka¹**

¹Pope John Paul II State School of Higher Education in Biała Podlaska

²Medical University of Lublin

Koziół-Montewka M., Pańczuk A., Tokarska-Rodak M., Paluch-Oleś J., Gładysz I., Sikora A., Filipek-Czerska A., Kawka E., Pawłowicz E., Kosińska B., Montewka M., Skrzek A., Koziół M., Gózd-Barszczewska A., Barszczewski P., Spisacka S., (2014) *Current infectious threats associated with the development of civilization and progress in medicine - methods of prevention and education*, Health Problems of Civilization 1 (8), p. 6-14

Summary: The development of civilization, economic growth, urbanization, industrialization and progress in medicine bring to the society an improvement in the quality of life, but at the same time caused changes in lifestyle, environmental conditions, and changes in the natural environment. All of these led to develop civilization diseases which have critical impact and the adverse effect on our health, about what we not always realize. In the past fifty years, about 30 new pathogens appeared causing diseases such as legionellosis, Lyme disease, and increase unexpectedly tuberculosis incidence which in some regions is associated with HIV infections. Also widespread use of antibiotics caused and still causing bacterial resistance increase to most of them. With the development of medicine and surgery, parallel effects of surgical areas and infections associated with implanted cardiac devices in the majority of the life-saving ones appeared. The development of research techniques allowed for the finding of new relationships between ecosystems in the microbiome of the gastrointestinal tract with of obesity in the society. The presence of new health aspects of civilization diseases impose pressure to create new prevention methods and public education.

Keywords: Lyme disease, legionellosis, tuberculosis, microbiome, antibiotic resistance

Civilization human health was changing over the centuries as a response to the processes of urbanization, industrialization and environmental change. It was related with development and size of infections epidemics, and mortality. During that time we observed progress in medical knowledge, prevention methods, and generally accepted public health status. Traces of the effects of infection are visible in prehistoric anthropological research, and they concern tuberculosis changes in bones, smallpox. The first mention of the epidemic was recorded in the fifth century BC, and its direct cause was crowding inhabitants and troops within the area of Athens. Mortality rate was high, and the main reason for that was the lack of awareness of proper hygiene. In the Middle were great epidemics of smallpox, plague, cholera, influenza which destroyed entire cities and the states. They were largely caused by overcrowding of cities and increased migration of the population. In the subsequent centuries the scale of infectious diseases was modified by the process of urbanization development of industry (late nineteenth and twentieth century). Progress of microbiological knowledge followed by discoveries of Louis Pasteur, Robert Koch and Ilya Mechnikov. The first preventive vaccinations against smallpox were introduced thanks to the observations of Edward Jenner in the eighteenth century.

Modern civilization is still not free from infectious diseases in spite of significant progress in medicine economic, and social achievements. We observe important changes in the profile of infections, prevention methods, species of pathogenic microorganisms and their sensitivity to antibiotics. At the end of the twentieth century infections of humans and animals with new species of bacteria and viruses occurred, and in some parts of the world long forgotten diseases returned. Human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) spread on a large scale, as well as encephalitis and tick-borne tires, hemorrhagic viral diseases, viral gastrointestinal infections, prion diseases, new forms of influenza, avian and swine flues, SARS (severe acute respiratory

Address for correspondence: Maria Koziół-Montewka, Państwowa Szkoła Wyższa im. Papieża Jana Pawła II w Białej Podlaskiej, 21-500 Biała Podlaska, ul. Sidorska 95/97, e-mail: koziolm@yahoo.com, phone +48 (83)-344-99-18

Tables: 0 **Figures:** 0 **References:** 36 **Full-text PDF** www.hpc.edu.pl **Copyright** © Pope John Paul II State School of Higher Education In Biała Podlaska, Sidorska 95/97, 21-500 Biała Podlaska **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non-commercial and is otherwise in compliance with the license.

syndrome), Lyme disease, and legionellosis. The advancement of medicine brought along widespread infectious diseases. Transmission of microorganism can happen by air inhalation, tissues or blood (hepatitis B, C virus). Bacteria and virus cause infection of patients also known as nosocomial infection. A separate problem is rapid and wide increase of antibiotic resistance in bacteria especially multidrug resistance (MDR). Another threat is military action involving the collection and modification of biological weapons including the most dangerous species of bacteria and viruses like: anthrax, smallpox, tularemia, and others. There is also a worrying return of tuberculosis. The new image of tuberculosis infection is primarily within multidrug- resistance strains, infection of the youth, and elderly people in countries with a high degree of civilization. We observe severity of tuberculosis as an epidemic in Asia and Africa, especially in conjunction with HIV infections.

In Poland, the significant newly emerging problems associated with contemporary processes of civilization are tuberculosis, Lyme disease, legionellosis and threats infections caused by multidrug-resistance bacteria. Also along with the advances in medicine nosocomial infections became a leading problem, particularly those infections associated with complex operations for eg. abdominal, orthopedic, infections of implantable devices for heart and vascular surgeries. The subject involving infectious risks in the era of modern civilization is multifaceted and includes various infections. There exist strong relationship and cause between development of various diseases in many aspects of life in the modern world.

Tuberculosis as a significant threat to the society in conjunction with economic state

Global threat of tuberculosis (TB) is expressed clearly, depending on the economic status of the region showing in a direct way economic dependence on the level of the civilization. The largest number of TB cases in the world in 2012 were recorded in South-East Asia (29%), Africa (27%) and the Western Pacific region (19%). India and China accounted for 26% and 12% of all cases, respectively. Compared to countries with high economic level where the incidence of tuberculosis constitutes a small percentage and the main groups of patients are immigrants from poor countries in terms of economy. Despite the undertaken efforts and huge financial outlay, tuberculosis remains a major global health problem. In 2012, the number of people who developed tuberculosis was estimated at 8.6 million and the number of deaths caused by tuberculosis at 1.3 million people (including 320 000 deaths among people infected with HIV). Since the announcement in 1993 by the World Health Organization (WHO) that tuberculosis was a global threat to the health of the population, the epidemiological situation of tuberculosis in the world is gradually improving. This is the effect of the Stop TB Strategy, implemented within the framework initiated in 2000, the Global Plan to Stop Tuberculosis (TB Stop Global Plan). Stop TB Plan was created as a response to formulated by the UN Millennium Development Goals involving the reduction in the incidence of tuberculosis by 2015 by about half as well as the change to the growth trend of TB in relation to diseases such as AIDS and malaria.

The current epidemiological global situation of TB shows the continuing downward trend, although not quite as fast as desired. In 2012, the number of people with TB, HIV-infected was estimated at the level of 1.1 million, which accounted for 13% of new cases of tuberculosis in the world. Three-quarters of the number of the cases were recorded in the African region. In 2012 all around the world 450 000 people with tuberculosis multidrug-resistant (MDR-TB) were recorded, and the number of deaths caused by this type of tuberculosis amounted to 170 000 people.

Epidemiological situation of tuberculosis in Poland is monitored by the Institute of Tuberculosis and Lung Diseases in Warsaw (Polish abbreviation: IGiChP), conducted by the National Register of Tuberculosis (Polish abbreviation: KRG). Annual IGiChP newsletter presents the most recent data on the incidence of tuberculosis reported to the KRG. In Poland, for the past number of years there has been a downward trend in the incidence of TB. In 2012 in Poland there were 7542 new cases and incidence rate was calculated at 19.6 /100 000 inhabitants. Most cases of TB were reported in the age group between 45 and 64 years of age (3404), while least cases were reported among children under 14 years of age (95). For several years a wide variation in cross-provincial maturity has been observed. In the year 2012 the highest incidence rates were reported in the provinces of Lublin and Świętokrzyskie (30.2/100, 000 and 29.3 /100, 000), and the lowest in the provinces of Lubuskie and Greater Poland (10.6/100, 000 and 10,9/100, 000).

One of the reasons for the slow decline in epidemiology of tuberculosis is still a large number of cases of latent tuberculosis infection (LTBI), estimated by (WHO) to 1/3 of the population of the world. Detection and treatment of LTBI is currently in the recommendations of the Centers for Disease Control and Prevention (CDC), which are related to new risk groups, resulting from the progress of civilization. These groups are health workers, HIV positive, patients qualified for biological therapies, patients who have undergone organ transplants, people with diabetes, dialysis patients, alcoholics and others with immunosuppression or treated with immunosuppressants (Jagielski

T. 2010). On the basis of recent studies, the number of latently infected persons in each group is from 20 to 50% depending on the characteristics of the group and the incidence rate for the entire population. Despite the existence of effective prophylactic treatment, there is no appropriate procedure for administration of people from all risk groups which is not conducive to stopping the transmission of infection. There are also no medical procedures to monitor people at high risk of developing TB. A particular threat are multidrug resistance strains (Augustynowicz-Kopeć E., Zwolaska Z. 2008).

The results of various studies show that low socio - economic status increases the likelihood of developing tuberculosis and progression of latent to active tuberculosis disease. In the United States it has been shown that the risk of tuberculosis depends on each of the indicators used to determine the status, that it is the density of housing, poor education, low income, use of welfare and unemployment care. Density of housing plays the role of the risk factor of the most paramount importance for tuberculosis. In the large cities of Western Europe dozens of differences in the incidence of tuberculosis between rich and poor districts of the city are observed. According to the results of tests for tuberculosis long-term unemployed persons suffer from it more frequently. According to U.S. data, more than half of the patients had remained without work for at least two years before the diagnosis of tuberculosis. In Estonia, a country more similar to Poland than the countries of Western Europe as far as the level of economic development is concerned, a risk factor for tuberculosis was loneliness, low levels of educational attainment, alcohol consumption, smoking, and periodic food shortages. The risk was higher for those with low income or without regular income, also among the unemployed and former prisoners. According to recent research carried out in Russia, greater risk of the disease coincided with low levels of wealth, lack of financial stability, living in crowded areas, drug addiction, imprisonment, and with diabetes and residing with a person with tuberculosis. The risk of tuberculosis among the unemployed was six times higher than among economically active people.

A special group exposed to mycobacterial infections is formed by the homeless. The United States is a country where the problem of homeless with tuberculosis was analyzed in several studies. Homeless shelters are often a place where the disease is transmitted. One of the residents of such shelters in Syracuse, New York, was the source of infection for 10 months before he began treatment, causing various new infections in the meantime. This hostel did not have a good ventilation, its inhabitants were often malnourished, HIV carriers or drug addicts, and all these factors contributed to the development of the disease.

In prisons, reformatories high rates of TB are noted which is associated with a low level of living conditions of prisoners from different backgrounds and communities. Conditions in the prison make both the infected and the healthy people remain in close proximity for a given time. At least three factors contribute to the high rate of tuberculosis in the closed facilities. Firstly, different numbers of incarcerated people are exposed to tuberculosis (eg, users of illicit substances, people with low socio-economic status, and people with HIV). Secondly, the physical structure of facilities contributes to the transmission of disease through inadequate ventilation of rooms which are closely adjacent. Thirdly, the movement of prisoners to overcrowded cells in conjunction with existing TB infection increases the risk of transmission of *M. tuberculosis* (Recommendations from CDC 2006).

On the basis of existing scientific knowledge and the applied experience of public health officials, the basic steps necessary to prevent tuberculosis in closed facilities were set out. These basic steps can be divided into the following recommendations: 1. screening tests (finding people with the disease and with latent tuberculosis), 2- stopping (preventing the transmission of tuberculosis and treatment of patients with the disease), 3- evaluation (monitoring and evaluation of the performance of screening), 4- cooperation of prisons and the health service in the control of TB. Overriding targets can best be achieved with the cooperation, action and shared responsibility of both the prisons, and the relevant departments of medical services (WHO Report 2010). The above included recommendations can help health professionals, objects enclosed in preventing the transmission of tuberculosis and its control among inmates and personnel of the institution.

Lyme disease - new infections and their relationship with ecological changes of the environment

Civilization changes indirectly affect environmental change and the causes of the observed increase in the incidence of Lyme disease are multi-faceted and include the etiological agent, vector and reservoir of spirochetes. The spread of *Borrelia burgdorferi* promotes broad geographical reach of ticks that are the carriers of these pathogens. Increasingly, their presence is noted within the cities (parks, private estates, gardens) and industrialized areas. A major role in the expansion of ticks is attached to wandering hosts, and in particular birds. The occurrence of ticks in new habitats is also the result of climate change and changes in land use (Rizzoli A. et al. 2011, Wójcik-Fatla A. et.al. 2009). In terms of climate change, the attention is paid to higher minimum temperatures (at night time and in the winter) and early spring. Changes in land use conversion of farmland into fallow fields and

woodlands promote development of tick populations. Another important factor that have strong influence for the increase in the incidence of Lyme disease is rising popularity of active, outdoor recreation and tourism. It is often associated with the penetration of ecosystems seldom previously visited. In the absence of a vaccine against Lyme disease only the non-standard prevention is possible. Educational activities seems to be very important aspects to prevent infection of *B. burgdorferi* (Rizzoli A. et al. 2011). In particular, these activities should be addressed to the inhabitants of endemic areas and persons occupationally exposed to ticks for example foresters, hunters, ground cover gatherers, farmers and many other professions that require work in the open air.

Researches are focused on antigenic variation of spirochetes, the location of the pathogen in tissues, and generation of persistent clinical manifestations of infection and issues post treatment of Lyme disease syndrome (PTLDS). In Europe exist 3 species of *Borrelia*, which were considered to be pathogenic: *B. burgdorferi* s.s., *B. garinii*, *B. afzelii* and 4 potentially pathogenic: *B. valaisiana*, *B. spielmanii*, *B. bissettii* and *B. lusitaniae*. In recent times another species became known - *B. bavariensis*. It is therefore necessary to take account of all the species in the generation of infections on an individual basis, participation in mixed infections and their impact on the clinical manifestation (Ruderko et al. 2009 Tjisse-Klasen et al. 2013).

In relation to the necessity of remaining in organisms with different immune potential (ticks, the reservoir species, men) spirochetes have developed mechanisms enabling them to adapt to these different micro-environments. The complexity and specificity of the processes that occur during infection with *B. burgdorferi* of different hosts is therefore observed. *Borrelia* spirochetes have a set of proteins to help them to adapt to the microenvironment in the body, to survive in these conditions, the colonize tissue but also they possess the ability to change the host.

Proper diagnosis and treatment does not always guarantee an effective eradication of the pathogen and the total elimination of symptoms of the disease. Approximately 10-20% of patients diagnosed with Lyme disease have non-specific clinical symptoms despite use of long antibiotic treatment (Lakos et al. 2012). This aspect should be considered in the context of (PTLDS). The cause of PTLDS occurrence is not entirely clear. It is believed that these symptoms may be related to tissue damage or dysfunction of the elements in immune system during infection.

Researches can better understand infection processes caused by *B. burgdorferi* using most modern technology. One of the method is atomic force microscopy (AFM). By using these technique we can visualize the changes that can occur on the surface of the bacteria by the action of lytic potential factors and to assess their effects. Young's module measurements allow for determining changes in the flexibility of the surface. The measurement of the coefficient of adhesion provides information on the adhesion ability of the pathogen. Precise measurements of the mechanical properties of cells allow in a very precise way to assess the size, intensity and extent of changes in the cells of pathogenic microorganisms thereby creating a new face of microbiology (Sapi et al. 2012).

Legionellosis new disease disclosed in connection with urbanization and industrialization

The first epidemic of legionellosis was reported in 1976 among the participants of the convention of U.S. veterans of the American Legion of Pennsylvania in Philadelphia in the United States. There was a sudden change of pneumonia which was subsequently called Legionnaires' disease (Abigail A et al. 2005). The cause of the infection was the presence of bacteria in the hotel air conditioning system. The disease affected the 186 people, both of the hotel guests, as well as the staff of this hotel, on the end 34 people died. In view of industrialization and urbanization lead to liberation of wide variety infectious agents. These pathogens are low pathogenicity, however, in patients with impaired immune system, can cause serious infections which are often life threatening. That kind of microorganism are *Legionella* spp. They are responsible for legionellosis, which can take the form of as clinically atypical pneumonia and Pontiac fever. The development of the infection and its clinical form depends on the interaction between the pathogen and macroorganism. The main role plays immune status of a person and risk of exposure to pathogen. The virulence and number of bacteria penetrating the lungs are also important. Especially the most virulent is strain - *L. pneumophila* serogroup 1 (SG 1) (Sikora A and Inn.2013). In Europe, the incidence of Legionnaires' disease is between 3-8% of the exposed people, while the incidence rate in the case of Pontiac fever is much higher, around 80-95%. In approximately 20% of the elderly people *Legionella* antibodies is detectable. It indicates the presence of exposure to the pathogen (Ciechomski P et al. 2005). *Legionella* colonize hot and cold water supply system in large public buildings, households, and industrial systems. The water distribution systems used not continuously are hazards for *Legionella* infection. Additionally other risk is connected with water distribution system with "dead legs" of the installation and the intake of water, eg. dredging taps, shower strainers pose a threat. *Legionella* spp. can colonize in medical equipment (e. g. dialyzers, respirators, spirometry, inhalers, dental turbines), equipment for hydrotherapy and balneotherapy, air conditioning systems, and cooling towers in industrial plants, and shopping centers. *Legionella*

infection is caused by the inhalation of aerosol water and air containing by bacteria (Gordon M. 2007, Bartram J. et al. 2006). Factors contributing to the colonization of artificial water distribution systems are: increased temperature (optimal temp. 20°C-45°C), the presence of sludge, mud, corrosion products, biofilm, and biological agents (other bacteria, protozoa), the stagnation of water installation (no recirculation, "dead legs" of the installation), and too low concentration of the disinfectant. In Poland, the epidemic outbreak of Legionnaires' disease was diagnosed between December 2006 and March 2007 in the Regional Specialist Hospital in Jastrzębie Zdroj (Department of Ophthalmology). 4 persons were infected, of which 3 people died (Antończyk M. et al. 2009). Another outbreak of *Legionella* was the case in Czeladź, where 23 people got ill. There were detected 10 cases of Legionnaires' disease in 2013 in Poland (data from National Institute of Public Health - National Institute of Hygiene). Researches show that in Poland hot water distribution system in hospitals other public buildings are the most frequently colonized by *L. pneumophila* (Matuszewska R. et al. 2009). In Polish law exist regulation for legionellosis which should be reported, and registered by the State Sanitary Inspection according to «Act on the Prevention and Control of Infections and Infectious diseases in humans» (from 5 December 2008).

Problems of nosocomial infection

With the development and progress in surgery operations that were previously impossible or too much of a risk are presently carried out. Operated patients are getting older, have many underlying diseases, with were considered non-operational (Halabi WJ et al. 2013). Nowadays, we have to deal with newly emerging threats such as fungal infections or surgical site infections (SSI). Developed schemes of actions in the prevention of bacterial and fungal infections tend to be less according to growing number of cases of SSI. The so-called Bayesian networks are helpful, also called as conviction networks. They are used to predict performance in the collective tests (eg, for a group of patients) and help to develop new workflows in the prevention of the aforementioned infections. It is possible that developing standards of advanced algorithms based on Bayesian networks- may allow for a significant reduction in the number of complications after surgery, shorter hospital stay, and reduced treating cost (Druzdzal M. 1999). Advanced statistical methods are also the neural networks. They were created as a result of research conducted in the field of artificial intelligence. They relate to the construction of models of the basic structures that occur in the brain. Bayesian networks and neural networks can give an answer to two important questions: 1) what factors are most important for the development of SSI in patients undergoing abdominal surgeries, and 2) whether the set of these factors is the same for bacterial infections and fungal infections.

In the group of civilization diseases important place take a part heart diseases. It is connected with dynamic progress in cardiology and cardiac surgery, in the range of clinical diagnostic and treatment methods. The main role play cardio-implants widely used in interventional cardiology. These include: permanent pacemakers (PM), implantable cardioverter defibrillators (ICD), cardiac resynchronization therapy (CRT), stents supporting light narrowed coronary arteries, artificial heart valves, and self-expanding occluders closing defects in the heart. A growing number of treatments help to expand the indications for their conduct, improve quality, and extend the life of patients. What is more it can cause of increased incidence of clinical important infections. Worldwide, there are about 3.25 million patients with PMs and 180 thousand with an ICD (Chua J.D et al. 2000). In 2011 in Poland over 36 thousand devices were implanted. It accounted for 250% increase in the number of procedures performed in the country in the past 10 years (Kuśnierz J. 2012). Unfortunately, this correlates with the increasing number of infections. The incidence of infection for PMs is set at 0,13-19,9% and 0.8% for the ICD (Sohail M.R. et al. 2007). In patients with PMs / ICDs early local complications in the form of a box of infection may occur. At the first year after surgery can occur early complication in form of a box infection and late complications like Cardiac Device Infective Endocarditis (CDIE). CDIE is one of the most serious systemic complications in this group of patients and is estimated at 6,4-23% (Greenspon A.J. et al. 2012). Microorganisms that infect PMs / ICDs systems are characterized by a broad spectrum of species and different sources. The group of microorganisms colonizing most of these devices includes: *Staphylococcus epidermidis* - 42-68%, *Staphylococcus aureus* - 24-45%, *Escherichia coli* - up to 22%, *Klebsiella* spp. - up to 9%, to 8% *Enterococcus* spp., *Streptococcus* spp. - 6% and other constituting 14%. *S. epidermidis* constitute the physiological skin flora of humans. It has been shown that *S. epidermidis* constituting is the most common isolated pathogen of areas around PMs / ICDs pockets. This species has the ability to produce mucus matrix, which is an early stage of the biofilm formation. This structure of closely adjacent to each other bacteria is formulated on the elements of the PMs / ICDs and significantly impairs the penetration of antibiotics (Chua J.D et al. 2000, Sohail M.R. et al. 2007).

The growing problem of bacterial resistance to antibiotics

An extremely important problem of modern civilization is the sharp increase in bacterial resistance to antibiotics. The discovery of antibiotics was a turning point in medicine and it completely revolutionized medicine. Unfortunately, nowadays the widespread overuse and inappropriate use of antibiotics with a broad spectrum of activity is of overwhelming and considerable size. As estimated by the *CDC* about one third of the prescribed antibiotics per year is not justified. The use of antibiotics without justification of the necessity of their administration, different patterns of conduct of empirical antibiotic therapy, failure to comply with the dosage by patients, and arbitrary shortening the therapy after resolution of clinical signs in the ambulatory treatment leads to their ineffectiveness. The rapid development of bacterial resistance to antibiotics is thus observed, and medical experts continue to warn of a return to the pre-antibiotic era (J. Davies and D. Davies, 2010; Brisht R. et al. 2009).

Drug resistance of microorganisms to antibiotics leads to serious consequences, ranging from no response to treatment in prolonged illness, thereby increasing the risk of death, the increase in the number of infected people in the environment of the patient, and a significant prolong hospitalization. The hospital environment plays a special role in the development of resistance, since about 70% of microorganisms that cause hospital-acquired infections are resistant to at least one of the antibiotics used in medicine. The use of combined therapy, although it is effective in many cases, further complicates this problem, cause it leads to selection of MRD bacteria (Brisht R. et al. 2009).

Most therapeutically problems are related with: methicillin-resistant and vancomycin-resistant *Staphylococcus aureus* (MRSA, VRSA), vancomycin-resistant *enterococcus* (VRE), clinical isolates with cross resistance to marcolides, lincosamides and spectogramins B (MLSB), *Enterobacteriaceae* with extended-spectrum β -lactamase (ESBL), strains producing carbapenemase (KPC – *Klebsiella pneumoniae carbapenemase*) and metallo- β -laktamase (MBL) (Bassetti M. and Righi E. 2013; Dzierżanowska D. 2009). Some strains may be resistant to all approved antibiotics, so only effective way of elimination seems to be the use of experimental and potentially toxic drugs (Brisht R. et al. 2009).

Excessive and irrational use of antibiotics for empiric therapy not only in medicine may have a negative impact on the quality of public health. The increasing use of tetracyclines and other antibiotics outside of medicine, like in animals, leads to their appearance in food of animal origin which entails a negative impact on the health of consumers. Residues of medicines consumed with food for a long time, even in small doses, can contribute to the creation and spreading of resistant strains of micro-organisms (selective pressure). Consequently, the possibility of failure of antibiotic therapy in clinical situations among humans increases (Gajda A. et al. 2012).

Growing microbial resistance to drugs is a priority in terms of public health. In numerous reports of international, national and local agencies attention is drawn to that serious multidrug-resistance problem. In spite of the proposed relevant resolutions and recommendations, we are observing quick development of antibiotic resistance (J. Davies and D. Davies, 2010). In order to hinder this disturbing phenomenon in Poland the National Program for the Protection of Antibiotics has been launched (www.antybiotyki.edu.pl). There is a need for continuous education in both the social and professional scope towards the rational use of medicines, improvement of medical and veterinary guidelines, reduction in the use of antibiotics as agents stimulating food and animals, as well as the further development of new therapeutic agents (Brisht R. et al. 2009).

Changes in nutrition-changes of the microbiome of the gastrointestinal tract, obesity as the cause of diseases of civilization

With the rapid changes in human lifestyle, including dietary habits we can observe alarming increase of obesity. This is all the more worrying that affects young people. Nowadays, obesity is classified as a civilization disease. Obesity is associated with an increased risk of many metabolic diseases, including cardiovascular diseases e.g. hypertension, dyslipidemia. A new research direction, which stems from the progress in the development of genetic methods, is the research on microbiome. Intestinal flora contribute towards the regulation of metabolic endotoxemia and play a role in pathogenesis of obesity (Cani P.D. et al. 2007). With regards to obesity, it has been shown that a relationship exists between the composition of gastrointestinal flora and nutrient absorption in the gastrointestinal tract (Jumpertz R. et al 2011).

Studies have shown the special relationship between the diet-induced obesity and the reduced amount of *Bifidobacterium* spp., *Bacteroidetes* and *Eubacterium rectale* (Cani P.D., et al. 2007). It has also been proven that there is an effect of bacteria colonizing the gastrointestinal tract on the control of expression of the lipid metabolism regulator Angiopoietin-like protein 4 (Angptl4). Function of that protein is regulation fatty acid oxidation in muscle

and adipose tissue (Bäckhed F. et al. 2007). These results suggest that species composition of the microflora, as well as the entire network of microbial mechanisms regulating homeostasis (eg. inflammation regulators, hormonal game or the state of immune system) are important factor in overweight and obesity. Looking at impact of the microorganisms on homeostasis and the development of certain pathological changes, new possible treatment options like use of pre- and probiotics should be considered.

Changes in microflora of the digestive tract are related to inflammatory bowel diseases (IBD) which are a group of diseases characterized by the presence of chronic inflammation of the gastrointestinal tract. The most common disease entities rated in this group are: ulcerative colitis (CU) and Crohn's disease (CD). In recent years we have seen a significant increase in the incidence of inflammatory bowel diseases - especially in Crohn's disease. The incidence varies in different regions of the world, but the highest range of new cases is found in countries of North America and Europe. According to the currently available data, the highest incidence rates for CU are recorded in Iceland 24,3 per 100000/per annum, while in Great Britain it is 12, 7 per 100000/per annum (Molodecky N. et al. 2012). Understanding the role of microflora in the development of IBD may help to create a new therapeutic options, and appropriate composition of microbiome can lead to reducing the incidence of these diseases.

Public education in the prevention of civilization diseases

An important role in the prevention of infectious diseases plays health education. Health care should start in childhood and to be continue for the entire life of any person. If health is the social value then the entire society ought to be involved in health education. Responsibility for healthy behavior ought to be accepted by the school while health education in nurseries and kindergartens extends the awareness of the parents. To prevent infectious diseases, educational activities must therefore be directed at all members of society. The scope and nature of its contents must be selected according to the needs of individuals and groups. Often the objectives and content are subordinated to health promotion programs (Ciechaniewicz et al. 2009). The concept of health promotion was established relatively recently. It appeared in the mid-70s of the last century. It is defined as activities aimed at raising awareness of health, promoting healthy lifestyles and creating conditions conducive to health. In Poland, for many years certain programs have been realized to prevent the negative phenomena related to health (Ślusarska B. 2004). Reliable implementation of prevention programs has a significant impact on public awareness about the nature of diseases. The first signs of the disease would convince people to go to the doctor, and thus there would be an increase in early detection. A special role in educating the public on the prevention of infectious diseases is thus served by public health workers. They are responsible for the transfer of knowledge to patients about the disease, recovery and prevention. Public education thus plays a major role in the prevention of infections. It shapes the habits of healthy lifestyles and pro-health behaviors towards infections, prevention methods in relation to the risks arising from the development of civilization

References:

1. Antończyk M. (2009), *Rozpoznanie, opracowanie, wygaszanie i postępowanie po wygaszeniu ogniska epidemicznego legionelli w oddziale okulistyki w Wojewódzkim Szpitalu Specjalistycznym Nr 2 w Jastrzębiu Zdroju w okresie 11.12.2006 r. 31.03.2007 r.* Nowa Medycyna, 1, p. 66-67.
2. Augustynowicz-Kopeć E., Zwolska Z. (2008), *Gruźlica w Europie i w Polsce - nowe rodziny molekularne i nowe wzory oporności.* PrzeglEpidemiol. 62, p. 113-121.
3. Bäckhed F., Manchester J., Semenkovich C., Gordon J.(2007), *Mechanisms underlying the resistance to diet-induced obesity in germ-free mice.* Proc Natl Acad Sci U S A, 104, p. 979-984.
4. Bartram J., Chartier Y., Lee J.V., Pond K., Surman-Lee S. (2007), *Legionella and the prevention of legionellosis.* World Health Organization http://www.who.int/water_sanitation_health/emerging/legionella.pdf (access: 10.04.2014)
5. Bassetti M., Righi E. (2013), *Multidrug-resistant bacteria: what is the threat?* ASH Education Book 6, p. 428-432.
6. Bisht R., Katiyar A., Singh R., Mittal P. (2009), *Antibiotic resistance –a global issue of concern.* Asian J Pharm Clin Res, 2,2, p. 34-39.
7. Cani P.D., Delzenne N.M. (2010), *Involvement of the gut microbiota in the development of low grade inflammation associated with obesity: focus on this neglected partner.* Acta Gastroenterol. Belg., 73, p. 267-269.
8. Cani P.D., Neyrinck A.M., Fava F., Knauf C, Brucelin R. G, Tuohy K.M., Gibson G.R., Delzenne N.M. (2007), *Selective increases of bifidobacteria in gut microflora improve high-fat-diet-induced diabetes in mice through a mechanism associated with endotoxaemia.* Diabetologia, 50, p. 2374-2383.

9. Chua J.D., Wilkoff B.L., Lee I., Juratli N., Longworth D.L., Gordon S.M. (2000), *Diagnosis and Management of Infections Involving Implantable Electrophysiologic Cardiac Devices*. Ann Intern Med.,133, p. 604-608.
10. Ciechaniewicz W. (2000), *Działalność pedagogiczna pielęgniarstwa, Pedagogika podręcznik dla szkół medycznych*. Wyd. Lekarskie PZWL, Warszawa, p. 239.
11. Ciechomski P., Mrozińska M. (2005), *Zapalenie płuc o etiologii Legionella pneumophila – przydatność badań diagnostycznych*. Klin. Pediatr., 13, 5, p. 5072-5074.
12. Davies J., Davies D. (2010), *Origins and Evolution of Antibiotic Resistance*. Microbiol Mol Biol Rev.; 74 ,3, p. 417-433.
13. Druzdzel M. (1999), *GeNIe: A development environment for graphical decision-analytic models*. In *Proceedings of the 1999 Annual Symposium of the American Medical Informatics Association (AMIA-1999)*, Washington, D.C., Nov 6-10, p. 1206.
14. Dzierżanowska D. (2009), *Mechanizmy bakteryjnej oporności na antybiotyki i chemioterapeutyki*. W: *Antybiotykoterapia praktyczna*, wydawnictwo α-medica press, Bielsko-Biała, p. 38-58.
15. Gajda A., Posyniak A., Mudzki J., Różańska H.(2012), *Występowanie tetracyklin w tkankach i produktach pochodzenia zwierzęcego- przyczyny i skutki*. Med. Weter., 68,11, p. 650-655.
16. Gordon M., Jahnz-Różyk K., Pancer K. (2013), *Współczesna diagnostyka legionelozy*. Forum Zakazań, 4, 2, p. 119-126.
17. Greenspon A.J., Prutkin J.M., Sohail M.R., Vikram H.R., Baddour L.M., Danik S.B., Peacock J., Falces C., Miro J.M., Blank E., Naber C., Carrillo R.G., Tseng C.H., Uslan D.Z. (2012), *Timing of the most recent device procedure influences the clinical outcome of lead-associated endocarditis: results of the MEDIC (Multicenter Electrophysiologic Device Infection Cohort)*. J Am Coll Cardiol., 59, 7, p. 681-687.
18. Halabi W.J., Jafari M.D., Nguyen V.Q., Carmichael J.C., Mills S., Pigazzi A., Stamos M.J. (2013), *Blood transfusions in colorectal cancer surgery: incidence, outcomes, and predictive factors: an American College of Surgeons National Surgical Quality Improvement Program analysis*. Am J Surg., 206, 6, p. 1024 - 1033.
19. Jagielski T., Augustynowicz-Kopec E., Zwolska Z. (2010), *Epidemiologia gruźlicy w perspektywie świata, Europy i Polski*. Wiadomości lekarskie, LXIII, 3, p. 230-246.
20. Jumpertz R., Le D.S., Turnbaugh P.J., Trinidad C., Bogardus C., Gordon J.I., Krakoff J. (2011), *Energy-balance studies reveal associations between gut microbes, caloric load, and nutrient absorption in humans*. Am J Clin Nutr., 94,1, p. 58-65.
21. Kuśnierz J. (2012), *Odelektrodowe zapalenie wsierdza - CDIE (Cardiac device infective endocarditis*. W *dobrym rytmie*. www.wdobrymrytmie.pl/archiwum/45-listopad-2012/193-odelektrodowe-zapalenie-wsierdza-cdie-cardiac-device-infective-endocarditism (access: 09.04.2014).
22. Lakos A., Igari E. (2012), *Advancement in Borrelia burgdorferi antibody testing: Ccomparative Immunoblot Assay (COMPASS)*. W: *Lyme disease*. Red A. Karami, INTECH, p. 55-78.
23. Leoni E., Sacchetti R., Zanetti F., Legnani P. (2006), *Control of Legionella pneumophila contamination in a respiratory hydrotherapy system with sulfurous spa water*. Infect. Control Hosp. Epidemiol., 27, 7, p. 459-465.
24. Matuszewska R., Krogulska B. (2009), *Problem występowania pałeczek Legionella w instalacjach i urządzeniach wytwarzających aerozol wodno-powietrzny w obiektach służby zdrowia w Polsce*. Nowa Medycyna, 1, p. 56-60.
25. Molodecky N.A., Soon I.S., Rabi D.M., Ghali W.A., Ferris M., Chernoff G., Benchimol E.I., Panaccione R., Ghosh S., Barkema H.W., Kaplan G.G. (2012), *Increasing incidence and prevalence of the inflammatory bowel diseases with time, based on systematic review*. Gastroenterology, 142, 1, p. 46-54.
26. Raport WHO 2010, Genewa, *Globalna kontrola gruźlicy*.
27. Recommendations from CDC (2006), *Prevention and Control of Tuberculosis in Correctional and Detention Facilities*.
28. Rizzoli A., Hauffe H.C., Carpi G., Vourc'h G.I., Neteler M., Rosf R. (2011), *Lyme borreliosis in Europe*. Eurosurveillance, 16, 27, p. 2-9.
29. Ruderko N., Golovchenko M., Ruzek D., Piskunova N., Mallátová N., Grubhoffer L. (2009), *Molecular detection of Borrelia bisettii DNA in serum samples from patients in the Czech Republic with suspected borreliosis*. FEMS Microbiol. Lett., 292, p. 274-281.
30. Salyers A.A., Whitt D.D. (2005), *Mikrobiologia. Różnorodność, chorobotwórczość i środowisko*. PWN, Warszawa, p. 151.
31. Sapi E., Bastian S.L., Mpoy C.M., Scott S., Rattelle A., Pabbati N., Poruri A., Burugu D., Theophilus P.A.S., Pham T. V., Datar A., Dhaliwal N.K., MacDonald A., Rossi M.J., Sinha S.K., Luecke D.F. (2012), *Characterization of biofilm formation by Borrelia burgdorferi in vitro*. PLoS One., 7,10, p. e48277, (doi: 10.1371/journal.pone.0048277).

32. Sikora A., Kozioł-Montewka M., Książek A., Grzebalska A., Bednarek-Skublewska A., Steć A., Rudzki S., Furmaga J., Paluch-Oleś J., Magryś A., Karaś M. (2013), *Prevalence of Legionella antibodies in immunocompromised patients*. Central European Journal of Medicine, 8, 2, p. 208-212.
33. Sohail M.R., Uslan D.Z., Khan A.H., Friedman P.A., Hayes D.L., Wilson W.R., Steckelberg J.M., Stoner S., Baddour L.M. (2007), *Management and Outcome of Permanent Pacemaker and Implantable Cardioverter - Defibrillator Infections*. J. Am. Coll. Cardiol., 49, p. 1851-1859.
34. Ślusarska B. (2004), *Działania edukacyjne w pracy pielęgniarki z pacjentem*. W: Ślusarska B., Zarzycka D., Zahradniczek K. (red.), *Podstawy pielęgniarstwa*. Wydawnictwo Czelej, Lublin, 2, p. 967-968.
35. Tjisse-Klasen E., Pandak N., Hengeveld P., Takumi K., Koopmans M.P., Sprong H. (2013), *Ability to cause erythema migrans differs between Borrelia burgdorferi sensu lato isolates*. Parasit. Vectors., 6, p. 23, doi: 10.1186/1756-3305-6-23.
36. Wójcik-Fatla A., Szymańska J., Buczek A. (2009), *Choroby przenoszone przez kleszcze. Część I. Ixodes ricinus jako rezerwuar i wektor patogenów*. Zdrowie Publiczne, 119, 2, p. 213-216.

Submitted: 12.03.2014

Accepted: 24.03.2014

THE ROLE OF PRO-INFLAMMATORY CYTOKINES IN THE GENESIS OF PHYSIOLOGICAL AND PATHOLOGICAL PREGNANCY PREDICTING

Oles Konovalenko¹, Lubov Lapovets²

¹Clinical facility Hospital in Lutsk

²National Medical University in Lions

Konovalenko O., Lapovets L., (2014) *The role of pro-inflammatory cytokines in the genesis of physiological and pathological pregnancy predicting*, Health Problems of Civilization 1 (8), p. 15-17

Objective: hold concentration determination and study changes in interleukin-1 (IL-1) and interleukin - 6 (IL-6) in pregnant women outside urban areas and in pregnant women living in the city, and to predict the appearance of a possible risk of premature birth.

Material study: Were examined 40 pregnant women who make up the group of 23-27 weeks of gestation who were admitted with threatened preterm labor (20 pregnant women living in the countryside, and 20 pregnant women living in the city), as well as a control group - 20 healthy pregnant women with physiological pregnancy.

Methods: In all patients and control group was performed determining the content of IL - 1 and IL - 6 in serum by enzyme immunoassay (ELISA) using a test system»Vector-Best» (Russia) on an automatic ELISA analyzer «Triturus». Statistical analysis of data was carried out using the method of variation statistics with using STATISTICA 6 (Statsoft, USA)

The results of the study: in determining kotsentratsiyiyi proinflammatory cytokines observed increase in IL-1 and IL-6 in pregnant women living in countryside and cities in the pregnant compared with the control group of pregnant women with physiological pregnancy (probability differences ($p < 0,05$)).

Conclusions: The definition and measurement of proinflammatory cytokines is an opportunity to use the test as early inflammation and mapping the degree of threat of preterm labor. The study of changes in the cytokine brings us to the pathogenic mechanisms of the transition process active infection.

Key words: Pro-inflammatory cytokines, pregnancy.

Introduction

The problems of modern obstetrics miscarriage are one of the first places as set high perinatal and infant morbidity and mortality. Despite some success rate of preterm birth does not have sustained downward trend and is 5-9%. The polietylological process of premature births leads that every third case its reason remains unexplained (Сидельникова В.М. 2006).

According to recent years in the regulation of the immune response during pregnancy play an important role local and systemic immune process. The immune system of a woman standing on guard antigenic homeostasis is an important of adaptation, including the carrying pregnancy. Commonly role of cytokines in the regulation of embryogenesis, the formation and development of several organs, including the immune system, blood, protective responses to local and systemic level, and the processes of regeneration and tissue damage . Particularly relevant is the study of cytokine status in different forms of pathology of pregnancy because of changes in serum concentrations may be an early indicator of systemic immune disorders (Макарова О.В.2007, ХонинаН.А.2006). The primary mediators of the interaction of immune cells of the mother and fetus are cytokines that play an important role in implantation, growth and development of the embryo (Coulam C. 2000). Cytokines - this endogenous mediators that are synthesized by almost all nuclear cells. Despite intensive research in immunology, it is not fully learned the importance of different cytokines in the genesis of physiological and pathological pregnancy. Cytokines perform regulatory role in the evaluation of the immune response. Changes in immune homeostasis are the major factor in the structure of gestational complications, the degree of severity of complications of pregnancy, predicting its course (Макарова О. et al 2007).

Address for correspondence: Oles Konovalenko, Clinical facility „Lutsk lying-in hoshital, Lutsk
e-mail: oles.konovalenko@gmail.com, phone +38 (50) 259-60-24

Tables: 1 **Figures:** 0 **References:** 16 **Full-text PDF** www.hpc.edu.pl **Copyright** © Pope John Paul II State School of Higher Education In Biała Podlaska, Sidorska 95/97, 21-500 Biała Podlaska **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License (<http://creativecommons.org/licenses/by-nc/3.0>), which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non-commercial and is otherwise in compliance with the license.

Objective

To determine the concentration of interleukin-1 (IL-1) and interleukin-6 (IL-6) in pregnant women outside of urban areas and in pregnant women who live in the city. Based on these data we will try to predict the emergence of a possible risk of preterm birth.

Facilities and methods

It was examined of 40 pregnant women who make up the group of 23-27 weeks of gestation who were admitted with threatened preterm labor, and the control group - 20 healthy pregnant women with physiological pregnancy. The main group was divided into 2 subgroups: the first subgroups were 20 pregnant women living in the countryside, in the second subgroup were pregnant, living in the city. All patients performed using immunofluorescence analyze determination of IL -1 and IL-6 using test system "Vector-Best" (Russia) on an automatic immunoenzymatic analyzer "TRITURUS".

Results of the research were analyzed using mathematical method - statistical treatment of data acquisition using the method of variation statistics using STATISTICA 6 (Statsoft, USA) (Боровиков В. 2001).

Results and discussion

Content of the study of cytokines in serum concentrations it was observed multidirectional changes of concentration IL-1 and IL-6 in pregnant women of the first and second subgroups of the main group, compared with the contents of cytokines in healthy pregnant (table 1).

Table 1. The level of cytokines in pregnant women according to residence area

Index	The main group		The control group (n=20)
	First subgroup (n=20)	Second subgroup (n=20)	
IL-1 (pg/ml)	23,2±4,9*	17,2±7,0*#	5,7±3,5
IL-6 (pg/ml)	177,0±79,8*	56,9±25,2*#	8,4±4,9

Note: 1) * - probability of the differences in performance compared to the control group (p<0,05).
2) # - probability of the differences in performance compared to the second group (p<0,05).

The central mediator of local and systemic inflammatory responses is IL-1. Describing the figure, there were elevated levels of IL-1 first subgroup at 4 times (p<0,05), compared to the control group and at 1,3 times compared to the second subgroup (p<0,05). Also increase of interleukin was observed in the second subgroup relative to the control group at 3,02 times (p<0,05).

It is believed that IL-1 promotes the development of the fetus stimulates the proliferation of cells that form the placenta barrier. Interleukin-1 selectively activates the synthesis and secretion of steroid hormones, which affect the level of pregnancy (Matsumura T.2004). IL-1 has a feature to stimulate the synthesis of prostaglandins, triggering the mechanism of preterm birth. Increased secretion of interleukin-1 may lead to the activation of pro-inflammatory cascade that probably complicates pregnancy, leading to the initiation of childbirth. Supporting this cytokine at low levels is one of the factors affecting the preservation of pregnancy (Dinarello C.2002, Xia H.2006).

Describing the level of interleukin-6 (IL-6) which refers to the pro-inflammatory cytokines it was observed its high concentration in the study group in both subgroups. Compared with the control group IL-6 growth in the first group is at 21 times and an increase in the second group is larger at 6, 77 times. Concentration IL-6 in pregnant that live outside the city exceed at 3,2 times the concentration in pregnant who lives in the city. Interleukin-6 is a major mediator of acute phase proteins. Under the influence of an infectious agent may increase the production of prostaglandins, IL-6 and the development of premature childbirth (Casart Y. 2007). There are opinions that interleukin-6 stimulates neutrophils, macrophages in the local production of pro-inflammatory cytokines that affect the maturation and opening of the cervix (Margni R. 2001).

Conclusions

The study of cytokines in pregnancy enables to establish the extent to which central mechanisms involved in immunoregulation. Growing concentrations of interleukin-1 (>11 pg/ml) and interleukin-6 (>10 pg/ml) shows the development of the inflammatory process that can be used as an early test of inflammation and severity of the process, which can lead to premature birth.

References:

1. Боровиков В. (2001) STATISTICA: искусство анализа данных на компьютере. Для профессионалов / В. Боровиков. – С-Пб: Питер,. – 656 с.
2. Володин Н.И., Румянцева А.Г., Владимирская Е.Б., Дегтярева (2001) М.В Цитокины и преждевременные роды // Педиатрия. -. - №4. - С. 72-74.
3. Casart Y. (2007). Serum levels of interleukin-6, interleukin-1beta and human chorionic gonadotropin in pre-eclamptic and normal pregnancy / Y. Casart, K., Tarrazzi, M. Camejo Gynec. Endocr. - Nr 23. – P. 300-320.
4. Сидельникова В.М. А.Г. Антонов. (2006) Преждевременные роды. Недоношенный ребенок. – М.; ГЭОТАР Медиа,. – 456 с.
5. Старостина Т.А., Демидова Е.А., Анкирская А.С (2002) и др Современные вопросы патогенеза и терапии невынашивания беременности /. // Акушерство и гинекология. - № 5. – С. 59—61.
6. Степанович М.Ю 2005. Цитокины как нейромодуляторы в центральной нервной системе / М.Ю. Степанович. // Биохимия,. - № 22: 1. – С. 5—11.
7. Сухих Г.Т., Ванько Л.В Сухих Г.Т. Иммунология беременности /. - М: Изд-во РАМН,. – С. 248—256.
8. Сухих Г.Т., Ванько 2005 Л.В Сухих Г.Т. Иммунология беременности в физиологии и патологии беременности /. // Иммунология. -. - № 9: 2. – С. 103—108.
9. Coulam C. (2000) Understanding The Immunobiology of Pregnancy and applying it to treatment of recurrent pregnancy loss. Early pregnancy / C. Coulam // Biol. Med. -. - Vol. 4, № 1. – P. 19—29
10. Dinarello C. (2002) The IL-1 family and inflammatory diseases / C. Dinarello // Clin. Exp. Rheumatol. -. - Vol. 20, № 1. – P. 170—177.
11. Лаповець Л.Є., Луцик Б.Д., Лебедь Г.Б., Акімова В.М. (2008)– Львів, Посібник з лабораторної імунології. – 268 с.
12. Макаров О.В., Ковальчук Л.В., Ганковская Л.В и др. (2007) - М: Гэотар-Медиа, Невынашивание беременности, инфекция, врожденный иммунитет. – С. 90—99.
13. Макарова О.В., Алешина В.А., Савченко Т.Н. (2007)- М.: МЕДпрессиформ Инфекции в акушерстве и гинекологии – 420 с.
14. Margni R (2001). During pregnancy, in the context of a Th2-type cytokine profile, serum IL-6 levels might condition the quality of the synthesized antibodies / R. Margni, A. Zenclussen // Am. J. Reprod. Immunol. - Vol. 46, № 3. – P. 181—187.
15. Matsumura T, Hayashi H, Takii T, et al. (2004) TGF- β down-regulates IL-1, induced TLR2 expression in murine hepatocytes /. // J. Leukocyte Biol. - Vol. 75. – P. 1056—1061.
16. Xia H, Peng J, Sun Q, et al (2006) Effects of IL-1 beta on RT1-A α /RT1-DM at the maternal-fetal interface during pregnancy in rats /. // Front Biosci. -. - № 11. – P. 2868—2875.

Submitted: 05.11.2013

Accepted: 13.12.2013

THE DYNAMICS OF SPECIAL EFFICIENCY OF SPORTSMEN, WHO SPECIALIZE IN MIDDLE DISTANCE RUNNING

Olha Roda

East European National University named after Lesya Ukrainka

Roda O., (2014) *The dynamics of special efficiency of sportsmen, who specialize in middle distance running*, Health Problems of Civilization 1 (8), p. 18-23

Summary: In sports training man tries to broaden the boundaries of his own capacities and the physical efficiency is an informative index, which defines a set of properties of the organism and, in the first place, the efficiency of blood flow and breathing mechanisms. In the article the impact of training load on the bodies of athletes, who specialize in middle distance running is analyzed and the dynamics of special efficiency, physiological mechanisms, responsible for the quality of athletes' endurance, is determined.

The dynamics of female athletes' special efficiency manifestation has cyclical character and depends on the hormonal status change influence on the athletes' body during the biological cycle. Special efficiency of male athletes has tendency of gradual results growth, which is explained by the functional possibilities change, resulted by the effective influence of training loads on their body.

The highest efficiency has been found in the second and fourth phases, the lowest one - in the third and especially in the first and fifth phases of MC. This is due to the increased functionality of the cardiovascular system and the effectiveness of power-ensuring in the second and fourth phases and its decrease in the first and fifth phases of MC, leading to stress of adaptation processes of women's bodies during these phases. As for men, their dynamics of special efficiency tended to gradual increase of the results, that, we think, can be explained by the growth of functional capabilities of the cardiovascular system and the effectiveness of power-ensuring on account of effective influence of training loads upon their organism.

Key words: heart rates, menstrual cycle, lactate

Introduction

The relevant problem of the athletes' preparation process is the justification of special efficiency and regulatory characteristics of the main functional parameters specific criteria system. With their help one can evaluate the physical loads' adaptation affectivity and also the functional possibilities' dynamics at stages of preparation.

Physical performance is a key factor in determining athletic achievements (Karpman et al. 1988). One should notice, that the term "efficiency" is interpreted in different ways, so basic research in this area were carried by G. Lehmann (1967), who considered physical efficiency as the body's ability to maximum of work. Other researchers understand physical efficiency as the willingness to make motor actions (Israel 1983) or as the ability of body to perform maximum physical work in any manifestation (Anokhin 1975), or as the ability to develop maximum power and economically spend it, reaching the goal (Viru, Kyrge 1983).

The fitness of athlete is characterized by the level of its special physical efficiency, which can be predicted by physiological functions' indexes in both – states of relative calm and states of dosed physical loads. There is a linear relationship between the power of the work and HR. Such dependence is kept to the level of heart rate – 170 beats/min. It characterizes optimal in efficiency cardio-respiratory system mode (Bondarenko 2010).

Physical performance is the most important aspect of fitness, conditioned by the state of morphological-functional changes of the main physiological body systems. In sports medicine the concept of general and special physical efficiency is highlighted. The long-term work of muscles is limited by shipping them oxygen, so the overall physical efficiency is largely determined by cardio-respiratory capacity, which, in turn, is determined by morphological-functional state of the cardiovascular and respiratory systems and neurohumoral influences on them (Anokhin 1975).

Special physical efficiency characterizes the possibility of athlete to perform in given kind of sport. For its evaluation specific load characteristics, typical for this kind of sport, are used. The level of general and special physical efficiency of the same athlete may differ substantially (Karpman et al. 1988). The manifestation of special endurance depends on some physiological and psychological factors. The main physiological factor is the anaerobic

Address for correspondence: Olga Roda, 43025 Łuck, Vinnichenka Street, 18/29, Ukraina,
e-mail: olya.roda@mail.ru, phone +38 (66) 057-85-92

Tables: 2 Figures: 2 References: 16 Full-text PDF www.hpc.edu.pl **Copyright** © Pope John Paul II State School of Higher Education In Biała Podlaska, Sidorska 95/97, 21-500 Biała Podlaska **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education.
This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non-commercial and is otherwise in compliance with the license.

possibilities of the athlete. Anaerobic capacities of the organism are determined by two correlated biochemical mechanisms: creatine-phosphatic (energy release due to phosphorus compounds) and glycolytic (energy release due to splitting of muscle glycogen). Special efficiency depends on the ability of the neuromuscular system, on the rate of intramuscular energy resources consumption, on the technique of motor action possession and the level of other motor skills' development.

The basis of functional training of middle distance runners is the endurance training, determined primarily by its aerobic and anaerobic opportunities. The main sources of energy production while endurance works are aerobic and anaerobic glycolytic reactions. They are characterized by energy release speed, terms, acceptable to use of fats, carbohydrates, glycogen, ATP, KTF and allowable metabolic changes in the body. Physiological basis of aerobic endurance is body's ability to ensure a share of energy in the process and contribute to the survivability of the organism after work of any length and capacity, ensuring speedy removal of metabolic exchange products (Zelichenok et al. 2000). Anaerobic glycolytic energy source plays a crucial role in efficiency supporting in maximal intensity exercises, duration up to 15–20 seconds. Anaerobic glycolytic sources are central to the process of work energy supply, continuing from 20 to 5–6 minutes (Korobov, Volkov 1983).

The aim of the article

The aim of the article is to analyze the survey results of leading scientists in the field of training load on the athletes' body and determining the dynamics of special efficiency, physiological mechanisms, responsible for quality endurance of athletes, who specialize in middle distance running.

Methods of investigation

Analysis of literature sources; to determine the dynamics of special efficiency of athletes, who specialize in middle distance running, we held 5 control 4x400 m races, women studies were conducted during the MC, and men studies – during mesocycle, along with women; with the aim of determining the concentration of lactate, the blood was taken from the phalange with the one-time scarifier. Lactate was determined using test strips BM–Lactate Lactate number 25 for the device Akkutrend Plus. Simultaneously the heart rate was monitored via Pulsometers Polar S610i.

Survey results analysis

Nature has granted women with complex physiological processes that are unique to women: menstrual function and pregnancy, which provide basic biological purpose of female body – the ability to procreate, procreation (Shakhlina 2000). It is also important to consider that athletes have to participate in correspondent competition despite the state, conditioned by the peculiarities of female body.

Studies, conducted in various kinds of sports, show that special efficiency varies depending on the phases of MC (Virus 1983, Efimova 1993). Throughout the whole period of modern sports existence, the evaluation of women sports efficiency in various MC phases causes contradictory points of view (Radzievskii, Shakhlina et al. 1997). Consideration of MC phases enables more efficient performance of various scopes of works, exercises that promote the upbringing of necessary physical qualities. Using knowledge of the female body hormonal status characteristics during MC for the construction of the training process, increase of the estrogen production may play a similar role to improve efficiency as introduction of exogenous anabolic steroids. Thus, women possess a higher performance during postmenstrual and postovulatory phase and lower – during premenstrual, menstrual and ovulate phase of the menstrual cycle (Virus 1981).

Disregarding the characteristics of cyclic changes in female athletes' body, restrictions in ingestions in precontest mesocycle can lead to disruption of adaptation and development of prepathologic conditions and diseases, before all, in reproductive system. Leading mechanisms of these disorders may be imbalances in the hypothalamus-pituitary-adrenal-ovarian advantage of androgen effects (Nehanevich 2010).

A lot of factors influence the level of women sporting achievements of women: age, biorhythmical, functional, adaptive, reproductive, physiological and others. As E. Ivanchenko (2001) states, the basic structural unit in the construction of the women training process must be mesocycle (set of 3–5 Microcycles), ie one menstrual cycle (MC). Since the nature and duration of MC flow is individual and not for all it may consist of five cycle phases, the cycles are recouped from the first day of the previous cycle to the first day of the next MC. For most women it lasts 27–29 days (Optimal length is 28 days), it can vary from 21 to 35 days, and sometimes – up to 42 days (Hmil et al. 1999). Most athletes train during menstruation with some limitation, because of their health deteriorates.

Many studies (Radzievsky 1990, Shakhlina 1999, Kalytka 2001, Soboleva 1999) found that the efficiency of athletes of different specializations and display of their physical qualities during MC may change. In premenstrual, menstrual and ovulation phases sports results deteriorate, and postovulatory and postmenstrual phase results for most athletes are the highest.

According to L.G. Shakhlina (1999), for the functioning of women body oxygen transporting system optimal is postmenstrual and postovulatory phase of the cycle, during other phases the voltage in the respiratory and cardiovascular systems is noticed.

According to the Kalytka S.V. (2000) athletic result in competition in menstruation phase is 7.5%, average – 85%, worse – 7.5%, a special efficiency increases during postovulatory, postmenstrual and ovulation phases and remains reduced in premenstrual and, especially, menstrual phases. Heart rate increased starting from postovulatory phase and reaches its highest values in the premenstrual phase.

Majority of researches, dedicated to the study of the sports activity influence on the body, treatment and methods of training were performed on male athletes, so their coach results are often mechanically transferred to the construction of the women training process, which is not justified, and sometimes even not safe at all.

Although, it is proven (Kraus 1994, Shakhlina 1999, Kalytka 2001) that not at all phases of the biological cycle women athletes can perform certain training loads. (Besides, competition calendar can not predict the variety of specific biological cycles of athletes – as its total duration and the timing of the individual phases).

We have investigated that the dynamics of special efficiency manifestation for women is cyclical in nature and depends on the influence of hormonal status on athletes' body during the MC. The highest efficiency was found in Phase II and IV, the lowest – in the third and, especially, in phase I and V of the MC (Fig. 1).

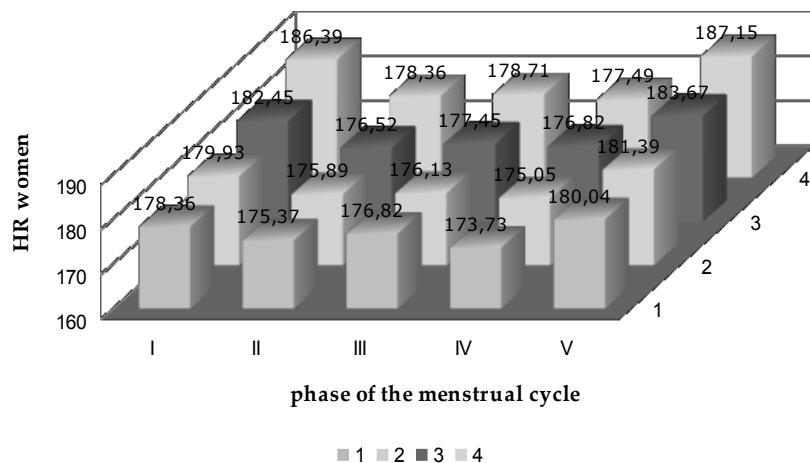


Figure 1. The dynamics of HR for women, who specialize in middle distance running, during MC

The dynamics of special efficiency for men had a tendency of graduate results growth, which, to our mind, can be explained by the growth of fitness, resulting from the training loads effective influence on the men body. (Fig. 2)

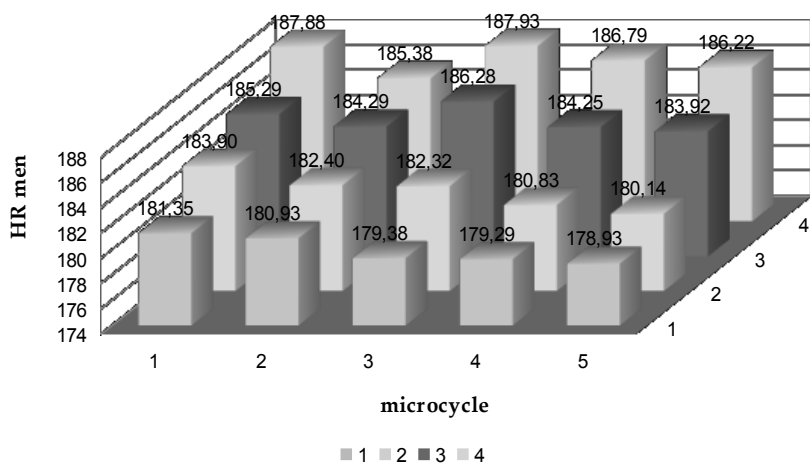


Figure 2. The dynamics of HR for men, who specialize in middle distance running, during mezocycle

One of the most informative criteria, which characterizes the adaptation of CVS to the physical loads is HR. We figured out, that while overcoming the distances, the highest HR indexes for women were fixed in II, III and IV phases, the lowest – in I and V phases of the MC. This means, that in II, III and IV phases functional possibilities of CVS are higher, comparing to I and V phases (table 1).

Table 1. The dynamics of special efficiency and the functioning state of women athletes, who specialize in middle distance running, during the MC

Parameters	№	Index									
		I phase of the MC	σ	II phase of the MC	σ	III phase of the MC	σ	IV phase of the MC	σ	V phase of the MC	σ
Time	1	81,35	3,70	75,28	3,27	78,49	3,15	74,24	3,54	82,84	3,48
	2	81,02	2,48	74,61	2,62	76,89	3,01	73,52	3,26	82,15	3,45
	3	80,84	3,02	73,64	3,42	76,02	3,52	73,05	3,47	81,01	3,72
	4	81,90	3,83	72,98	3,28	75,36	3,41	72,17	3,25	81,98	3,84
HR	1	178,36	4,23	175,37	4,62	176,82	4,79	173,73	5,37	180,04	6,38
	2	179,93	3,93	175,89	3,85	176,13	4,37	175,05	4,82	181,39	6,73
	3	182,45	4,16	176,52	5,38	177,45	4,12	176,82	5,37	183,67	7,43
	4	186,39	4,78	178,36	4,84	178,71	5,28	177,49	5,52	187,15	6,82
Lactate	1	7,68	1,37	6,83	1,45	6,93	1,37	5,87	1,23	7,93	1,35
	2	8,89	1,83	8,24	1,73	8,03	1,59	7,83	1,46	8,99	1,73
	3	10,58	2,03	9,05	2,30	9,10	2,38	8,92	2,35	10,89	2,15
	4	13,42	2,94	9,94	2,45	10,38	2,49	9,17	2,83	14,03	2,49

*Author's calculation

For men, heart rate indexes gradually decreased during mesocycle that, we believe, points to increase of the functionality of CVS-related training impact.

To evaluate the intensity of the load and energy contribution of anaerobic processes in the work we determined the concentration of lactate in the blood after overcoming of each segment of the test.

Thus, the highest concentration of lactate in the blood of women was recorded in phase I and V, the lowest – in the second, third and fourth phase of the MC. This indicates stress adaptation processes of the athletes' body in dealing with distances in phase I and V of the MC.

Concentrations of lactate in the blood of men have been consistently high and did not differ significantly during mesocycle, which may be associated with participation of mainly anaerobic energy production sources while ensuring of distance overcoming (table 2).

Table 2. The dynamics of specific efficiency and functional state of male athletes, who specialize in middle distance running, during mesocycle

Parameters	№	Index									
		1	σ	2	σ	3	σ	4	σ	5	σ
Time	1	60,36	3,60	60,29	2,93	60,59	2,98	60,38	2,58	60,15	2,48
	2	60,01	3,41	60,21	3,26	60,19	3,28	60,25	2,49	60,11	2,93
	3	61,27	2,89	60,92	3,31	60,02	3,63	60,01	3,41	59,92	3,45
	4	60,45	3,02	60,78	3,52	59,47	3,82	59,26	3,73	59,15	3,52
HR	1	181,35	4,31	180,93	4,79	179,38	5,18	179,29	5,83	178,93	5,48
	2	183,90	6,38	182,40	5,38	182,32	6,03	180,83	6,32	180,14	6,14
	3	185,29	5,27	184,29	5,24	186,28	5,13	184,25	4,93	183,92	5,22
	4	187,88	6,49	185,38	6,39	187,93	6,11	186,79	5,39	186,22	6,55
Lactate	1	6,89	1,62	7,02	1,34	6,05	1,48	5,99	1,33	6,13	1,72
	2	8,27	1,93	8,10	1,83	8,02	1,36	7,52	1,49	7,48	1,89
	3	10,12	2,37	9,76	2,89	10,14	1,99	9,48	2,04	9,41	2,57
	4	14,58	2,84	13,48	2,99	14,46	2,38	14,50	2,91	14,07	2,86

*Author's calculation

Energy consumption in running middle distances is covered almost equally by aerobic processes, associated with the absorption of oxygen and anaerobic processes that occur without oxygen. This largely determines task training stayers, the body of which should have significant aerobic capacity. Middle distance runners should have a high level of special efficiency; in other words, to have the ability to run the full distance to the maximally high pace, often during changeable running speed (acceleration at the start, spurts at a distance, fast finish). The basis for the formation of special efficiency is physical or power force of runner, his overall endurance and speed. To overcome 800 or 1500m at the high rate, the athlete must have strong muscles, supple and strong ties and movable joints.

Thus, we have found, that the dynamics of display of special efficiency of women is cyclical by nature and depends upon the influence of hormonal changes in athletes' bodies during their MC. The highest efficiency has been found in the second and fourth phases, the lowest one - in the third and especially in the first and fifth phases of MC. This is due to the increased functionality of the cardiovascular system and the effectiveness of power-ensuring in the second and fourth phases and its decrease in the first and fifth phases of MC, leading to stress of adaptation processes of women's bodies during these phases. As for men, their dynamics of special efficiency tended to gradual increase of the results, that, we think, can be explained by the growth of functional capabilities of the cardiovascular system and the effectiveness of power-ensuring on account of effective influence of training loads upon their organism.

Conclusions

1. Sports outcome depends on the level of fitness, body composition and functioning of all body systems, which, in turn, depend on the hormonal status of the organism, which has a significant difference between men and women.

2. The dynamics of special efficiency manifestation for women is cyclical in nature and depends on the influence of hormonal status on the athletes' body during the MC. The highest efficiency was found in the second and fourth phases, the lowest – in the third and, especially, in phase I and V of the MC. This is due to the increased functionality of the body in the second and fourth phase and its decrease in phase I and V of the MC.

3. For men, the dynamics of special efficiency tended to gradual results growth that, we believe, can be explained by the growth of functional possibilities, resulted from the effective influence of training loads on their body.

References:

1. Анохин П. К. (1975), Очерки по физиологии функциональных систем, М: Медицина, 447.
2. Бондаренко, А. Е. (2010), Физиология спорта: практическое пособие для студентов 3 курса специальности. А.Е. Бондаренко, Т. А. Ворочай, В. В. Солошик; Мин-во обр. РБ, Гомельский государственный университет им. Ф. Скорины, «УО ГГУ им. Ф. Скорины», 86.
3. Виру, А. А., Кырге, П. К. (1983), Гормоны и спортивная работоспособность, М: Физкультура и спорт, 158.
4. Ефимова, И. В., Будыка, Е. В. (1993), Адаптационные возможности организма студенток в разные фазы овариально-менструального цикла. Физиология человека, Т. 19, no. 1, 112–118.
5. Зеличенко, В.Б., Никитушкин, В.Г., Губа, В.П. (2000), Легкая атлетика: Критерии отбора, М: Терра-Спорт, 238.
6. Калитка, С. В. (2001), Особливості побудови тренувального процесу жінок, які спеціалізуються в спортивній ходьбі: дис. на здобуття наук. ступеня канд. наук з фіз. вих. і спорту: спец. 24.00.01 "Олімпійський і професійний спорт", 24.
7. Карпман, В. Л., Белоцерковский, З. В., Гудков, И. А. (1988), Тестирование в спорте, М: Физкультура и спорт, 4–10.
8. Коробов, А.И., Волков, Н.И. (1983), Бег на средние дистанции. Факторы результативности, Легкая атлетика, no. 11, 6–8.
9. Краус Т. А. (1994), Построение тренировочного процесса в скоростно-силовых видах легкой атлетики с учетом ОМЦ: Автореф. канд. дис.: 24.
10. Неханевич, О.Б. (2010), Репродуктивна функція спортсменок, які займаються важкою атлетикою та тхеквондо, Мофологія, Т. IV, no. 1, 33–39.

11. Радзиевский, А. Р., Шахлина, Л. Г., Яценко, З. Р., Степанова, Т. П. (1990), Физиологическое обоснование управления спортивной тренировкой женщин с учетом фаз менструального цикла, Теория и практика физической культуры, 47–50.
12. Соболева, Т. С. (1999), О проблемах женского спорта. Теория и практика физической культуры, no. 6, 56–63.
13. Хміль, С. В. (1999), Гінекологія, К, "Укрмедкнига", 538.
14. Шахлина, Л. Г. (2000), Женщины на рубеже третьего тысячелетия. Наука в олимпийском спорте, 10–21.
15. Шахлина, Л. Г. (1999), Проблема полового диморфизма в спорте высших достижений, Теория и практика физ. культуры, no. 6, 51–55.
16. Шубина, И. Ф. (1997), Планирование тренировочного процесса в женской спортивной ходьбе на этапе специальной подготовки: Автореф. дис. ... к. пед. наук., Омск: 25.

Submitted: 28.06.2013

Accepted: 08.08.2013

FEATURES OF THE CORTICAL ACTIVITY OF MEN HAVING A HIGH OR LOW ALPHA-FREQUENCY BACKGROUND OF THE EEG WHILE PERFORMING ALTERNATE FINGER MOVEMENTS

Alevtyna Morenko, Anatolij Tsos, Ichor Kotsan

Lesia Ukrainka Eastern European National University in Lutsk

Morenko A., Tsos A., Kotsan I., (2014) *Features of the cortical activity of men having a high or low alpha-frequency background of the eeg while performing alternate finger movements*, Health Problems of Civilization 1 (8), p. 24-31

Summary: The purpose of this paper is to identify the cerebral electrical activity features in men with a high or low α -frequency background while performing the alternate finger movements. A test group consisting of 104 healthy men from the ages of 19 to 21 was divided into two groups according to the magnitude of their individual α -frequency (IAF) median – groups with high ($n = 53$, $IAF \geq 10,04$ Hz) and low ($n = 51$, $IAF \leq 10,03$ Hz) levels of IAF. Changes in power and the coherence of the EEG oscillations during the alternate finger movements as well as intergroup differences were evaluated. Men with high a IAF are distinguished by higher rates of speed and accuracy in terms of their sensory-motor response. The role of inhibitory neural processes increases in the case of men whose frequencies are low. The implementation of alternating finger movements in male groups is accompanied by a decrease in the coherence of θ -, α_1 -, α_3 - EEG oscillations in the cortex in general, β - and γ -activity - in the rear temporal and occipital areas. In the frontal and central lobes of α_2 -, β - and γ - ranges an increase in EEG coherence fluctuations was observed. The power of θ -, α - and β_1 - waves, especially in the posterior cortex areas, decreases. A larger degree of low-frequency fluctuations in EEG power can be observed in the frontal area. Thus, more economical brain processes providing the processing of any sensory or motor information in men with a high IAF determine higher levels of the speed and accuracy of their sensorimotor responses. Men with a low IAF have lower ductility but a higher voltage of brain processes correlated with a decrease in the sensorimotor response of speed capabilities increasing the role of inhibitory effects.

Key words: power, coherency, electroencephalogram, individual alpha-frequency, alternate movements by fingers

Introduction

Human functional capabilities largely depend upon the genetic qualities of person's nervous system. A direct reflection of the human nervous system individual characteristics is human brain activities where the electroencephalogram (EEG) is its integrative characteristics. It shows the activities of many neuronal groups primarily resulting in the manifestation of the background electrical activity (Begleite et al., 2006; Van Beijsterveldt et al., 2002). It is believed that the spontaneous cortical electrical activity is determined by genetically grounded characteristics of the brain structural and functional organization. It is also clear that features of the structural and functional organization of the brain underline individual differences and functional abilities. It turned out that the most informative frequency among various parameters of the background of the EEG belongs to the maximum peak of EEG α -rhythm (Anokhin et al., 2006; Hooper 2005). Various α -sub-bands are differed by the specific brain generators, functional significance, and varying degrees related to the major systems of the brain activation (Klimesch et al., 2007). A low or high range of the α -rhythm superiority in the background encephalogram of the person can cause his/ her psychomotor and cognitive abilities (Doppelmayer et al., 2005; Hyde 2005).

Simultaneously, it has been found a lack of information about detected features of the central programming in men with the different individual α -frequency while performing manual movements. Existing data, despite their importance, are inconsistent and insufficient yet.

In view of this, the main goal of our research is to elucidate issues answering the question how the function of the cerebral cortex is changed in men with a different output individual α -frequency under the influence of alternative movements in response to special signals. This issue is urgent and has not only the theoretical importance but also obvious practical application as it concerns fundamental matters affecting the neuro-physiological purposeful human hand movements. The alternative movements of fingers used in our study as a motor load are the most commonly using manual movements by a person and playing a significant role in the person's day-to-day life,

Address for correspondence: Morenko Alevtyna, Lesia Ukrainka Eastern European University 13, Voli Street, Lutsk, Ukraine 43000, e-mail: alevmore@gmail.com, phone: +38 (66) 826-27-23

Tables: 2 Figures: 3 References: 20 Full-text PDF www.hpc.edu.pl **Copyright** © Pope John Paul II State School of Higher Education In Białą Podlaska, Siderska 95/97, 21-500 Białą Podlaska **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License (<http://creativecommons.org/licenses/by-nc/3.0>), which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non-commercial and is otherwise in compliance with the license.

training, operator performance and production activities. The elucidations of the EEG prognostic criteria and their successful implementation have become increasingly important in case of the electronic engineering significance in people's public life, particularly, in the practice of the distance manual control and its evolution.

The aim

The purpose of this paper is to identify the cerebral electrical activity features in men with a high or low α -frequency background while performing the alternate finger movements.

Materials and methods

Participants

The participants in our study were 124 male volunteers from the ages of 19 to 21, each of whom has given written consent. Biomedical ethics rules in accordance with the Helsinki Declaration of the World Medical Association on the Ethical Principles of Scientific and Medical Research involving Human Subjects were adhered to during the experiment. All the testees were healthy and had normal hearing with regard to the judgment and advisory conclusions of their medical professionals.

Procedure

Psychophysiological examination

As part of the psychophysiological testing for each subject was determined profile of manual and auditory asymmetry. It determined by the nature of responses in the survey, execution of the motor and psychoacoustic tests and counting the individual ratio of the manual and auditory asymmetries (K skew) (form. 1) (Zhavoronkova 2009).

$$K_{\text{skew}} = \frac{\Sigma_{\text{right}} - \Sigma_{\text{left}}}{\Sigma_{\text{right}} + \Sigma_{\text{left}}} \times 100\% \quad \text{Formula 1}$$

where Σ_{right} – the amount of tasks where a right hand (right ear) is dominating during their execution, Σ_{left} – the amount of tasks under which the left hand (left ear) is dominant.

Further studies involved dextral testees whose coefficients of manual and auditory asymmetries were positive and were above 50%. The total number of men was of 104 people.

The level of psychodynamic properties of testees' nervous processes were surveyed with a simple sensorimotor reaction taking into consideration time period and sensorimotor responses in the choice of one of three objects as signals (triangles, circles, squares). See the program „Diagnostician -1”, Ukraine. All testees had to respond to the certain stimuli as quickly as possible with pressing the button by the right hand. Men evaluated and measured time intervals in minutes.

All examinations were performed in the morning. The profile of the asymmetry and psychodynamic properties of neural processes was evaluated 30 minutes before the EEG recording registration. It made impossible to influence on the experiment, particularly, on EEG results.

EEG testing procedures

The testees were in a quiescent state with their eyes closed and in a reclining position with their limbs relaxed and not crossed during the EEG testing. The experiment was carried out in a room which was sound-proof and light-proof. The whole experimental procedure consistently included the following steps for each testee:

Step 1. The EEG recording in the functional balance (background)

Step 2. The EEG recording while performing the alternate movements by fingers of the right hand.

Each step lasted 40 s. To exclude the edge effects, the EEG recording registration was started at 15 s after the beginning and had been stopped at 5 s by its completion.

The testees performed finger movements one by one in the following order: forefinger – fourth finger – third finger – little fingers. The sequence of movements was reported to the testees just before the test to reduce the stereotype of the task.

Movements of each finger were in its bending and unbending. Each finger flexion or extension was performed by the testees in response to the sound. The electronic version of the drum battle (the software of Finale 2006) was used for this purpose. Binaural stimuli were produced by four speakers placed in different corners of the room at the distance of 1.2 m from the testee's right or left ear. The stimulus duration was 130 ms; the playback sound volume did not exceed 55-60 dB at outlet from the speakers under the measurements carried out by the sound level meter of the 'DE-3301' type (certificate of attestation # 025-2009, valid until 21.12.2014). Additionally, the sound loudness was individually regulated for each testee to achieve the necessary level. The rate of the sound stimuli delivery was 2 Hz.

Registration and primary analysis of EEG data

Active electrodes were placed in accordance with the international system 10/20 in nineteen points on the scalp of the head during the electroencephalogram (EEG "Neurocom", and the Certificate of State registration # 6038/2007, valid until 18.04.2014) recording. The performance of the EEG recording was monopolar, with the use of ear electrodes as a reference. The Fourier analysis era was 4 s with a 50% overlap. Duration of sample was 40 s. ICA-procedure analysis was used for the rejection of EEG anomalies.

Both the power (μV^2) and the coherence of the brain electrical activity in the θ -, α -, β - and γ -frequency intervals were also evaluated. Taking into consideration the functional heterogeneity of different sub-bands of the EEG α - and β -rhythms, the changes in the power and coherence of each of them were considered, and coefficients of coherence (Coh) above 0.5 were analyzed as well.

The maximum frequency peak of the α -rhythm was determined for each testee in each EEG lead at a functional balance (Klimesch et al., 2007). Its value was averaged for all leads and the obtained values were considered as the testee's individual α -frequency (the individual alpha-frequency of EEG, IAF, and Hz). The IAF median was also determined and calculated for the group of men. It was 10.04 Hz. Thus, there were formed subgroups of testees in according to the value of the median:

- subgroup with a high IAF ($n = 53$, $IAF \geq 10.04$ Hz);
- subgroup with a low IAF ($n = 51$, $IAF < 10.04$ Hz).

The EEG frequency interval limits were determined individually, relying on the value of the testee's IAF. The following algorithm (Klimesch et al., 2007) was used and the truth of which was that the upper limit of $\alpha 3$ -subband was set to the right side of the IAF in increments of 2 Hz. It corresponded to the lower limit of the $\beta 1$ -band. The upper limit of the $\beta 1$ -sub-band was defined according to the standard concepts as 25 Hz. The lower limit of the $\alpha 2$ -band was determined in steps of 2 Hz to the left of the peak, and the $\alpha 1$ -band in 4-Hz steps, as well as θ -frequencies – in 6 Hz. Limits of $\beta 2$ - and γ -bands were recognized as standard, properly, 26 – 35 Hz and 36-45 Hz.

The resulting individual values of the power and coherence of EEG oscillations within the selected groups of men were averaged for each lead.

Statistical analyses

A statistical data analysis was performed by using the package 'STATISTICA 6.0' (Stat-Soft, 2001). Any normalcy of the data distribution in testees' subgroups was evaluated by means of the Shapiro - Wilks test (indicator SW). Based on test results, it was found that all of our studied samples had a normal data distribution. To estimate the significance of differences existing in testees' subgroups, the Student's t-test (index t) was used between steps of testing both for independent equal samples and for dependent samples. Significant differences between testees' subgroups and among steps of testing were statistically considered at $p \leq 0.05$ and $p \leq 0.001$.

Results

Psychodynamic properties of neural processes in the testees' groups with different levels of IAF

The testees with a high IAF spend less time both for a simple sensorimotor coordination and any choice reaction ($p \leq 0.001$) (table 1). The analysis and evaluation of metering minute time intervals indicate that the testees having a high IAF are characterized by more accurate estimation of time (table 2) than others. Moreover, men with a low IAF have relatively higher overestimation as well as incompletely measured timeslots. Simple with Choice Sensorimotor Reaction Latency and Estimation and Constant Time-Step Advancement in Minutes in Testees' Subgroups is shown in table 1, table 2.

Table 1. Simple with Choice Sensorimotor Reaction Latency in the Surveyed Subgroups (sec)

	Subgroups	Mean±SD
Simple reaction time	Men with a high IAF	232.35±5.15
	Men with a low IAF	299.21±6.40 ^{^^}
Choice reaction time	Men with a high IAF	334.82±7.19
	Men with a low IAF	399.9±15.29 ^{^^}

own study

Note to Tables 1 and 2:

[^] ^{^^} – differences between subgroups of men, $p \leq 0.05$ and $p \leq 0.001$.

Table 2. Estimation and Constant Time-Step Advancement in Minutes in Testees' Subgroups

	Subgroups	Mean, %
Overestimation of measured timeslots	Men with a high IAF	14.60
	Men with a low IAF	24.00
Accurate estimation of measured timeslots	Men with a high IAF	65.40
	Men with a low IAF	56.00
Underestimation of measured timeslots	Men with a high IAF	20.00
	Men with a low IAF	20.00

own study

Changes in the electrical activity of the cortex while performing the alternate movements by fingers of men with a high or a low output IAF

The increasing power of θ -, $\alpha 1$ - and $\beta 2$ -waves of the EEG in the frontal area as well as γ -activity - generally in the cortex ($p \leq 0.05$, $p \leq 0.001$) was observed in men having a high IAF and performing the alternate movements by fingers rather than in quiescent state. Moreover, the recorded relative depression of EEG oscillations was seen in the parietal-occipital and posterior temporal areas, particularly, in the left hemisphere, and in the θ - and $\alpha 1$ -sub-bands, or in the $\alpha 2$ -, $\alpha 3$ - and $\beta 1$ -bands ($p \leq 0.05$, $p \leq 0.001$) - generally in the cortex. These power changes in the electrical activity of the cortex are accompanied by the desynchronization of θ -, $\alpha 1$, $\alpha 3$ -waves of the EEG oscillations in the cortex ($p \leq 0.05$), as well as β - and γ -waves - in the back temporal, parietal and occipital lobes ($p \leq 0.05$, $p \leq 0.001$). Furthermore, a comparatively increase value of the $\alpha 2$ -subband coherence was registered in the frontal and central, right anterior temporal and left parietal areas ($p \leq 0.05$, $p \leq 0.001$), and $\beta 1$ -activity - in the central area ($p \leq 0.05$), $\beta 2$ waves - in the frontal and central-parietal areas ($p \leq 0.05$, $p \leq 0.001$), and γ -rhythm - in front of the frontal area of the cortex ($p \leq 0.05$). Changes in power and coherence of EEG oscillations in the cortex of men with a high IAF during the alternate finger movements are in Fig. 1.

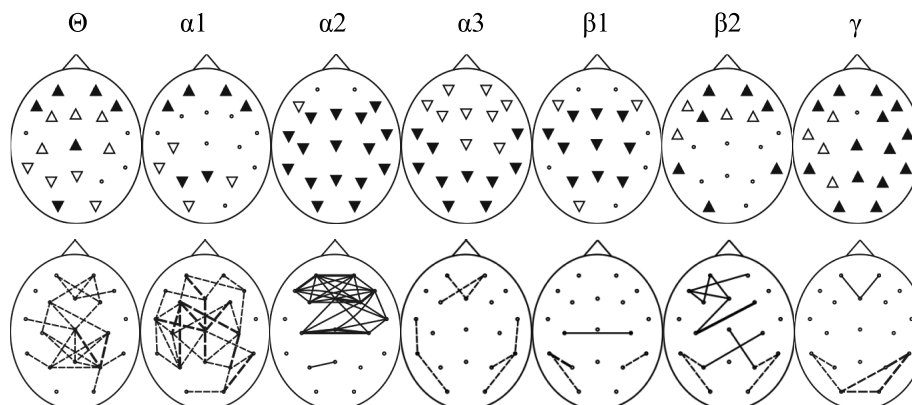


Figure 1. Changes in power and coherence of EEG oscillations in men having a high level of IAF during the alternate finger movements

own study

Notes to Fig.1-2:

- 1) $\Delta \nabla \blacktriangle \blacktriangledown$ increase (decrease) of power, $p \leq 0.05$, $p \leq 0.001$,
- 2) $\text{—} (\text{---})$ increase (decrease) of coherence, $p \leq 0.05$, $p \leq 0.001$.

The alternate finger movements performed by men having the low IAF are accompanied by a comparable growth of power in θ -, $\alpha 1$ -, $\alpha 3$ -waves of the EEG oscillations in the frontal area, $\beta 2$ -and γ -waves – generally, in the cortex ($p \leq 0.05$, $p \leq 0.001$) compared with rest. However, a relative decline was fixed in the temporal and posterior parietal-occipital parts of θ -, $\alpha 1$ -and $\alpha 3$ -bands, generally, in the cortex - the $\alpha 2$ -and $\beta 1$ -subbands ($p \leq 0.05$, $p \leq 0.001$). Under these conditions, some decrease was seen in the coherence values of θ -and $\alpha 1$ -waves of EEG oscillations in the cortex ($p \leq 0.05$, $p \leq 0.001$), $\alpha 2$ -, $\alpha 3$ -and $\beta 1$ -and γ -waves - in the temporal and parietal area ($p \leq 0.05$), predominantly, in the right hemisphere, compared to the background. Instead of it, the relative intensification was observed in the coherence of $\alpha 2$ -, $\alpha 3$ -, β -and γ -frequencies of the EEG activity in the anterior, central and temporal areas of the cortex ($p \leq 0.05$, $p \leq 0.001$). Changes in power and coherence of EEG oscillations in the cortex in men with a low IAF during the performance of alternate finger movements is shown in Fig. 2.

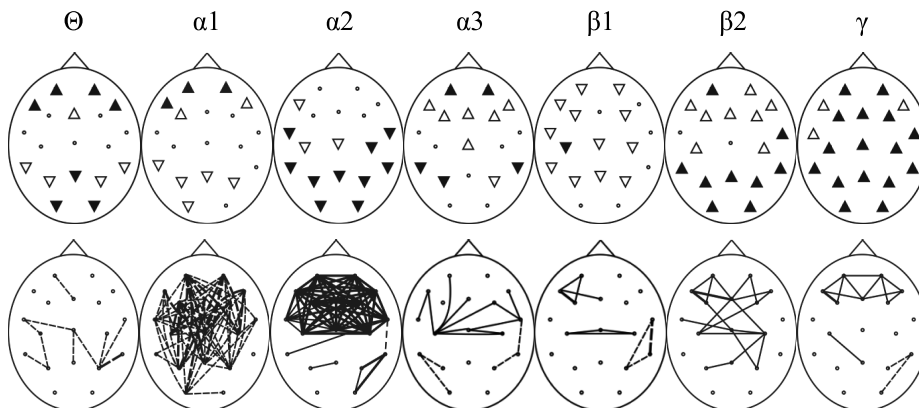


Figure 2. Changes in power and coherence of EEG oscillations in men having a low levels of IAF during the alternate finger movements
own study

Differences in power and coherence of EEG oscillations between subgroups of men

Men with a low IAF belonging to this subgroup are characterized by a higher power of θ -, α -and $\beta 1$ -waves ($p \leq 0.05$, $p \leq 0.001$) in their cortex than men having a high IAF. Meanwhile, a relatively lower power is observed in $\alpha 1$ -, β -and γ -bands ($p \leq 0.05$, $p \leq 0.001$), especially in the frontal area. Men with a low IAF have relatively higher EEG coherence oscillations in the cortex ($p \leq 0.05$). The significance of these differences is increased in the frontal area of the cortex ($p \leq 0.05$, $p \leq 0.001$). Differences in power and coherence of the EEG oscillations between subgroups of men are presented in Fig. 3.

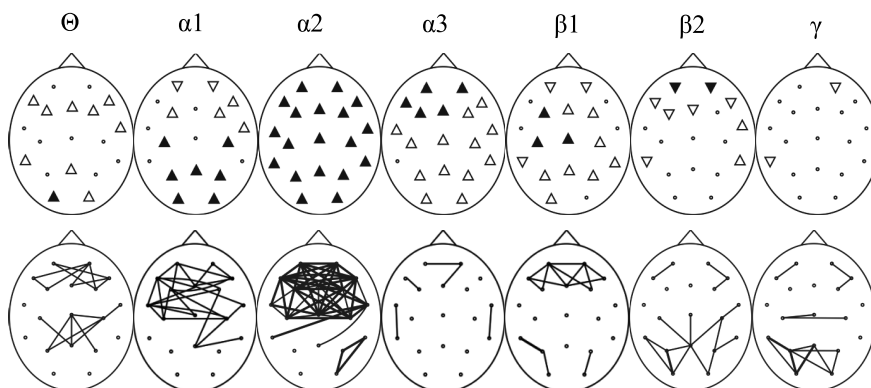


Figure 3. Differences in the EEG frequency power between male subgroups during alternate finger movements
own study

Notes to Fig.3:

- 1) $\triangle \nabla \blacktriangle \blacktriangledown$ higher (lower) rates in men with a low IAF level, $p \leq 0.05$, $p \leq 0.001$,
- 2) $\text{—} (\text{---})$ rates in men with a low IAF level, $p \leq 0.05$, $p \leq 0.001$.

Discussion and conclusions

Psychodynamic properties of nervous processes in men with a high or low background IAF

Any analysis of the brain activity during the alternate movements performed with fingers requires a delineation and consideration of psychodynamic properties of the nervous system in men with different levels of the IAF.

Testees with a high IAF are characterized by a higher speed performance of the neuro-motor apparatus in terms of both simple sensorimotor and choice reactions requiring the involvement of associative processes, re-encoding of information, and complex inter-system interactions. Men of this subgroup are also characterized by a more accurate estimation of time, which may indicate an increase in balance of nervous processes of the excitation and inhibition (Bushov et al., 2003). Long-term observations of researcher that was made by Portnova et al. (Portnova et al., 2010) show a direct correlation between the perception of time and the activities: the more accurate perception of time, the more successful activities are. Men with a low IAF have relatively higher rates of the overestimation and incompletely measured minute intervals. Thus, it may indicate a predominance of neural inhibitory processes. Aforesaid psychodynamic features of nervous system caused by the prevalence of low or high α -frequency rhythm in the background EEG made an impact on the electrical activity of the cortex while performing the alternate finger movements.

Features of the cortical activity while performing the alternate movements of fingers in subjects having a different IAF

The phenomenon of the spatial desynchronization occurred in the θ -, α_1 -, α_3 - frequencies of the EEG bands in the whole cortex, and in the β - and γ -frequencies – in the back temporal and occipital areas is an important aspect of brain processes during the alternate finger movements performed by men having a high IAF. These changes may reflect a decrease in the functional state of the cortex (Klimash et al., 2010). We think this reduction may be caused by conditional nonspecific activating influences of the reticular formation both on the cortex, and the septum which generates low-frequency EEG oscillations (Klimash et al., 2010). However, those brain structures directly guaranteeing the implementation of activities are supported at high levels of activity. The increased coherence of EEG α_2 -, β - and γ -waves in the frontal and central lobes, a depressed electrical activity of the cortex in the range of θ -, α - and β_1 -oscillations, especially in the posterior cortex became the evidence of it. In our opinion and according to the literature (Buzsáki 2006; Tebenova 2009), these phenomena may reflect an increase in the interaction of cortical areas involved in the processes of sensory analysis, motor programming and integration of sensory and motor information. An increase diffusivity of changes in the range of α_2 -, α_3 - and β_1 -waves of the EEG may indicate a weighty enhance of the sensory-spatial attention. The phenomenon of the dual semispherical spatial-frequency synchronization of any activity in the frontal and central lobes of its simultaneous desynchronization primarily in temporal and posterior occipital areas of the cortex attracts attention. It should be noted that the effects of simultaneous alpha synchronization and desynchronization in the anterior posterior cortical areas are observed while carrying out some cognitive tasks (Pfurtscheller et al., 1999). Based on these data the spatial processes of the β - and γ -synchronization found in men with a high IAF and α_3 -, β - and γ -synchronization found in men having the low IAF may indicate the role of the integrative processes and mental tensions during the formation of motor commands. Simultaneously, the asymmetric desynchronization in posterior temporal and occipital areas apparently reflects to the reciprocal changes in the focus of the attention – from processing of sensory stimuli to the process of programming movements in the frontal and central areas. The frontal expression of θ -, α_1 -waves is a consequence of the increased frontal thalamic feedback effects (Klimesh et al., 2007) it is likely to increase the selectivity of any voluntary attention and updating the memory trace. A diffuse increase of power in β_2 - and γ -oscillations occurred in the cortex can display the interface of widely distributed neural networks involved in sensorimotor integration (Pulvermuller et al., 1997).

Changes of the EEG power and coherence found in men with a high IAF are generally observed in men with a low IAF too. However, the phenomenon of the spatial synchronization in α_2 -, α_3 -, β - and γ -sub-bands are more important. Thus, the conditions for a compensatory relief of the excitation and its spread among different nodes of structural and functional systems of the perception (Zhavoronkova 2009) are created under these conditions. Such changes may be indicative as to a greater stress in brain processes modeled under the nonspecific effects of the reticular formation (Knipst et al., 1982). The observed power increase in α_3 -waves of the frontal zone may reflect on additional braking mechanisms of sensory input and activity of thalamocortical neural feedback loops (Klimesh et al., 2007). According to Ioffe (Ioffe 2003), the program including two components: a picture of the new coordination and a drawing of specialized downstream impacts was formed in the performance of unusual movements in the motor cortex. Under these conditions, a local synchronization of α_3 -activity found by us may be the EEG correlation in the mapping process to compare any afferent information flow and new parameters of the muscles with descending impulses from the frontal cortex of the previous motor program. Such descending inhibitory influences on the course of unusual movements interfere in the implementation of new coordination

(Ioffe 2003), and according to Kostandov (Kostandov 2010), they indicate a lower ductility of the set. Apparently, such specific cortical dynamic processes indicate a greater subjective difficulty of the task to men in this group, most inhibitions of nervous processes and the need to involve additional mechanisms assisting in information processing for its implementation during activities. Obtained results are correlated with our data (Korsakova et al., 1995) as to the decrease of thalamic projections to the cortex reduces its specific activation and selectivity as well as plasticity and nervous processes.

Defined power and coherence changes in subgroups of men are generally justified by testing conditions, which put forward higher requirements for facilities of the surveyed to efficiently allocate attention between the sensory perception and motor response as well as rebuild a motor program as a result of the inclusion of work performed by different muscles of various fingers. Identified cortical activation processes may be also associated with overcoming of the motor command disorganization in case of a less stereotyped experimental task.

Differences in power and coherence of the EEG oscillations between subgroups of men during the alternate finger movements generally showed higher levels of expression and spatial synchronization of EEG oscillations in the cortex of men having a low IAF. These patterns may reflect the higher voltage level of brain processes (Knipst et al., 1982) modulated by tonic effects of nonspecific brain systems: the limbic system – in the low-frequency range and the reticular formation – in the high frequency band of the EEG (Pulvermuller et al., 1997; Buzsáki 2006). A lower α 1-, β - and γ -power in the frontal area can be the indicator of a lower level of specific attention providing the control under information and abstract thought processes in men with a low IAF.

Thus, the performance of alternate movements of fingers in subgroups of men is accompanied by a certain decrease in the functional state of the cortex as the general trends caused by the conditional reduction of nonspecific reticular formation impacts both on the cortex and the septum, which generates low-frequency EEG oscillations. Simultaneously, cortical areas being directly involved in the processes of the sensory perception, sensory-spatial attention, motor programming and sensorimotor integration are supported at high levels of activity. The frontal EEG expression of low-frequency vibrations provided with a feedback of the frontal and thalamic influences probably increases the selectivity of the voluntary attention and updating the memory trace. The observed spatial synchronization of high-frequency EEG oscillations in the frontal and central lobes of the cortex and simultaneous desynchronization in posterior may be mechanisms of the reciprocal change of the focus on the process of programming and running of motor commands rather than on processing of sensory stimuli.

The detected cortical activities have specific features in men with high and low background IAFs and are closely related to psychodynamic properties of nervous processes. More economical brain processes providing the sensory and motor information processing in men with a high IAF determine the best performance of some speed and accuracy of their sensory-motor responses. Men with a low IAF have a lower ductility but a higher voltage of brain processes; need to involve additional mechanisms of information processing correlating with decreased sensorimotor speed capabilities in response, and increasing the role of inhibitory effects.

We are of the opinion that the establishment of such common factors in the studied subgroups is an important step towards the release of the clear prognostic criteria for the functionality of men in the fine motor area according to the EEG.

Conclusions

1. Men with high a IAF are distinguished by higher rates of speed and accuracy in terms of their sensory-motor response. The role of inhibitory neural processes increases in the case of men whose frequencies are low.
2. The implementation of alternating finger movements in male subgroups is accompanied by a decrease in the coherence of θ -, α 1-, α 3- EEG oscillations in the cortex in general, β - and γ - activity - in the rear temporal and occipital areas. In the frontal and central lobes of α 2-, β - and γ - ranges an increase in EEG coherence fluctuations was observed.
3. The power of θ -, α - and β 1- waves, especially in the posterior cortex areas, decreases during periods of alternating finger movements in male subgroups. A larger degree of low-frequency fluctuations in EEG power can be observed in the frontal area.
4. Men with a low IAF are characterized by higher power and coherence in their EEG oscillations over a wide frequency spectrum in the cortex area than men with high IAF. In the frontal area a relatively lower capacity of α 1-, β - and γ - ranges is demonstrated in the case of men with low-frequency AIF.

Acknowledgement

The work has been performed under the research project using the state budget funds of Ukraine, reg. no.0111U002143.

References:

1. Anokhin A., Muller V., Lindenberger U., Heath A., Myers E. (2006) *Genetic influences on dynamic complexity of brain oscillations*. "Neuroscience Letters", vol. 397 (1-2), Elsevier Science Ireland Ltd., Netherlands, p. 93-98.
2. Bastiaansen M., van der Linden M., ter Keurs M., Dijkstra T., Hag P. (2005) *Theta responses are involved in lexical-semantic retrieval during language processing*. "Journal of Cognitive Neuroscience", vol. 17, Mit Press, Cambridge, USA, p. 530-541.
3. Begleiter H., Porjesz B. (2006) *Genetics of human brain oscillations*. "International Journal of Psychophysiology", vol. 60 (2), Elsevier, Netherlands, p. 162-171.
4. Buzsáki G., (2006). *Rhythms of the brain*. Oxford University Press, New York, USA.
5. Bushov Ju., Hodanovych M., Ivanov A., Rjabova G. (2003). *EEG korelyaty tochnosti vosproizvedeniya vremennyh intervalov*. "Human Physiology", vol. 29 (4), Russian Academy of sciences Press, Moscow, Russia, p. 189-191. (in Russian)
6. Doppelmayr M., Klimesch W., Hodlmoser K., Sauseng P., Gruber W. (2005) *Intelligence related upper alpha desynchronization in a semantic memory task*. "Brain Research Bulletin", vol. 66, Elsevier, Netherlands, p. 171-177.
7. Hooper G. (2005) *Comparison of the distributions of classical and adaptively aligned EEG power spectra*. "International Journal of Psychophysiology", vol. V. 55 (2), Elsevier, Netherlands, p. 179-189.
8. Hyde J. (2005) *The gender similarities hypothesis*. "American Psychologist", vol. 60 (6), Official publication of the American Psychological Association, Washington, USA, p. 581.
9. Ioffe M. (2003) *Mozgovyye mehanizmy formirovaniya novykh dvizheniy pri obuchenii: evolyutciya klassicheskikh predstavleniy*. "Journal of Higher Nervous Activity", 53 (1), Russian Academy of sciences Press, Moscow, Russia, p. 5-21. (in Russian)
10. Klimash A., Tsytsershyn M., Shepoválnikov A., Zajtseva L., Kondakov E., Borovikova V. (2010) *Violations of the spatial organization of the bioelectrical activity of the cerebral cortex in boldnyh with severe traumatic brain injury at a different intensity of oppression consciousness*. "Human Physiology", vol. 36 (5), Russian Academy of sciences Press, Moscow, Russia, p. 49-65. (in Russian)
11. Klimesch W., Sauseng P., Hanslmayr S. (2007) *EEG alpha oscillations: the inhibition-timing hypothesis*. "Brain Research Reviews", vol. 53, Elsevier, Netherlands, p. 63-88.
12. Korsakova H., Moskovichute L. (1995) *Podkorkovyye struktery mozga i psichicheskiye protsessy*. Moscow University Publishing, Moscow, Russia, p. 119. (in Russian)
13. Knipst I., Kurova N., Korinevsky A. (1982) *Dinamika topogtam potentsyalov i funktsionalnoye sostoyaniye kory bolshyh polushariy*. Press "Science", Moscow, Russia, p. 166. (in Russian)
14. Kostandov Je. (2010) *Vliyaniye konteksta na plastichnost kognitivnoy deyatelnosti*. "Human Physiology", vol. 36 (5), Russian Academy of sciences Press, Moscow, Russia, p. 19-28.
15. Pfurtscheller G., Lopes da Silva T. (1999) *Event-related EEG/MEG synchronization and desynchronization: basic principles*. "Clinical Neurophysiology", vol. 110, Elsevier, Netherlands, p. 1842-1857.
16. Portnova G., Susojeva O., Ivanicky A. (2010) *Psihofiziologicheskoye issledovaniye vliyaniya zvukovoy ritmicheskoy stimulyatsii na subektivny otschet vremeni i skorost vypolneniya kognitivnyh zadaniy*. "Journal of Higher Nervous Activity", vol. 60 (4), Russian Academy of sciences Press, Moscow, Russia, p. 419-429. (in Russian)
17. Pulvermuller F., Birbaumer N., Lutzenberger W., Mohr B. (1997) *High-frequency brain activity: its possible role in attention, perception and language processing*. "Progress in Neurobiology", vol. 52(5), Pergamon Press Ltd., London, United Kingdom, p. 427-445.
18. Tebenova K. (2009) *Izucheniy bioelektricheskoy aktivnosti mozga operatorov telefonnyh stantsiy*. "Modern problems of science and education", vol. 4, Publishing house "Academy of natural sciences", Moscow, Russia, p. 138-141. (in Russian)
19. Van Beijsterveldt C., van Baal G. (2002) *Twin and family studies of the human electroencephalogram: a review and a meta-analysis* "Biological Psychology", Elsevier, Netherlands, vol. 61, № 1-2, p. 111-138.
20. Zhavoronkova L. (2009). *Pravshi-Levshi: Mezhpolutsharnaya assimetriya biopotentsialov mozga cheloveka*. Press "Ekoinvest", Krasnodar, Russia, p. 240. (in Russian)

Submitted: 10.12.2013

Accepted: 14.01.2014

THE ANALYSIS OF SPECIFIC IMMUNE RESPONSE FOR BORRELIA BURGDORFERI ACCORDING TO IN VIVO ANTIGENS IN REGARD TO SYMPTOMS SUBJECTIVELY PERCEIVED BY FORESTERS

Małgorzata Tokarska-Rodak^{1,2}, Maria Koziół-Montewka^{1,2}, Dorota Plewik³,
Justyna Paszkiewicz², Adam Szepeluk³, Anna Pańczuk²,

¹Department of Medical Microbiology, Medical University of Lublin

²Department of Health, Pope John Paul II State School of Higher Education in Biala Podlaska

³Innovation Research Center, Pope John Paul II State School of Higher Education in Biala Podlaska

Tokarska-Rodak M., Koziół-Montewka M., Plewik D., Paszkiewicz J., Szepeluk A., Pańczuk A. (2014) *The analysis of appearing and disappearing dynamics of antibodies for borrelia burgdorferi antigenic protein form in vivo group among forest service employees on the basis of two-stage studies*, Health Problems of Civilization 1 (8) p. 32-38

Summary:

The aim of our this work was analysis of specific immune response for *B. burgdorferi* according to in vivo antigens in regard to symptoms subjectively perceived by foresters, in 2009 and 2012.

Material and methods: study group include 41 foresters (19 - 86 years old), from the forest district in Lubelskie region. All persons underwent serological diagnostic. We used 2 phase diagnosis method of Lyme diseases according to standards. Used tests include *Borrelia* antigens from in vivo group, which are not use in standard diagnosis test. The study was carried out in 2009 and then again in 2012.

Results: The analysis of antibodies for *Borrelia* proteins, including the in vivo, demonstrated how active, long-term and time-variable is the process of *B. burgdorferi* infection.

Conclusions: The expression of *Borrelia* proteins and high immunogenicity translates into effectiveness of diagnostic procedures concerning *B. burgdorferi* identification. Considering to not clear clinical manifestation and changeable immune response require individual approach to each patient.

Keywords: *Borrelia burgdorferi*, in vivo antigens, Lyme disease

Introduction

Borrelia spirochaetes dispose of the package of proteins facilitating adjustment to: the microenvironment conditions in a specific organism, survival in those conditions, tissues colonization, and facilitate the ability to change the host. Since a considerable number of spirochaetes proteins is characterized by high immunogenicity, they are also significant from the perspective of diagnosis of *Borrelia* infections in humans. The most significant marker for early-stage infection are IgM antibodies directed against to OspC protein. They have significance diagnostic meaning and decreases in the period of late anti-*Borrelia* response. After that immunodominant role is taken over by VlsE, p30, DbpA (Aguero-Rosenfeld et al., 2005, Aberer 2007, EUCALB 2008, Bárcena-Uribarri et al., 2012, Coburg et al. 2013). Incredibly significant are *Borrelia burgdorferi* proteins which are expressed only in mammal organisms, whereas such expression is not observed in ticks or in culture mediums. A group of this type of proteins calls 'in vivo' proteins. Together with VlsE and DbpA, also BBA36, BBO323, CRASP3, pG are included in that group (Aguero-Rosenfeld et al., 2005, Zajkowska et al., 2006, Wilske et al., 2007, Bykowski et al. 2008, EUCALB 2008, Coburg et al., 2013). BBA36 and BBO323 proteins are considered as an important marker for advanced stages of Lyme disease in IgG serology. They are detected in patients with disseminated Lyme disease and neuroborreliosis (Zajkowska et al., 2006) and with Lyme arthritis (Tokarska-Rodak et al., 2008, Tokarska-Rodak et al., 2010). Although the antigens from in vivo group are most commonly specified as distinctive for the late Lyme disease stage, researches have shown that we can find them in patients with early stage borreliosis (Zajkowska et al., 2006). The appearance and disappearance of antibodies to various antigenic proteins of *Borrelia* is therefore a dynamic and time-variable process. It is a matter for people occupationally exposed to tick bites. Foresters are expose to multiple tick bites, and high risk of being infected with *Borrelia*.

Address for correspondence: Małgorzata Tokarska-Rodak Department of Medical Microbiology, Medical University of Lublin, Chodźki 1, 20-093 Lublin, e-mail: rodak.malgorzata@gmail.com, phone +48 (81) 742-37-47

Tables: 7 Figures: 0 References: 19 Full-text PDF www.hpc.edu.pl **Copyright** © Pope John Paul II State School of Higher Education In Biała Podlaska, Sidoraska 95/97, 21-500 Biała Podlaska **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non-commercial and is otherwise in compliance with the license.

The aim of work

The aim of our work was analysis of specific immune response for *B. burgdorferi* according to in vivo antigens in regard to symptoms subjectively perceived by foresters, in 2009 and 2012.

Material and methods

The study group include 41 foresters (19 to 86 years), from one forest district in Lubelskie region. The screening test Elisa (Euroimmun) has been carried among all persons from the tested group towards the presence of antibodies IgM/IgG anti-*Borrelia*. Among those who met positive or delimited results from screening test Elisa, another test of Western blot (Wb, Euroimmun) has been carried in order to confirm the infection. The subjects who met positive results of Wb (Euroimmun) test with the presence of antibodies IgM and/or IgG anti-*Borrelia* have been submitted to broader diagnostic tests regarding the infection with *B. burgdorferi*. The antibodies IgG has been detected for in vivo antigens of *Borrelia burgdorferi*: BBA36, BBO323, CRASP3, pG (Virotech GmbH). The study was carried out in two periods: December 2009 and then the same people again, in December 2012. Also the surveys were taken. We asked about: tick bites in 2009-2012 period, presence of erythema migrans (EM) in that period, and others symptoms which can be associated with being bitten by a tick, and antibiotic therapy. The study obtained the approval of the bioethics committee.

Results

The 32% foresters from study group have not immune response for IgM/IgG anti-*B. burgdorferi* in two diagnostic periods (2009, 2012). During 3 years period (2009-2012) foresters noticed tick-bitten: once (10 persons) or multiple (3 persons). None of 13 respondents developed erythema migrans (EM) or symptoms which could be associated with tick bites (table 1).

Table 1. Results of the Western blot test aimed to detect the presence of anti-*Borrelia* antibodies among forest service employees – no *Borrelia burgdorferi* infection

Number of patients	2009				2012			
	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms
13 (32%)	no <i>Borrelia burgdorferi</i> infection				no <i>Borrelia burgdorferi</i> infection			

In 10% (4 persons) in 2009 no anti-*Borrelia* antibodies were found. The same persons in December 2012 had positive results of IgM and IgG antibodies for *Borrelia burgdorferi* (table 2). The respondents this group declared symptoms like headaches, osteoarticular pains, myalgia and reported undertaking the treatment (table 2).

Table 2. Results of the Western blot test aimed to detect the presence of anti-*Borrelia* antibodies among forest service employees – identification of infection in a tested period

Number of patients	2009					2012				
	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Treatment	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Treatment
4 (10%)	no <i>Borrelia burgdorferi</i> infection					OspC anti- <i>B. afzelii</i> <i>B. garinii</i> <i>B. burgdorferi</i> s.l. <i>B. spielmanii</i>	+	VlsE, CRASP3, BBA36	Headaches osteoarticular pinas myalgia	+

The dynamics of appearance, maintenance and disappearance of IgM/IgG anti-*Borrelia* antibodies is an incredibly individual matter. In accordance with existing guidelines, presence of antibodies cannot constitute the only criteria taken into account when diagnosing Lyme disease. Clinical picture, epidemical and clinical history are significance of individual patient.

One person (2%) declared a tick bite, and EM symptoms, and also reported undergoing the treatment in 2009, while in 2012 IgG anti-*Borrelia* were detected, without the presence of the symptoms (table 3).

Table 3. Results of the Western blot test aimed to detect the presence of anti-*Borrelia* antibodies among forest service employees – profile change of produced anti-*Borrelia* antibodies

Number of patients	2009					2012			
	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Treatment	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms
1 (2%)	OspC anti- <i>B. afzelii</i> <i>B. garinii</i> <i>B. burgdorferi</i> s.l. <i>B. spielmanii</i>	-	-	EM	+	-	+	VlsE, CRASP3, BBA36, BB0323, pG	no symptoms

The treatment used in patients in early stage of immune response to the infection can bring satisfactory results by reducing symptoms and elimination of a specific immune response directed against bacteria. However, patients after treatment can be seronegative, but clinical symptoms can stay. Situation like that hinders proper functioning and professional work, especially physical work. For many people it is also emotional problem, what is emphasized by a large number of infectious diseases physicians treating Lyme disease. The above observations confirm the examples of 4 patients (10%) in whom, in 2009 we observed presence of IgM anti-OspC for *B. afzelii*, *B. burgdorferi* s.s., *B. garinii* i *B. spielmanii*. In the 2012 diagnosis period the obtained results were negative (table 4). All patients underwent antibiotic therapy after 2009 relating to the symptoms, but in 2 case, osteoarticular pains and myalgia were not eliminated.

Table 4. Results of the Western blot test aimed to detect the presence of anti-*Borrelia* antibodies among forest service employees – elimination of infection with maintenance of symptoms

Number of patients	2009					2012				
	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Treatment	Number of patients	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms
4 (10%)	OspC anti- <i>B. afzelii</i> <i>B. garinii</i> <i>B. burgdorferi</i> s.l. <i>B. spielmanii</i>	-	-	osteoarticularpains, myalgia	+	2	no anti- <i>Borrelia burgdorferi</i> antibodies			osteoarticular pinas myalgia
						2	no anti- <i>Borrelia burgdorferi</i> antibodies			no symptoms

In 2009 one forester (2%) had IgG anti-VlsE antibodies, and he reported osteoarticular pains and antibiotic treatment (table 5). In the test in 2012, there was no presence of anti-*Borrelia* antibodies in any class in his serum. Forester declared the existence of another tick bite in spring 2012, the occurrence of EM, and informed about used treatment because of EM.

His pain declared in 2009 remained and during the test in December 2012. The existence of clinical symptoms associated with Lyme disease does not exclude the occurrence of early skin manifestations (EM) after subsequent ticks bites. Antibiotics, used in accordance with the recommendations, successfully stopped the process of early new infection as evidenced by the lack of specific IgM antibodies. Despite multiple treatments, there was not satisfactory elimination of other symptoms for the patient that had existed after the first infection.

Table 5. Results of the Western blot test aimed to detect the presence of anti-*Borrelia* antibodies among forest service employees – elimination of infection with maintenance of symptoms and subsequent infection including EM in the history

Number of patients	2009					2012				
	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Treatment	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Treatment
1 (2%)	-	+	VlsE	osteoarticular pains myalgia	+	no anti- <i>Borrelia burgdorferi</i> antibodies			EM osteoarticular pains myalgia	+

In 17% of foresters in tests conducted with an interval of 3 years, there existed only IgM anti-OspC *Borrelia* (Table 6). They informed about existence of clinical symptoms and treatment used. Probably it can be presumed that kind of serological status is associated with existence of *Borrelia* infection in 2009, which was eliminated. However, in 2012, was a re-infection with *B. burgdorferi*. Foresters are still exposed to multiple bites by ticks, so one cannot rule out the existence of occurring infections.

Table 6. The results of Western blot test for the presence of anti-*Borrelia* antibodies in forest service workers - only the presence of OspC anti-*Borrelia burgdorferi*

Number of people	2009					2012				
	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Treatment	Wb IgM	Wb IgG	Antigens from <i>in vivo</i> group	Symptoms	Treatment
3 (17%)	OspC anti- <i>B. afzelii</i> <i>B. garinii</i> <i>B. burgdorferi</i> s.s. <i>B. spielmanii</i>	-	-	headaches osteoarthritis muscle pain	+	OspC anti- <i>B. afzelii</i> <i>B. garinii</i> <i>B. burgdorferi</i> s.s. <i>B. spielmanii</i>	-	-	headaches, osteoarthritis muscle pain	+

In 15 foresters (36%) treated by antibiotics had still strongly expressed immune response occurred as IgM/IgG anti-*Borrelia* (Table 7). During 2009 – 2012 period they were repeatedly stinging by ticks and they declared symptoms of osteoarthritis, muscle pain, and headache. In 7 out of 15 foresters (47%) there was persistence of response against the same antigens from *in vivo* group (grey boxes in Table 7). In case of the next 7 people in this subgroup (47%) there was some dynamics: the disappearance or appearance of IgG to specific antigens from *in vivo* group. It showed us that the process of immunostimulation is active, time-varying and possibly associated with *Borrelia* strategies (black boxes in Table 7). We observed different frequencies- disappearance of IgG to specific proteins BBA36, BBO323, CRASP3 and pG in 4 of 15 patients (27%). In 3 people (20%) there was appearance of IgG antibodies for the same *in vivo* antigens. The only exception was IgG anti-VlsE antibodies. It was consistently reported in all of subgroup (15 people) infected with *B. burgdorferi*.

Table 7. The results of Western blot test for the presence of anti-*Borrelia* antibodies in forest service workers - the dynamics of appearance and disappearance of IgG antibodies to *Borrelia* antigens from the in vivo group

Number of people	2009					2012				
	Wb IgM	Wb IgG	Antigens from in vivo group	Symptoms	Treatment	Wb IgM	Wb IgG	Antigens from in vivo group	Symptoms	Treatment
15 (36%)	-	+	OspC anti- <i>B. afzelii</i> <i>B. garinii</i> <i>B. burgdorferi</i> s.s. <i>B. spielmanii</i>	headaches, osteoarthritis muscle pain	+	-	+	VlsE, CRASP3, BBA 36, BBO323	headaches osteoarthr - it is muscle pain	+
			VlsE, BBO323							
			VlsE, CRASP3							
			VlsE, BBA36, CRASP3							
			VlsE, BBO323, CRASP3							
			VlsE, BBA36, BBO323							
			VlsE, BBA36, CRASP3							
			VlsE, BBA36, BBO323, CRASP3							
			VlsE, pG							
			VlsE, CRASP 3, pG							
			VlsE, BBA36, BBO323, CRASP3							
			VlsE, BBA36, BBO323, CRASP3							
			VlsE, BBA36, BBO323, CRASP3							
			VlsE							

Grey box - persistence of antibodies to the in vivo antigen within three years from the last study
Black box - the appearance or disappearance of IgG antibodies for the in vivo antigen within three years from the last study

Discussion

The immune response to infection with *B. burgdorferi* occurs in a diverse and individual pace. It should be taken into consideration while estimating the clinical and serological status of each patient. Clinical symptoms of Lyme disease may not be eliminated despite the implemented treatment. Simultaneously there may be strongly expressed stimulation of the production of IgG anti-*Borrelia* antibodies. The presence of IgG antibodies to the in vivo antigen indicates their importance in the late response to infection with *Borrelia*. Appearance and disappearance of antibodies to in vivo proteins shows continued availability of bacterial antigens to the host organism and long-term immune stimulation.

In vivo proteins, in addition to VlsE and DbpA, are not usually used in the serological diagnosis, even though many researchers notice high diagnostic potential (Aguero - Rosenfeld et al. 2005, Hofmann et al., 2006, Zajkowska et al., 2006, Bykowski et al., 2008). The tests carried by Hofmann et al. showed that late *Borrelia* infection is characterized by presence of IgG anti-BBA36, BBO323, CRASP3, pG. In patients with Lyme arthritis there were antibodies to BBO323 (90%), BBA36 (67 %), p83 (71 %) (Hofmann et al., 2006). In their own studies, in patients repeatedly stabbed by ticks, with clinical manifestations of Lyme arthritis, there were also antibodies for BBA36, BBO323, CRASP3 and pG (Tokarska - Rodak et al., 2008, Tokarska - Rodak et al., 2010). The percentage of positive results for IgG anti- BBO323 antibodies increases in persistent infections as neuroborreliosis and arthritis (Aberer 2007 Tokarska - Rodak et al., 2010). Anti - *Borrelia* antibodies can persist despite implemented treatment. In patients with clinical manifestations of Lyme disease observed them both before the implementation of antibiotic therapy, after antibiotic therapy, and for 6 weeks after the end of treatment (Tokarska - Rodak et al. 2010). IgG antibodies to *Borrelia* antigens, including ones expressed in vivo, may exist consistently even for 3 years but they may also be characterized by certain dynamics. This indicates how dynamic the process of *Borrelia burgdorferi* infection is, and demonstrates that the process of immunostimulation is active and time-varying. Possibly that this process is associated with the *Borrelia* strategies, among other things by the expression of CRASPs proteins and their role in the binding of complement regulation factors (Singh et al. 2004, von Lackum et al. 2005, van Burgel et al. 2010, Siegel et al., 2011).

Foresters are exposed to multiple bites by ticks, so we cannot eliminate existence repetitive infections. In 17% foresters, who underwent examination with an interval of 3 years (2009 and 2012), in both tests there were IgM anti-OspC, at the same time with the absence of IgG antibodies. IgM anti-OspC antibodies are highly acclaimed in the diagnosis of Lyme disease, and their presence in the absence of IgG antibodies signalizes an early response to infection process (Chmielewska-Badora et al., 2006, Hofmann et al., 2006, Zajkowska et al., 2006). Therefore, it is right to perform the annual diagnostic tests for Lyme disease in groups that are exposed to infection with *B. burgdorferi* on the grounds of their occupation. Anti-*Borrelia* antibodies can be possibly persistent, despite previous treatment and elimination of the symptoms of the infection. Nevertheless presence of *Borrelia* antibodies in the absence of clinical symptoms is not an indication, for the implementation of antibiotic therapy, according to guidelines (Wilske et al., 2007, EUCALB 2008, CDC 2011).

The treatment used in Lyme disease may be effective and lead to the total elimination disease symptoms, and disappearance of specific antibodies. In some cases, despite of antibodies elimination there is no symptoms reduction of Lyme diseases. It may suggest existence of post- treatment Lyme disease syndrome (PTLDS). The PTLDS can be signalized if symptoms associated with *Borrelia* infection are persistent, and last longer than 6 months after treatment. According to the guidelines, this condition does not justify the use of antibiotics, which is referred as useless and potentially harmful to the patient with PTLDS (Lakos, 2012, CDC, 2011). Then the medical and laboratory activities should be focused on assessing the effectiveness of treatment, exclusion of possible failure of therapy or taking into account other factor which is not related to *Borrelia* infection (Lakos, 2012, CDC, 2011). The cause of PTLDS is not completely clear. It is assumed that these symptoms may be related to the elements of tissue damage or dysfunction of the immune system during the infection. Similar complications including autoimmune reactions may occur in other infectious diseases (CDC, 2011). Long-standing persistence of symptoms that may be associated with PTLDS is an important and strongly noticed problem of both doctors and physiotherapists.

The obtained results indicate the advisability of annual tests for *Borrelia* infection for people working in conditions predisposing to infection. Unfortunately, in the vast majority of forest districts, the employer finances only the first stage of diagnosis (ELISA tests). Confirming tests (Wb) employees found on their own.

In practice it means that many people who are advised to do a confirmation test do not do such tests. At the moment there is no legislation which would impose an obligation on employers to perform a full, two-stage diagnosis in the direction of Lyme disease.

Conclusions

Analysis of appearance and disappearance antibodies to *Borrelia* antigens expressed in vivo showed, how active, long and time-varying process is this infection. This forces an individual approach to each patient, in whom there is a suspicion of Lyme disease. What is more it imposes a need to consider often ambiguous serological results with clinical manifestations of infection. Especially it is important for people exposed to *Borrelia* infection on the grounds of their occupation.

The expression of individual proteins of spirochetes and their exceptionally high immunogenicity make diagnostic procedure effective. It is postulated that the use of a wider range of antigens *B. burgdorferi* from in vivo group: BBA36, BBO323, CRASP3 and pG in Western blot diagnostic tests could help to increase diagnostic accuracy in difficult and ambiguous cases of *B. burgdorferi* infection.

References:

1. Aberer E. (2007), *Lyme borreliosis - an update*. Journal der Deutschen Dermatologischen Gesellschaft, 5, 5, s. 406-413.
2. Agüero-Rosenfeld M.E., Wang G., Schwarz I., Womser G.P. (2005), *Diagnosis of Lyme borreliosis*. Clin. Microbiol. Rev. 18, 3, s. 484-509.
3. Bárcena-Uribarri I., Tein M., Bonde M. (2012), *Porins in the Genus Borrelia*. W: A. Karami (red.), *Lyme disease. INTECH*, s. 139-160.
4. Bykowski T., Woodman M.E., Cooley A.E. (2008), *Borrelia burgdorferi complement regulator-acquiring surface proteins (BbCRASPs): Expression patterns during the mammal-tick infection cycle*. I.J.M.M. 298, Supl 1, s. 249-256.
5. Chmielewska-Badora J., Cisak E., Wójcik-Fatla A., Zwoliński J., Buczek A., Dutkiewicz J. (2006), *Correlation of tests detection of Borrelia burgdorferi sensu lato infection in patients with diagnosed borreliosis*. Ann. Agric. Environ. Med. 2006, 13, s. 307-311.
6. Hofmann H., Wallach R., Lorenz I., Bechtel, M. (2006), *Comparison of a New line assay using purified and recombinant antigens with a European lysate blot for serodiagnosis of Lyme borreliosis*. I.J.M.M. 296, s. 288-290.
7. Lakos A., Igari E. (2012), *Advancement in Borrelia burgdorferi antibody testing: Ccomparative Immunoblot Assay (COMPASS)*. W: A. Karami (red.), *Lyme disease. INTECH*, s. 55-78.
8. Singh S. K., Girschick H. J. (2004), *Molecular survival strategies of the Lyme disease spirochete Borrelia burgdorferi*. Lancet Inf Dis, 4, s. 4575-83
9. Tokarska-Rodak M., Fota-Markowska H., Śmiechowicz F., Gajownik, B., Prokop, M., Modrzewska, R., Koziół-Montewka, M. (2010), *Antibodies against in vivo B. burgdorferi antigens evaluated in patients with Lyme arthritis with reference to treatment*. Adv. Clin. Exp. Med. 19, 4, s. 489-496.
10. Tokarska-Rodak M., Koziół-Montewka M., Fota-Markowska H., Bielec, D., Modrzewska, R., Pańczuk, A. (2008), *Frequency and specificity of the antibodies against Borrelia burgdorferi tested by Western blot method in patients with symptoms of arthritis*. Cent. Eur. J. Immunol. 33, 4, s. 220-223.
11. Von Lackum K., Miller J.C., Bykowski T. (2005), *Borrelia burgdorferi regulates expression of Complement Regulator-Acquiring Surface Protein 1 during the mammal-tick infection cycle*. Infect. Immun. 73, 11, s. 7398-7405.
12. Wilske B., Fingerle V., Schulze-Spechtel U. (2007), *Microbiological and serological diagnosis of Lyme borreliosis*. FEMS Immunol. Med. Microbiol. 49, s. 13-21.
13. Zajkowska J., Kondrusik M., Pancewicz S.A., Sienkiewicz, I., Grygorczuk S. Wierzbińska R., Hermanowska-Szpakowicz T. (2006), *Laboratory diagnosis of Early Lyme borreliosis – comparison of ELISA, Western blot (EcoLine), and PCR results*. I. J Med. Microbiol. 296, s. 291-293.
14. Zajkowska J., Kondrusik M., Pancewicz S., Grygorczuk S., Wierzbińska R., Hermanowska-Szpakowicz T., Czczuga A., Sienkiewicz I. (2006), *Test Western blot z białkiem VlsE oraz antygenami „in vivo” w diagnostyce boreliozy z Lyme*. Przegl. Epidemiol. 60, s. 177-185.

Websites

1. Van Burgel N., Kraiczky P., Schuijt T., Zipfel P.F., van Dam A.P. (2010), *Identification and functional characterization of Complement Regulator Acquiring Surface Protein -1 of serum resistant Borrelia garinii OspA serotype 4*. BMC Mikrobiol. 10.43. <<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2833144/>>, (10 lipca 2013).
Cytowanie w tekście (van Burgel, 2010)
2. European Concerted Action on Lyme Borreliosis (2008), http://meduni09.edis.at/eucalb/cms/index.php?option=com_content&task=view&id=38&Itemid=102, (20 lipca 2011).
Cytowanie w tekście (EUCALB, 2008)
3. Coburn J., Leong J., Chaconas G. (2013), *Illuminating the roles of the Borrelia burgdorferi adhesins*. Trends. Microbiol. <http://www.cell.com/trends/microbiology/retrieve/pii/S0966842X13001145?_returnURL=http://linkinghub.elsevier.com/retrieve/pii/S0966842X13001145?showall=true>, (30 lipca 2013).
Cytowanie w tekście (Coburg, 2013)
4. Siegel C., Hallström T., Skerka Ch., Eberhardt, H., Uzonyi, B., Beckhaus, T., Karas, M. (2010), *Complement factor H-related proteins CFHR2 and CFHR5 represent novel ligands for the infection-associated CRASP proteins of Borrelia burgdorferi*. <<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2958145/?tool=pubmed>>, (03 sierpień 2013).
Cytowanie w tekście (Siegel, 2010)
5. Centers for Disease Control and Prevention. <http://www.cdc.gov/lyme/>, (14 września 2011).
Cytowanie w tekście (CDC, 2011)

Submitted: 21.10.2013

Accepted: 30.11.2013

GENERAL ANAESTHESIA IN PATIENTS WITH CEREBROVASCULAR DISEASES - RISKS AND COMPLICATIONS

Piskorz Jolanta^{1,2}, Hżeczka Joanna², Wójcik Gustaw^{3,4}

¹Department of Anesthesiology and Intensive Care,
The Zofia z Zamoyskich Tarnowska Regional Hospital in Tarnobrzeg

²Neurological Rehabilitation Laboratory,
Chair of Rehabilitation, Physiotherapy and Balneotherapy at the Medical University in Lublin

³Balneotherapy Department, Chair of Rehabilitation,
Physiotherapy and Balneotherapy at the Medical University in Lublin

⁴Diagnostic Imaging Department,
The Zofia z Zamoyskich Tarnowska Regional Hospital in Tarnobrzeg.

Piskorz J., Hżeczka J., Wójcik G. (2014) *General anaesthesia in patients with cerebrovascular diseases - risks and complications*, Health Problems of Civilization 1 (8), p. 39-44

Summary: The aim of the study is to present the problems arising during general anesthesia in patients with cerebrovascular diseases, taking into account the appropriate perioperative preparation. When planning the anesthetic procedure strategies aimed at the prevention of cerebral ischemia or hemorrhage into the brain must be taken into account.

Material and research methods: a descriptive analysis was applied on the basis of the literature collected from the years 1992 to 2013.

Conclusions: Preoperative evaluation of patients with cerebrovascular disease requires a thorough neurological examination, assessment of cardiovascular complications, including the risk of cerebrovascular, respiratory, renal, and endocrine system complications. During general anesthesia one should take care of haemodynamic stability and proper ventilation parameters. The choice of anesthetic agents so that during the induction of anesthesia, throughout anesthesia, during the recovery from the anesthesia there is no risk of hemodynamic instability and an appropriate level of blood perfusion in the brain is maintained. In the postoperative period the neurological status of the patient should be assessed, in order to ensure that he does not demonstrate symptoms of delirium and that he does not experience a recurrence of previous neurological deficits. Each surgery and anesthesia should be discussed with the operator in terms of the risks and benefits of surgery. Scheduled surgery in patients with acute cerebrovascular incidents need to be postponed until their performance is reasonably safe for the patient.

Key words: general anesthesia, ischemic stroke, intracerebral hemorrhage, cerebral vascular malformation

Introduction

Cerebrovascular diseases are responsible for a large portion of complications resulting from neurological diseases. They more often lead to disability than death and they are associated with insufficient blood flow in part or all of the structures of the brain. Advances in the treatment of cerebrovascular significantly increase patient survival. More and more patients with a history of CVD require general anesthesia for operations other than neurological. It is in such cases that the additional requirements for anesthesia are required (Kohl, Rosenbaum, 2010). At all stages of perioperative care, the anesthesiologist must plan such action to prevent cerebral ischemia or hemorrhagic stroke, select the optimal anesthetic technique and an appropriate level of monitoring (Kohl, Rosenbaum, 2010).

Cerebrovascular diseases are usually divided into occlusions, such as narrowing of the carotid arteries and intracranial bleeding, as a result of which there is bleeding, such as endovascular aneurysm or arteriovenous malformation.

General anaesthesia in patients with occlusive cerebrovascular diseases

The brain is supplied with blood through the carotid arteries (providing approximately 80% of the total cerebral blood flow (CBF) and vertebral arteries (approximately 20% CBF), which extend from the extracranial section of the aorta and other large arteries, then run through the neck, the base of the skull into the cranial cavity

Address for correspondence: Jolanta Piskorz Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin
e-mail: jolapis@op.pl, phone: 506-113-385

Tables: 0 Figures: 0 References: 26 Full-text PDF www.hpc.edu.pl **Copyright** © Pope John Paul II State School of Higher Education In Biała Podlaska, Sidorska 95/97, 21-500 Biała Podlaska **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education.
This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non-commercial and is otherwise in compliance with the license.

(Rowland, Pedley 2012). In case of 5-10% of patients over the age of 65 more than 50-percent carotid stenosis is detected (O'Leary et al. 1992 Fine-Edelstein and in.1994). Most common risk factors for cerebrovascular occlusive diseases are: atherosclerosis, vascular congestion and hypertension. Occlusion of the common carotid and vertebral-basal are frequently encountered in the elderly group of the population.

Cerebral circulation in these patients is maintained by cerebral autoregulation, which allows maintaining blood flow in a wide range of perfusion pressures (50-150mm Hg), the collateral blood flow from the circle of Willis and other sources (Joshi et al. 2001). Autoregulation of cerebral circulation consists of reflex cerebral vasoconstriction in response to elevated average arterial blood pressure and expansion in case of its reduction. The driving force of cerebral blood flow (CBF) is a perfusion pressure (CPP), which is dependent on the mean arterial blood pressure (MABP) and intracranial pressure (ICP). The correct value of the CPP is 70mmHg (Zauner et al. 2002).

The intracranial pressure equates to from 7 to 15 cm H₂O in the horizontal position is directly related to the pressure inside the thoracic and records changes in the respiratory system. When the intracranial susceptibility decreases slight increase in volume causes an increase in ICP, such changes may cause anesthetics like halothane, isoflurane, vasodilators, hypercapnia, and trauma or surgery.

Procedure related to anesthesia in patients with known cerebrovascular stenosis is primarily dependent on adequate cerebral perfusion pressure to prevent new or recurrent episodes of ischemia.

The preoperative evaluation should pay attention to the symptoms, duration, severity and etiology of previous ischemic events. Any acute or residual neurological change should be noted, that it can be applied to any symptoms that occurred in the postoperative period. The standard procedure should require postponing all elective surgery if an ischemic episode occurred during the last four weeks. Post-stroke changes, such as increased permeability of the blood-brain barrier, impaired autoregulation of cerebral blood flow, or loss of response to CO₂ concentrations may persist for longer than 4 weeks (Finnigan et al. 2007, Zhao et al., 2009).

In the anesthesia examination it should be noted whether when changing the position of the head there is no reaction in the form of ischemia, on a clear airway and whether there is a presence of sleep apnea, both its central and obstructive form. A common perioperative complication in these patients is aspiration pneumonia and nosocomial pneumonia (Kohl, Rosenbaum, 2010).

In this group of patients, there is a large proportion of serious comorbidities on important systems and organs. They are often related to the cardiovascular system. The anesthetist should gather a detailed history, perform a physical examination of the designation of the output of blood pressure. It is recommended to perform the ECG to detect possible changes in ischemic myocardial infarction or arrhythmia. Additional examinations such as transthoracic echocardiography, transesophageal echocardiography are recommended if there is a need to perform an overall assessment of myocardial function, heart valves, barrier function or intracardiac thrombi possible detection and evaluation of the aorta (Aitkenhead et al., 2008).

Patients with cerebrovascular diseases often have dysphagia disease, gastroesophageal reflex, and other stomach diseases (Schaller et al. 2006). Should assess the nutritional status of the patient and consider the continuation of parenteral nutrition during surgery in patients chronically malnourished.

A common comorbid disease in these patients is diabetes. Glucose levels during anesthesia and in the postoperative period must be closely monitored and the insulin must be administered according to the protocol. Maintaining normoglycemia patronage indirectly influences the brain. Hyperglycemia is an indicator of poor prognosis in patients with focal cerebral ischemia (Weir et al. 1997). Hypoglycemia is also dangerous, which can be more damaging to the damaged brain tissue than hyperglycemia (Van den Berghe et al., 2009).

Preoperative preparation also requires the completion of a full panel of laboratory tests to assess the state of hydration and serum electrolytes. Electrolyte disturbances may be caused by a disease or may have an iatrogenic origin. One should also assess renal parameters, perform hematology and coagulation system check. Patients with a high risk of ischemic stroke apply preventive anticoagulation and antiplatelet (Kohl, Rosenbaum, 2010).

Patients for elective surgeries are most often diagnosed, but if the diagnosis has not been made, Doppler examination should be performed on carotid and vertebral arteries using angiography and magnetic resonance (MR). These studies may be helpful in determining perioperative actions. MRI is helpful in detecting the so-called „silent“ ischemic lesions of the brain in patients with transient ischemic attack (TIA), which is particularly important when it is expected that a high-risk or cardiac surgery will be performed (Latchaw et al., 2009).

When selecting anesthetic agents to provide anesthesia one should take into account their impact on cerebral blood flow, particularly in patients with hypertension who are permanently taking pressure lowering drugs, because the use of anesthetics may increase ischemic brain perfused distal areas to the place of stenosis of cerebral vessels. One should consider the merits of lowering medication, or raising the blood pressure on the basis of baseline blood pressure, type of thrombolytic therapy and the patient's overall condition. Higher risk of cerebral edema and hemorrhage occurs in patients with hypertension (Kohl, Rosenbaum, 2010).

At each stage of anesthesia in patients with cerebrovascular disease the anesthesiologist must maintain proper cerebral perfusion pressure, cerebral blood flow to prevent the decline in cerebral blood flow and embolism. These activities are aimed at protecting brain tissue. Intravenous anesthetics, with the exception of ketamine, depending on a dose cause as CNS depressants on metabolism, reducing the oxygen demand of the brain, reducing CBF by secondary cerebral vasoconstriction, reducing ICP. Benzodiazepines are often used for premedication of patients before anesthesia, because they act anxiolytically, sedatively, and antiepileptically inducing lack of memory. Undoubtedly, this has a beneficial effect on the protection of brain tissue because it removes the blood pressure increases induced by anxiety of patients before surgery.

Benzodiazepines also reduce the demand of the brain tissue for oxygen, reducing cerebral blood flow without losing the vascular response to changes in carbon dioxide concentration. These measures should be used with caution, however, especially in patients with cerebrovascular disease, because the side effects of benzodiazepines include drowsiness and impaired psychomotor skills, as well as reducing ventilation and retention of carbon dioxide (Aitkenhead et al. , 2008).

Another group of drugs used during anesthesia is opioids. They have a minor and transient effect on intracranial pressure and on cerebral perfusion pressure. They cause a slight decrease in cerebral blood flow and cerebral oxygen consumption. For premedication they should be used with caution, because particularly in case of the elderly persons, they can cause respiratory depression and retention of carbon dioxide. (Aitkenhead et al. , 2008).

Nondepolarizing agents blocking neuromuscular conduction used for general anesthesia have little effect on the function of the CNS. In contrast, depolarizing muscle relaxant succinylcholine causes an increase in intracranial pressure, and therefore it should be used with caution in patients with elevated ICP or it may be best to choose a non-depolarising agent (Mayzner-Zawadzka, 2009).

Among the inhaled anesthetic agents most commonly used in general anesthesia there are isoflurane, sevoflurane and desflurane, which in concentrations exceeding 1.5 MAC have similar effects on intracranial homeostasis. Sevoflurane has an influence on biochemical processes at the cellular level and it has neuroprotective properties visible in its ability to modulate perfusion as a result of reactions which limit the extent of damage. It has the protective effects of focal cerebral ischemia (Duffy, Mata, 2000). Isoflurane has similar properties to sevoflurane.

Both the induction of anesthesia, intubation, and procedure of waking-up should be done with caution, taking into account the difficulties in maintaining patient's airway, the risk of aspiration and airway obstruction. Sudden fluctuations in blood pressure need to be avoided, and patients need to be extubated after the wake up from anesthesia.

Monitoring of patients with cerebrovascular diseases during general anaesthesia

Monitoring of patients and adequate intravenous access should be tailored to the type of surgery. For each patient, a standard monitor includes: a non-invasive monitoring of blood pressure, heart rate, oximetry pulse, monitoring of ventilation parameters, and temperature. If an arterial line is set up this allows for continuous invasive blood pressure monitoring, as well as facilitates blood samples for research. It is important to maintain blood pressure within „normotension” to stabilize the cerebral perfusion pressure, and protect brain tissue against further ischemia (Jellish 2006). During the surgery, one should also monitor arterial blood gases, serum electrolytes and glucose in the blood.

Postoperative period

Each patient in the postoperative period should have an assessment of the neurological status carried out, and attention must be paid to possible symptoms of delirium or on recurrence of previous neurological deficits. Pain should be monitored and fought against, because it directly stimulates the sympathetic nervous system which leads to the release of catecholamines and an increase in blood pressure. During this period we monitor the respiratory and circulatory systems (Kohl, Rosenbaum, 2010).

In patients with a history or existing brain hemorrhages

This intracerebral haemorrhage is an acute spontaneous blood extravasation into the brain, which can spread to the chambers, less frequently into the subarachnoid space. Subarachnoid hemorrhage due to aneurysms account for 5-15% of strokes and are subject to high mortality. Within a month of illness about 30-40% of patients die, and approximately 50% of patients die within six months from the occurrence of brain hemorrhage. The most

common and the most important factor is the risk of intracerebral hemorrhage hypertension, which badly treated damages blood vessels causing fragmentation, degeneration and rupture of an artery in the brain parenchyma piercing (Rowland, Pedley 2012).

Another risk factor is alcohol abuse, which interferes with platelet function, and may trigger vascular fragility. The use of antiplatelet drugs also increases the risk of spontaneous bleeding into the brain tissue in patients with hypertension. Risk factors that do not undergo modification include age, smoking, and male gender (Rowland, Pedley 2012).

Preoperative preparation of patients with cerebrovascular aneurysms or intracerebral bleeding requires a thorough evaluation by an anesthesiologist of aneurysm rupture risk factors, to determine the duration of the disease since its diagnosis and aneurysm growth and changes in morphology. Comorbidities, particularly regarding cardiovascular and breathing should be taken into account. Preoperative blood pressure assessment and its treatment is essential. Antihypertensive therapy must be optimized, as during anesthesia and the surgery itself sudden pressure surges threatening aneurysm rupture may occur (Kohl, Rosenbaum, 2010).

Intraoperative Procedure: during general anesthesia it is necessary to maintain cerebral perfusion pressure at the appropriate level and to minimize the transmural pressure in the aneurysm. Haemodynamic stability should be maintained during the induction of anesthesia and the intubation. Fluctuations in blood pressure within 20% of baseline are considered as acceptable. The introduction of anesthesia should be mild, generally used with additional anesthetic intracranial pressure-lowering mechanism of the reduction of cerebral blood flow. During the operation too light level of anesthesia ought to be avoided. However, during the waking up time after the anesthesia hypercapnia, hypoxia and airway obstruction should be avoided, since these factors contribute to the development of cerebral edema (Larsen 2003).

In a post-operative procedure an increase in blood pressure above 20% must not be allowed. If necessary antihypertensive drugs should be applied. If possible, neurological assessment of patients should be performed in order to rule out neurological deficits that would indicate the occurrence of intracranial complications.

A special group of patients is formed by patients with venous malformations arteriovenous (AVM). These malformations are more common among younger people and are a major cause of neurological diseases and mortality associated with hemorrhage. Cerebral arteriovenous malformations, are present at a frequency of 10-18 cases per 100,000 adults (Stapf et al. 2003). Anesthetic perioperative procedure towards patients with non-fractured AVM is similar to that in cases of aneurysms. It is necessary to maintain a stable blood pressure, and after waking from general anesthesia it is necessary to conduct neurological examination (Kohl, Rosenbaum, 2010).

Purpose of study

The aim of the study is to present the problems that occur during general anesthesia in patients with cerebrovascular diseases, taking into account the appropriate perioperative preparation.

Material and methods

Descriptive analysis of the literature from the years 1992 to 2013 was applied. Cases of patients with severe cerebrovascular disease were analyzed, taking into account the preparation for surgery under general anesthesia and the problems and risks associated with general anesthesia and the perioperative period.

Discussion

In clinical practice, due to the progress in the treatment of acute cerebrovascular incidents anesthesia is increasingly applied to patients undergoing non-neurological surgeries who had ischemic or hemorrhagic stroke. This creates additional requirements for anesthesia. Anesthetic procedure is targeted at prevention of cerebral ischemia or cerebral hemorrhage. The preoperative examination should take into account comorbidities, medications taken by the patient and, finally, the state of the cerebral circulation (Kohl, Rosenbaum, 2010).

Patients with cerebral ischemic strokes often take oral anticoagulants (McGrath et al. 2013). There is a risk of increased bleeding during surgery. These patients should be adequately tested from anesthetic point of view before any scheduled surgery to change the antithrombotic prophylaxis into a safer heparin.

Despite the adequate preparation of patients with known vascular disease of the brain during anesthesia and in the postoperative period vascular events of acute character may occur. If the patient during anesthesia suddenly undergoes a bradycardie and high blood pressure, it is usually associated with the occurrence of hemorrhage com-

bined with a sudden increase in intracranial pressure (Young 2007). Acute ischemic attacks and minor vascular cracks in patients who are under general anesthesia may take place generally in the form of difficulty in waking up from anesthesia, disturbances of consciousness and focal neurological deficits. In case of ischemic changes in the brain thrombolytics medications are applied to improve peripheral perfusion (Berkowitz et al. 2013)

In the case of acute intracerebral hemorrhage, blood pressure should be maintained at a lower level of the norm, and if anticoagulant therapy was applied, it should be immediately neutralized. If we are dealing with an increase in intracranial pressure during intracerebral haemorrhage, the patient should be treated with the method of ICP-lowering including the following actions such as: the supply of mannitol, elevation of the head by 15 degrees, normocapnia, normothermia or cooling during fever. Every patient with suspected embolism or ruptured aneurysm requires a computed tomography in an urgent mode (Kohl, Rosenbaum, 2010).

Rupture of an aneurysm is an event that has catastrophic consequences. Thanks to the greater availability and better research techniques many cases of asymptomatic intracranial aneurysms are diagnosed during routine radiological examinations. In the case of high-risk aneurysms intravascular or operational clipping is made preventing its rupture (Ishibashi et al. , 2009).

Rare disease, which the anesthetist may encounter, is the Moyamoya disease. It is an occlusive cerebrovascular disease manifested through ischemia or cerebral hemorrhage. This disease may be accompanied by intracranial aneurysms (Vercauteren, Heytens 2007). The treatment is conducted through the application of vasodilators, anti-coagulant and antiplatelet drugs as well as surgery. The prognosis is however bad.

General anesthesia in patients with cerebrovascular diseases shall be applied in such a way, so as to ensure above all the haemodynamic stability. The critical moment is the introduction of anesthesia and intubation, especially in case of intracranial aneurysm surgery. The frequency of rupture during the induction of anesthesia is approximately 1%, but it is subject to 50% mortality. Therefore, it is recommended that the use of large doses of opioids, thiopental, etomidate or propofol and in addition the supply of β -blocker, or a blocker $\alpha\beta$ lignocaine (Levy, Nowicki 2002). One can apply the inhalatory methods and the technique of total intravenous anesthesia (TIVA), or combine these two techniques (Kohl, Rosenbaum, 2010).

Cerebrovascular diseases lead to failure of vital organs and systems, which should be taken into account during anesthesia and within the perioperative period. When it comes to subarachnoid haemorrhage ischemic stress of the hypothalamus occurs and leads to a massive burst of catecholamines. The consequence of this mechanism is in systemic disorders of the cardio-respiratory and water-electrolyte balance. For almost 100% of patients changes in the ECG in the form of bradycardia, tachycardia, atrioventricular dissociation, and sometimes ventricular tachycardia or ventricular fibrillation are observed. These disturbances occur within the first 48 hours after subarachnoid hemorrhage and may persist for up to several weeks (Lam 2001).

Increase in the concentration of catecholamines in patients with severe neurological condition can lead to neurogenic pulmonary edema. Disorders of consciousness, respiratory depression, decreased reflexes of the throat and larynx increase the risk for aspiration pneumonia. Meanwhile, the most frequently observed electrolyte disturbances in the course of SAH include hyponatremia, hypokalemia and hypocalcemia (Levy, Nowicki, 2002).

Conclusions

1. Preoperative assessment of patients with cerebrovascular diseases requires careful neurologic examination, evaluation of cardiovascular complications, including the risk of cerebrovascular, respiratory, kidney and the endocrine system complications.

2. General anesthesia must be performed in such a way so as to maintain hemodynamic stability, which ensures an adequate cerebral blood flow.

3. In the postoperative period it is necessary to implement the treatment of pain-relief, since pain leads to increased intracranial pressure, impaired ventilation, adversely affecting the cardiovascular system.

4. Each procedure and anesthesia should be discussed with patient's surgeon or neurosurgeon, depending on the type of operation in order to determine whether the benefits of surgery outweigh the risks associated with it.

References:

1. Aitkenhead AR., Smith G., Rowbothan DJ. (2008), Choroby towarzyszące a znieczulenie. W: Anestezjologia, Elsevier Urban& Partner Wrocław, s. 478-498.
2. Aitkenhead AR., Smith G., Rowbothan DJ. (2008), Środki sedujące i przeciwpadaczkowe. W: Anestezjologia, Elsevier Urban& Partner Wrocław, s. 103-110.
3. Berkowitz AL., Mittal MK., McLane HC., Shen GC. (2013), Worldwide reported use of IV tissue plasminogen activator for acute ischemic stroke. *Int J Stroke*, 10: s. 1111-1118.

4. Duffy CM., Mata BF. (2000), Sevoflurane and anesthesia for neurosurgery. *J. Neurosurg. Anesthesiol.*, 12(2) s. 128-140.
5. Fine-Edelstein JS., Wolf PA. i in. (1994), Precursors of extracranial carotid atherosclerosis in the Framingham Study. *Neurology*, 44(6): 1046-1050.
6. Finnigan SP., Walsh M., Rose SE. i in. (2007), Quantitative EEG indices of sub-acute ischaemic stroke correlate with clinical outcomes. *Clin Neurophysiol*, 118(11): 2525-2532.
7. Ishibashi T., Murayama Y., Urashima M. (2009), Unruptured intracranial aneurysms: incidence of rupture and risk factors. *Stroke*, 40(1): s. 313-316.
8. Jellish WS. (2006), Anesthetic issues and perioperative blood pressure management in patients who have cerebrovascular diseases undergoing surgical procedures. *Neurol Clin*, 24(4): s. 647-659.
9. Joshi S., Ornstein E., Young WL. (2001), Cerebral and spinal cord blood flow. In: Cottrell JE, Smith DS, editors. *Anesthesia and neurosurgery*. 4th edition. St. Louis: Mosby, s. 19-68.
10. Kohl BA., Rosenbaum SH. (2010), Problemy anestezyjologiczne u chorych ze stwierdzoną niewydolnością naczyń mózgowych. W: *Anesthesiology clinics*. Elsevier Urban& Partner Wrocław, s. 1-13.
11. Lam AM. (2001), Cerebral aneurysm: anesthetic consideration. W: *Anesthesia and Neurosurgery* (Cottrell JE, Smith DS- red.). Mosby, St Louis, London, Filadelfia, Sydney, Toronto.
12. Larsen R. (2003), Neurochirurgia. W: *Anestezjologia*. Urban& Partner Wrocław, s. 1173-1185.
13. Latchaw RE., Alberts MJ. i in. (2009), Recommendations for imaging of acute ischemic stroke: a scientific statement from the American Heart Association. *Stroke*, 40(11): s. 3646-3678.
14. Levy DM., Nowicki R. (2002), Anesthesia for treatment of cerebral aneurysms. *Anesthesia*, 4(3): s. 106-114.
15. McGrath ER., Eikelboom JW., Kapral MK., O'Donnell MJ. Novel oral anticoagulants: A focused review for stroke physicians. *Int J Stroke*, 2013; 10(22): 1215-1219.
16. Mayzner-Zawadzka E. (2009) Anestezja w neurochirurgii. W: *Anestezjologia kliniczna z elementami intensywnej terapii i leczenia bólu*. PZWL, Warszawa. s. 583-586.
17. O'Leary DH., Polak JF., Kronmal RA. i in. (1992), Distribution and correlates of sonographically detected carotid artery disease in the Cardiovascular Health Study. The CHP Collaborative Research Group. *Stroke*, 23(12): 1752-1760.
18. Rowland LP, Pedley TA. (2012), Patogeneza, klasyfikacja oraz epidemiologia chorób naczyniowych mózgu. W: *Neurologia*. Elsevier Urban& Partner Wrocław, s. 273-310.
19. Schaller BJ., Graf R., Jacobs AH. (2006), Pathophysiological changes of the gastrointestinal tract in ischemic stroke. *Am J Gastroenterol*, 101(7): s. 1655-1665.
20. Stapf C., Mast H., Sciacca RR. (2003), The New York Islands AVM Study: design, study progress and initial results. *Stroke*, 34(5): s. 29-33.
21. Van den Berghe G., Bouillon R., Mesotten D. (2009) Glucose control in critically ill patients. *N Engl J Med*, 361(1): s. 89-91.
22. Vercauteren M., Heytens L. (2007), Anaesthetic considerations for patients with a pre-existing neurological deficit: are neuraxial techniques safe? *Acta Anaesthesiol Scand*, 51(7): s. 831-838.
23. Weir CJ., Murray GD., Dyker AG. i in. (1997), Is hyperglycemia an independent predictor of poor outcome after acute stroke? Results of a long-term follow-up study. *BMJ*, 314: s. 1303-1306.
24. Young WL. (2007), Anesthesia for endovascular neurosurgery and interventional neuroradiology. *Anesthesiol Clin*, 25(3): s.391-412.
25. Zauner A. i in. (2002): Brain oxygenation and energy metabolism: part I biological function and pathophysiology. *Neurosurgery*, 51 s. 289-302.
26. Zhao P., Alsop DC. i in. (2009), Vasoreactivity and peri- infarct hyperintensities in stroke. *Neurology*, 72(7): 643-649.

Submitted: 13.12.2013

Accepted: 07.01.2014

OVERWEIGHT AND OBESITY AMONG MIDDLE SCHOOL STUDENTS FROM LUBARTÓW INCLUDING NUTRITION AND PHYSICAL ACTIVITY

Diana Piaszczyk¹, Anna Ławnik¹, Jolanta Abramczyk²

¹Pope John Paul II State School of Higher Education in Biała Podlaska

²Independent Public Healthcare Centre in Lubartów, Pediatric Ward

Piaszczyk D., Ławnik A., Abramczyk J. (2014) *Overweight and obesity among middle school students from Lubartów including nutrition and physical activity*, Health Problems of Civilization 1 (VIII), p. 45-54

Summary: The percentage of children and adolescents with overweight and obesity problem is higher in Poland than in other European countries, and for this reason, this group ought to be covered by educational actions in order for them to cause changes in their current lifestyle.

The aim of the study was to present the scale of overweight and obesity, and knowledge of the principles of nutrition, dietary behaviors and physical activity in daily life of middle school students from Lubartów. The study was conducted on a group of 100 Lubartów students in grades I-III, aged 13-15 years. The applied method of research was diagnostic survey and authorial interview questionnaire was the main tool. 11.3% of researched girls were found to be overweight and obesity was confirmed for 7.5% of all respondents. Most overweight boys and boys with obesity were 15 years of age. Respondents declared knowledge of the principles of nutrition, more frequently girls with abnormal body weight than boys. Youngsters tend to eat what they like, while they rarely draw attention to the fact whether the product is healthy. Five meals a day were consumed by a total of 30% of students and 44.0% of the students always ate breakfast. It has been shown that 59.1% of adolescents with abnormal body weight were dissatisfied with their performance. Based on the results the following conclusions were drawn up:

1. Obesity occurs in 7.50% of girls and 8.50% of boys of the middle school in Lubartów.
2. Youth knows the principles of nutrition, but does not always select the healthy products, eats inappropriately, eats snacks between meals.
3. Middle school students rarely eat vegetables, fruits and dairy products.
4. Hereditary phenomenon of obesity was observed in subjects with abnormal body weight.
5. Youth is not physically active, they spend their free time in a passive way.
6. Overweight / obesity determine a negative social assessment by peers.

Introduction

Overweight and obesity is a serious public health problem, referred to as an epidemic, concerning each age group, creating a threat that it might survive to adulthood and cause cardiovascular disease, diabetes type II, cancers, diseases of the osteoarticular system, emotional disorders (Mazur 2011).

Pro-health behaviors emerging at the stage of school education have a significant impact on health in the future. An important element of health education is to develop the right habits and promote daily physical activity (Smorczevska-Czupryńska et al., 2004).

Overweight according to Oblacińska is an excess of body weight in relation to height, caused by a long-term positive energy balance and low physical activity (Oblacińska et al., 2007). Obesity is a metabolic disease manifested by an increase of body fat, resulting from the imbalance between energy intake and energy expenditure (Oblacińska et al., 2007).

Depending on the distribution of adipose tissue four types of obesity are distinguished. First, general obesity, in which excess body fat is distributed evenly. In the android (apple) form the fat accumulates in the upper body and in the visceral (abdominal) part is localized in the abdomen. The last type of obesity called by researchers genocidal, „pear”, is associated with the area of accumulation of fat on the hips, buttocks, thighs, and affects female (Dolżał-Ołtarzewska, Starzyk 2005). In the literature, it is noted that the type II and III obesity, typical for men, increases the risk of metabolic disorders, hypertension, diabetes and cardiovascular disease (Dolżał-Ołtarzewska, Starzyk 2005).

Due to the causes of obesity, we can distinguish the primary (simple) and secondary obesity. In the primary form, environmental factors and genetic factors are important, but it is always a prerequisite for there to occur a long-lasting, positive energy balance (Jarosz 2010). This phenomenon refers to the excessive consumption of foods

Adres do korespondencji: Diana Piaszczyk, Pope John Paul II State School of Higher Education in Biała Podlaska, ul. Siderska 95/97, 21-500 Biała Podlaska e-mail: dianaj23@tlen.pl, phone: +48 (83) 344-99-18

Tables: 16 **Figures:** 0 **References:** 23 **Full-text PDF** www.hpc.edu.pl **Copyright** © Pope John Paul II State School of Higher Education In Biała Podlaska, Siderska 95/97, 21-500 Biała Podlaska **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non-commercial and is otherwise in compliance with the license.

rich in animal fats and simple carbohydrates and a limited physical activity. It is observed in 40-70% of children and adolescents and it is associated with a sedentary lifestyle and the presence on the market of unhealthy food (Plewa, Markiewicz 2006).

Research conducted up to date on the subject indicate a genetic basis, since the body weight is inherited according to the rules concerning the transfer of operations of multigene systems regulating the metabolic activity of adipose tissue, the sensitivity level of the central nervous system towards leptin. Hereditary tendency of obesity constitutes tendencies stemming from the construction of the body, improper storage of fat, slow metabolism and thermoregulation (Oblacińska et al., 2006).

It is found that overweight and obesity are adverse to the health and economic point of view, and the previous studies show that the cost of health care for obese people is about 44% higher than in subjects with normal body weight. In addition, individuals with a BMI > 30 live shorter, and the risk of premature death is with them about 50-100% higher than in subjects with normal BMI (Oblacińska et al., 2006).

It is observed that as the cases of overweight or obesity intensify, pathologies and dysfunctions appear, for all systems and organs, such as changes in overload of the osteoarticular system (pain, swelling, distortion, flat feet, scoliosis), mental changes (depression, neurosis) (Gałuszka, Gałuszka 2010).

It is observed that obesity in children and adolescents affects health in adulthood, because with age the risk of obesity-related diseases increases. Lipid disorders and hypertension leading to myocardial infarction, heart failure, stroke, left ventricular hypertrophy, cancer (breast, colon, prostate, kidney, gallbladder). These changes contribute to the development of type II diabetes, degenerative diseases of the spine and lower limbs (Gawlik et al., 2009, Kochman, Karaś 2011, Krebs, Primak 2012).

On the basis of the literature it is stated that you can not clearly define the extent of the problem of overweight and obesity in Poland, but only observe that this percentage increases in the various regions of the country, however, an objective presentation of national data encounters difficulties related to the lack of uniform criteria for the assessment of nutritional status of the test performing individuals.

Due to the fact that the BMI in children and adolescents varies with height increase, research on the measurement of body weight uses tables or centile charts that take into account gender and age of the respondents (Jodłowska 2007, Oblacińska et al., 2007). Nutritional status of the organism is evaluated on the basis of BMI determining the weight to height ratio, the so called weight-growth rate. In children and adolescents, BMI varies with age, therefore, to assess the degree of overweight and obesity in children and adolescents a grid or centile tables for BMI indicator for age and gender are used (Jodłowska et al., 2007).

In view of the literature it is stated that to assess the degree of obesity measure of waist circumference navel is used, the so called WC (Waist Circumference), waist-to-hip ratio, the so-called. WHR (Waist Hip Ratio) and the ratio of waist circumference to height of the body, ie, WHtR (Waist to Height Ratio). Skinfold thickness is less often used through the use of skinfoldmeter [20]. Other diagnostic methods that allow to recognize obesity and body fat distribution in organs are retroperitoneal imaging MRI, CT, bioelectrical impedance analysis (BIA), the X-ray absorptiometry of the two energies (DEXA) (Jodłowska i et al., 2007).

When considering the problem of prevention of overweight and obesity it must be noted that reasonable feeding of the children and adolescents is a complex process as the need for energy can not be clearly defined, as every person grows individually and hence the differences in energy demand according to gender, but excess of calories at this age is the cause of overweight and obesity. It is found that the intervals between meals should not exceed 3-4 hours, since longer breaks cause a habit of snacking. The correct menu should contain 5 meals, of which at least 3 meals should contain whole grain. Vegetables should be spread over 3-5 servings, and fruits- 2-4, as they provide vitamins, minerals and fiber. According to the researchers the right amount of protein and calcium will be provided by 3-4 servings of milk, two servings of fish, poultry, legumes, lean meat, and nuts. It is stated that fats should constitute only a food additive. Important role in proper nutrition is played by water, the necessary intake of which equates to 2200-3000ml/day depending on gender and age. The salt in the diet should be limited to 5 g per day, since excess increases the risk of cardiovascular disease and hypertension (Jarosz 2010).

According to WHO recommendations, children and adolescents should devote to physical activity at least 60 minutes a day and exceeding the recommended minimum exercise time promotes the prevention of overweight and obesity (Jarosz 2010).

The problem of overweight and obesity is a public health priority, because the costs associated with the treatment of obesity and its consequences are disproportionate to the preventive measures (Jarosz 2010, Krajewska-Siuda et al. 2009). A special role in the prevention of overweight and obesity in children and adolescents is served by a nurse, and knowledge possessed by her allows for early identification of a student with excess body weight, thanks to screening tests.

Activities of health education coordinator in schools rely on providing students information about healthy lifestyles, the role of movement and knowledge on the effects of overweight and obesity, which become the motivation to change negative habits (Jodłowska et al., 2007). Health education coordinator carries out health education in schools within individual subjects, agrees implemented educational programs, interacts with the school nurse, school counselor and school organizations offering educational programs and preventive programs, organizes and conducts internal training of teachers and training for others (Jodłowska et al., 2007).

Target of the research

The aim of the study was to show the extent of overweight and obesity, and knowledge of the principles of nutrition, dietary behaviors and physical activity of daily life of high school students from Lubartow.

Materials and methods

The study was conducted in the Henryk Sienkiewicz Middle School No. 2. in Lubartów in October 2012, on a group of 100 students of classes I to III. The study used BMI indicator, which is calculated based on weight and height of the subjects. For each tested pupil, the positioning percentile BMI using growth charts was identified having considered their age and gender. It was assumed that BMI equal to or greater than the 85 percentile and less than 95 percentile for age and sex indicates overweight, while a value equal to or greater than the 95th percentile is obesity (Oblacińska and others., 2007).

The method of research was a diagnostic survey while the research tool was author's interview questionnaire. The first part of the questionnaire related to age, weight, height, place of residence of the respondents. The second one consisted of 24 questions about diet, leisure time, physical activity, self-perception and obese peers in the school environment. The questionnaire was anonymous. The results were analyzed, percentage rates calculated, tables of test results compiled.

The study involved 100 students aged 13-15 years. The largest group consisted of children at the age of 15 years (55 students). This age range consisted of mostly boys (29%) than girls (26%). At the age of 13 years there were less boys (7%) than girls (15%). Similar size groups of subjects aged 14 years among girls and boys (respectively 12%, 11%) were noted. Nutritional status of respondents was rated on the basis of measurements of height and weight. The degree of obesity was based on BMI growth charts and body mass index of boys and girls.

Research results

It was shown, that there was the same group of girls and boys (4 persons in each group) with a score above 95 percentile. The largest group consisted of subjects whose score ranged from 5 to 85 percentile, but it included more girls (43.0%) than boys (35.0%). Numbers of respondents whose nutritional status was in the range of 85-95 percentile was similar (girls 6.0%, boys 8.0%) (Table 1). Among girls overweight problem was found in 11.3% and obesity in 7.5% of all respondents, more often in girls at the age of 14 (5.67%) and over five times more than among girls at the age of 15 (1.88%). Obesity, almost twice as often was demonstrated in girls of fifteen (7.5%) than of 14 year old (3.77%). There was no evidence of obesity or overweight in girls at the age of 13 years old. Normal weight was most frequently demonstrated in girls of 15 years old (39.6%) than in the 13 years old (28.3%) and 14 years old (13.20%). It was shown that most of the boys were overweight or obese at the age of 15 years old (respectively 10.63% and 4.25%). The same shares were noted among 14 year old overweight and obese boys (4.25% each). Obesity was found in 2.12% of boys and normal weight was found in 40.82% of boys of 15 years of age, and similar percentage shares concerned the 13 and 14 year old (respectively 12.7%, 14.9%) (Table 2).

According to the obtained results of the study it was showed that 85% of respondents lived in the city and 15% in rural areas. Girls were twice as likely to be living in rural areas (10 people) than boys (5 persons). Similar percentage share were shown among subjects with normal and excessive body mass, living in rural areas (respectively 26.70%, 21.20%) or urban areas (respectively 73.30%, 78.80%), thus overweight and obesity does not depend on the place of residence.

Table 1. Level of nutrition of the researched-total recipients according to gender

Level of nutrition of the researched	5-85 centile	85-95 centile	95 centile and higher
girls	43,0%	6,0%	4,0%
boys	35	8	4
total	78	14	8

Table 2. Overweight, obesity and correct body weight-total researched according to gender and age

	girls at the age of 13	girls at the age of 14	girls at the age of 15	boys at the age of 13	boys at the age of 14	boys at the age of 15	All
overweight	0,0%	3,77%	7,50%	2,12%	4,25%	10,63%	14,0%
obesity	0,0%	5,67%	1,88%	0,0%	4,25%	4,25%	8,0%
correct body weight	28,30%	13,20%	39,68%	12,78%	14,90	40,82%	78,0%

Respondents declared a general knowledge of the principles of nutrition, (58.2%, 54.3%), but more often it were the girls with abnormal body weight than boys (40.0%, 33.3%). A good knowledge of the principles of rational nutrition was declared by 46.0% of boys and 39.5% girls with normal body weight. In comparison, in case of the tested pupils with abnormal body weight, a good knowledge of the rules was admitted by boys (66.7%) than girls (50%). Only 2.3% of girls with normal body weight and., 10% of those with excess body weight did not know the rules of proper nutrition.

Eating habits of the respondents were analyzed. Students were asked if they paid attention to healthy products and whether they could select them from the list. The results of boys and girls with normal body weight and excess body weight were analyzed separately. In both groups, it was found that young people ate what they liked, rarely drawing attention to the fact that the product was healthy or not (Table 3). Respondents chose from a list of products those that are healthy according to them. The youth correctly pointed to dark bread, vegetables and cheese as healthy products, but they also considered as healthy an orange juice, which due to the high sugar content is not a healthy product (Table 4).

Table 3. Eating habits-total recipients according to body weight and gender

	Girls with proper body weight	Boys with proper body weight	Girls with excess body weight	Boys with excess body weight	Total
Chosen food products	32,6%	11,40%	25,0%	30,0%	24,0%
I eat what I like	62,80%	80,0%	58,30%	50,0%	67,0%
I don't pay attention	4,70%	8,60%	16,70%	20,0%	9,0%

Table 4. „Healthy” food products in the opinion of the researched-all recipients

	Wholemeal bread	White bread	Cheese	Orange juice	Sausage	Vegetables	Fries
Girls with proper body weight	88,0%	10,0%	50,0%	70,0%	10,0%	70,0%	10,0%
Boys with proper body weight	77,10%	31,40%	74,30%	88,6%	8,60%	88,60%	5,90%
Boys with excess body weight	58,30%	0,0%	50,0%	100,0%	8,30%	83,0%	8,30%
Girls with excess body weight	90,00%	10,0%	50,0%	70,0%	10,0%	70,0%	10,0%

It was shown that 5 meals are eaten by a total of 30% of the students, more often by girls with excess body weight (50%) than boys (16.6%). It was shown that 2-3 meals a day are more often consumed by boys with excessive body weight (30%) than with normal weight (8.6%). It was shown that boys with excessive body weight ate 4 meals a day five times more often than girls, respectively (50%, 10%). Among those who consumed more than 5 meals a day, these were more likely boys of normal weight (22.9%) than boys with excessive body weight (8.3%) (Table 5).

Table 5. Number of consumed meals during the day-total researched according to gender and body weight

	2-3 meals	4 meals	5 meals	More than 5 meals
Girls with proper body weight	27,90%	27,90%	30,20%	13,00%
Boys with proper body weight	8,60%	40,0%	28,60%	22,90%
Boys with excess body weight	25,0%	10,0%	50,0%	10,0%
Girls with excess body weight	30,0%	50,0%	16,60%	8,30%
Total	21,0%	33,0%	30,0%	16,0%

Based on the results of the research included in Table 6 it was demonstrated that 44.0% of students always eat breakfast, but up to 42.0% of all respondents answered that it so happens that they do not eat breakfast. It was observed that young people with excess body weight more often „do not eat breakfast at all” than those with normal body weight. It was shown that boys with normal body weight „always” eat breakfast (48.6%). The respondents were also asked what they most commonly consumed for lunch during the break (Table 7).

Table 6. Eating breakfast-total researched according to gender and body weight

	I always eat breakfast	I don't eat breakfast	It happens that I don't eat breakfast
Girls with proper body weight	42,0%	14,0%	44,0%
Boys with proper body weight	48,60%	11,40%	40,0%
Boys with excess body weight	40,0%	20,0%	40,0%
Girls with excess body weight	41,60%	16,60%	41,60%
Total	44,0%	14,0%	42,0%

Table 7. Food products consumed at 2nd breakfast-total researched according to gender and body weight

	Sandwich	Fruit	I don't eat 2nd breakfast	Yeast cake	Crisps
Girls with proper body weight	48,80%	23,20%	20,90%	30,20%	2,30%
Boys with proper body weight	25,70%	5,70%	40,0%	28,60%	2,90%
Boys with excess body weight	30,0%	0,0%	40,0%	10,0%	20,0%
Girls with excess body weight	58,30%	8,30%	25,0%	16,60%	8,30%
Total	40,0%	13,0%	30,0%	26,0%	5,0%

It was shown that pupils consumed sandwiches for the second breakfast (40.0%) or bun (26.0%). Fruits were eaten by boys with normal weight for their second breakfast five times less often (5.7%) than by girls (23.2%), and only by 8.3% of boys with excess body weight. It was found that 30% of students did not eat their second breakfast at school and 20% of girls with excess body weight ate chips for second breakfast.

It was shown that 40% of boys with normal weight, drew attention to the regularity of meals, but this was more seldom among girls (23.2%). It was observed that almost ½ of boys with excessive body weight did not pay attention to the regular nutrition and up to 50.0% consumed meals at different times (Table 8). The answer to the question „do you snack between meals” was by 42.9% of boys and 48.8% of girls of normal weight given as positive, admitting that they do it often. Similar percentage groups of boys and girls with normal body weight ate between meals rarely, respectively (51.4%, 48.8%). Not snacking between meals was more often declared by girls with excessive weight (Table 9)

Table 8. Regularity of eating-total of researched according to gender and body weight

	Yes, I try to eat regularly	I don't pay attention to when I eat	I don't eat at various times
Girls with proper body weight	23,20%	39,50%	37,20%
Boys with proper body weight	40,0%	45,70%	14,30%
Boys with excess body weight	0,0%	50,0%	50,0%
Girls with excess body weight	33,30%	33,30%	33,30%
Total	28,0%	42,0%	30,0%

Table 9. Snacking between meals-total researched according to gender and body weight

	Yes, often	It happens but rarely	I don't snack
Girls with proper body weight	48,80%	48,80%	2,30%
Boys with proper body weight	42,90%	51,40%	5,70%
Boys with excess body weight	50,0%	40,0%	10,0%
Girls with excess body weight	50,0%	41,60%	5,70%
Total	37,0%	48,0%	5,0%

The questionnaire questions concerned the preferred beverage of pupils. It was observed that boys with normal body weight frequently drank tea (62.9%) and girls - juices (58.10%). Girls with excessive weight indicated juices and mineral water (40%) and boys pointed to the tea (58.3%) (Table 10).

The results of the research show that 11.6% of girls with normal weight and 30% of girls with excess body weight did not eat dairy products. It was shown that 45.7% of boys with normal weight and 50% of boys with excess body weight consumed products in the group once a day. 62.8% of girls of normal weight declared consuming milk several times a week (Table 11).

Table 10. Beverages in youth's diet-total researched according to gender and body weight

	Juices	Carbonated drinks	Mineral water	Tea
Girls with proper body weight	58,10%	18,60%	55,80%	48,80%
Boys with proper body weight	51,40%	48,60%	37,10%	62,90%
Boys with excess body weight	40,0%	30,0%	40,0%	20,0%
Girls with excess body weight	41,60%	41,60%	50,0%	58,30%
Total	52,0%	33,0%	47,0%	52,0%

Table 11. Frequency of eating dairy products-total researched according to gender and body weight

	Once a day	Several times a day	I don't eat them
Girls with proper body weight	25,90%	62,80%	11,60%
Boys with proper body weight	45,70%	51,40%	2,90%
Boys with excess body weight	30,0%	40,0%	30,0%
Girls with excess body weight	50,0%	41,60%	8,40%
Total	36,0%	54,0%	10,0%

All respondents were asked the question about the frequency of consumption of fruits and vegetables. The analysis of the data shows that slightly more than ½ of the respondents (54%) ate them every day, and 43% of those surveyed consumed them several times a week. Only 3% of respondents admitted that they do not eat any fruit and vegetables. It was observed that boys of normal weight (60%) more often than girls (48.8%) consumed fruits and vegetables daily. The girls of normal weight (48.8%) more frequently than those with excessive weight (40%) consumed fruits and vegetables several times a week, while 10% of girls with excess body weight did not consume any fruit and vegetables (Table 12).

Table 12. Frequency of eating vegetables and fruits-total researched according to gender and body weight

	Everyday	Several times a week	I don't eat them
Girls with proper body weight	48,80%	48,80%	2,30%
Boys with proper body weight	60,0%	37,10%	2,90%
Boys with excess body weight	50,0%	40,0%	10,0%
Girls with excess body weight	58,0%	41,60%	0,0%
Total	54,0%	43,0%	3,0%

Due to the increasing trend among young people of eating „fast food” the respondents were asked whether they feed themselves in this way. It was shown that 78% of respondents consumed these products very rarely. Similar number of respondents who consumed these products every day (7%) or several times a week (9%) (Table 13).

The thirteenth question in the questionnaire concerned the family tendency towards obesity. Based on the analysis results it was indicated that adolescents who are overweight or obese pointed to the obese or overweight person in the family. This was indicated by 68.0% of the respondents answered with excess body weight, but up to 65.0% of all respondents did not indicate overweight or obesity in their family (Table 14).

It was shown that 80.0% of boys and 76.7% girls with normal body weight eat meals at home, and 9.1% of adolescents with abnormal body weight eat dinner-supper combined (Table 15).

Table 13. Frequency of eating products of “ fast food” type-total researched according to gender and body weight

	Everyday	Several times a week	Very rarely	I don't eat them
Girls with proper body weight	2,30%	11,60%	76,70%	9,30%
Boys with proper body weight	11,40%	0,0%	85,70%	29,0%
Boys with excess body weight	20,0%	10,0%	60,00%	10,0%
Girls with excess body weight	0,0%	25,0%	75,00%	0,0%
Total	7,0%	9,0%	78,0%	6,0%

Table 14. Family occurrence of excess body weight-total researched according to gender and body weight

	there is a person in the family with excess body weight or obesity	there is no person in the family with excess body weight or obesity
Girls	40,0%	60,0%
Boys	29,0%	71,0%
Youth with excess body weight	68,0%	32,0%
Total	35,0%	65,0%

Table 15. Ritual of eating meals by the youth-total researched according to gender and body weight

	Meals prepared by parents	I eat at the couteen	I buy take away dinners	I eat dinner-supper combined
Girls with proper body weight	76,70%	9,30%	2,30%	11,60%
Girls with proper body weight	80,0%	5,7,0%	0,0%	14,30%
Youth with excess body weight	86,40%	4,50%	0,0%	9,10%
Total	80,0%	7,0%	1,0%	12,0%

It was found that 97.1% of boys with normal body weight consider physical activity to be important in life. A slightly smaller percentage of them were girls of normal weight (95.4%). Percentage shares of recipients with normal body weight who did not have an opinion on this were similar. For 9.0% of adolescents with excess body weight physical activity was not significant in life. All participants were asked how much time per day they devoted to physical activity. It was shown that 62.9% of boys with normal weight and 44.2% of girls with normal body weight devoted to the activity 1-2 hours a day. It was shown that adolescents with excessive body weight more often exhibited physical activity during physical education classes. The time of „less than an hour” was less frequently pointed by boys of normal weight than girls, respectively (8.6%, 25.6%). It was shown that the question „how many times a week are you physically active outside of physical education classes”, 44.2% of girls of normal

weight and 41.6% of boys with excessive body weight answered 2-3 times week. Daily physical activity was noted by 31.4% of boys of normal weight and 30% of girls with abnormal body weight. It was shown that 33.3% of boys and 10% girls with abnormal body weight did not take any physical activity, and 50% of girls with excess body weight were physically active once a week.

It was shown that 91.6% of boys with excessive body weight spent their free time at the computer, and 33.3% watched television. Only 10% of girls with abnormal body weight spent their free time actively. It was shown that 67.0% of girls of normal weight, „worked” at the computer, 51.10% read books, and 32.0% watched television. Among the boys of normal weight the predominant form of leisure was computer (65.7%) and physical activity (57.1%) (Table 16).

Table 16. Free time activities-total researched according to gender and body weight

	I watch TV	Computer	I read	I spend active time	Walk	Social meetings	Other
Girls with proper body weight	32,50%	67,40%	51,10%	27,90%	39,50%	81,40%	1,0%
Boys with proper body weight	20,0%	65,70%	28,60%	57,10%	5,70%	40,0%	2,0%
Boys with excess body weight	30,0%	70,0%	20,0%	10,0%	20,0%	60,0%	0,0%
Girls with excess body weight	33,30	91,60%	8,30%	0,0%	16,60%	50,0%	0,0%
Total	28,0%	70,0%	34,0%	33,0%	23,0%	61,0%	3,0%

It was shown that 35% of boys with excessive body weight and 40% of girls spent in front of the computer more than four hours a day. It was also shown that there were two identical groups of respondents (51.0% each), which spent at the computer 1-2 hours a day. It was found that 59.3% of boys with abnormal body weight spent at the computer 3-4 hours a day.

The research results made it possible to show the most popular places visited by the students outside the classroom. Membership to Sports Club was indicated by 28.6% of boys and 6.9% of girls with normal body weight and only 9.10% with abnormal body weight. House of Culture was rarely pointed out by boys (2.9%) with normal body weight, but more girls (16.3%) than adolescents with abnormal body weight (13.6%). Library was more frequently indicated by girls than boys with normal body weight, respectively (34.9%, 14.3%). It was shown that 54.5% of adolescents with excess body weight did not use any form of extra-curricular activities.

It was shown that 59.1% of adolescents with abnormal body weight were dissatisfied with their operability, and 9.10% thought they were more physically fit than their peers. It was shown that boys with normal weight were more than twice happier with their physical fitness (51.4%) than girls (23.3%). It was also shown that up to 65.1% of girls with normal body weight were of the opinion that their efficiency was similar to that of their peers.

According to the researched boys of normal weight physical activity improves health and physique. It was shown that 18.2% of adolescents with excess body weight was of the opinion that physical activity allows to pleasantly spend time and according to 63.6% of the students physical activity improves condition.

The question ‘How do you assess your figure?’ was answered by 62.9% of boys and 44.2% girls with normal body weight and 8.3% of boys with excessive body weight that it was considered by them to be normal. It was shown that 90% of girls and 83.3% boys could see the need for losing weight, more frequently girls with normal body weight, than boys, respectively (46.5%, 20%). For the rest, the appearance of their own silhouette had no meaning or they had no opinion on the subject.

It was shown that adolescents with abnormal body weight, more often than those with normal body weight were of the opinion that being overweight or obese causes teasing from peers. Percentage shares of researched pupils with normal weight (34%) who responded that there are no differences in the perception of people with excess body weight were identical.

Discussion

All over the world, a steady increase in the number of young people who are overweight and obese is observed. (Gawlik et al., 2009, Oblacińska et al., 2007). The report of the International Organization of Fighting Overweight and Obesity (IOTF - International Obesity Task Force) for the years 2007-2011 period shows that every fifth child in Europe has a problem with maintaining a healthy weight, and in Poland about 10% of the pediatric population has health problems due to obesity (Jarosz 2010).

Preventive measures of overweight and obesity should be multidirectional, and according to previous studies, the children do not know or do not follow the rules of healthy lifestyle: healthy eating and physical activity. For these reasons, their health education needs to be conducted in such a way so that they understood how important this issue is (Smorzewska-Czupryńska et al., 2002).

Studies have shown that body weight in 43.0% of girls and 35.0% boys ranged between 5 and 85 percentiles, but overweight (11.3%) was more frequent than obesity (7.5%) among the girls. The reason for this may be the popularization of thinness among girls (Gałaszka, Gałaszka 2010). It is noted that a hallmark of rational nutrition is adequate quantity and regularity of meals (Kochan, Karaś 2011). The recommended 4-5 meals per day are consumed by 30.0% of respondents. This did not confirm the results of other authors (Pieszko-Klejnowska et al., 2007, Piórecka et al., 2007), as 4-5 meals a day were more often indicated by girls with excess body weight than boys. The study revealed the problem of the lack of first breakfast and second breakfast. The first breakfast was consumed more often by the boys (48.6%) with normal body weight and as much as 30.0% of respondents did not eat a second breakfast. This is confirmed by the results of Pieszko-Klejnowska and other authors (Jeżewska-Zychowicz 2006 Jeżewska-Zychowicz 2003 Pieszko-Klejnowska et al., 2007, Suliga 2006). Pieszko-Klejnowska showed lack of breakfast among 48% of girls and 39% boys in junior high schools in the Pomeranian province (Pieszko-Klejnowska et al., 2007). It is concluded that the psychophysical consequences of the lack of breakfast cause: distraction, lack of concentration, fatigue and apathy, and hunger that provokes aggressive behavior toward peers (Wojnarowska, Komosińska 2000).

Piórecka and other authors in their study demonstrated that fast food is a favorite form of snacks between meals among male high school students in Malopolska (Piórecka et al., 2007, Połom, Sińska 2003). Author's findings showed that 78% of respondents do not prefer this method of feeding. According to Czupryński et al consumers of fast food products are a group of people potentially exposed to the occurrence of diet-related diseases in the future (Smorzewska-Czupryńska et al., 2004). In our study, 42.9% of boys and 48.8% of girls of normal weight often snack between meals, which corresponds to reports Białokoz-Kalinowska. The author showed that 83.5% of students snacks sweets between meals (Białokoz-Kalinowska i in., 2000).

Results by Pieszko-Klejnowska and Zawadzka indicate that young people rarely eat vegetables and fruit. An example might be the youth from Pomeranian province where only 53.1% consumed fruits and vegetables on a daily basis (Pieszko-Klejnowska et al., 2007, Zawadzka 1999). This was confirmed by author's elaboration, because 54.0% of the respondents consumed fruits and vegetables daily. Zawadzka found that the youth draws energy from the sweet carbonated beverages, and the issue of consumption of cola drinks is a serious problem in the whole world (Zawadzka, 1999). It was shown that the sweet carbonated beverages in a daily diet were indicated by 34% of respondents.

According to Stankiewicz and others, the young person spends passively until 3.5 hours per day using a variety of media (Krebs, Primak 2012, Mazur 2011, Plewa, Markiewicz 2006). It was shown that up to 91.6% of boys with excessive body weight spend their free time at the computer, and only 10% of girls with abnormal body weight spend their free time actively.

Conclusions

Based on the results the following conclusions were drawn:

1. Obesity occurs in 7.50% of girls and 8.50% of boys of middle school in Lubartów.
2. The youth knows the principles of nutrition, but not always selects healthy products, eats inappropriately, snacks between meals.
3. Middle school students rarely eat vegetables, fruits and dairy products.
4. Hereditary phenomenon of obesity has been observed in subjects with abnormal body weight.
5. The youth is not physically active, their free time is spent in a passive way.
6. Overweight / obesity determines a negative social assessment and the assessment by peers.

References:

1. Białokoz-Kalinowska I., Zagórecka E., Piotrowska-Jastrzębska J. (2000), *Ocena sposobu żywienia dzieci w wieku szkolnym z terenu miasta i okolic Białegostoku*. *Pediatrics Polska*, 75, 8, s. 643-646.
2. Dolżał-Ołtarzewska K., Starzyk J. (2005), *Otyłość*, W: J. Pietrzyk (red.), *Wybrane zagadnienia z pediatrii*. tom IV, Wydawnictwo Uniwersytetu Jagiellońskiego. Kraków, s. 333-341.

3. Gałuszka G., Gałuszka R. (2010), *Otyłość u dzieci jako problem psychospołeczny*, W: M. Juszczyk (red.), *Wybrane zagadnienia z edukacji zdrowotnej*. Wyższa Szkoła Ekonomii i Prawa w Kielcach, Kielce, s. 399-407.
4. Gawlik A., Zachurzok-Buczyńska A., Małecka-Tendera E. (2009), *Powikłania otyłości u dzieci i młodzieży*. Endokrynologia, Otyłość i Zaburzenia Przemiany Materii, tom 5, nr 1 s. 19-27.
5. Jarosz M. (2010), *Działania prowadzone w Polsce na rzecz zwalczania nadwagi i otyłości*. Endokrynologia Otyłość i Zaburzenia Przemiany Materii, tom6, nr 1. s. 49-53.
6. Jeżewska-Zychowicz M. (2006), *Wpływ wybranych cech indywidualnych i środowiskowych na zachowania żywieniowe młodzieży*. Wydawnictwo SGGW, Warszawa s. 127-154.
7. Jeżewska-Zychowicz M. (2003), *Wpływ środowiska rodzinnego i szkolnego na częstotliwość spożywania posiłków przez młodzież w wieku 13-15 lat na przykładzie środowiska warszawskiego*. Żywnienie Człowieka i Metabolizm, 30,1, s. 93-97.
8. Jodłowska M., Oblacińska A., Woynarowska B. (2007), *Test przesiewowy do wykrywania zaburzeń w rozwoju fizycznym u dzieci i młodzieży w wieku szkolnym*. Instytut Matki i Dziecka, Warszawa, s. 9-14.
9. Kochman D., Karaś H. (2011), *Przyczyny i następstwa otyłości prostej u dzieci* W: M. Wojciechowska (red.), *Wyzwania współczesnej pediatrii*. Akademia Humanistyczno –Ekonomiczna w Łodzi, Łódź, s. 201-229.
10. Krajewska-Siuda E., Nowak A., Matusik P., Wypych-Ślusarska A., Małecka-Tendera E. (2009), *Opinie młodzieży na temat otyłości w zależności od ich własnej masy ciała*. Endokrynologia, Otyłość i Zaburzenia Przemiany Materii, tom 5, nr 1, s.7-11.
11. Krebs N., Primak L. (2012), *Żywnienie dzieci i zaburzenia odżywiania*, W: A. Milanowski (red.), *Pediatrics t.1*. Elsevier Urban &Partner, Wrocław, s. 109-128.
12. Mazur A. (2011), *Epidemiologia nadwagi i otyłości u dzieci na świecie, w Europie i w Polsce*. Wydawnictwo Uniwersytetu Rzeszowskiego, Rzeszów, 2, s.158-163
13. Oblacińska A., Jodłowska M., Tabak I. (2006), *Epidemiologia otyłości u młodzieży w okresie pokwitania w Polsce* W: A. Oblacińska, I. Tabak (red.), *Jak pomóc otyłemu nastolatkowi – rola pielęgniarek szkolnych i nauczycieli wychowania fizycznego we wspieraniu uczniów i ich rodziców*. Instytut Matki i Dziecka, Warszawa, s.11-84.
14. Oblacińska A., Jodłowska M., Tabak I. (2007), *Ocena częstości występowania nadwagi i otyłości u młodzieży w wieku 13-15 lat w Polsce przy zastosowaniu różnych narzędzi badawczych*. Przegląd Epidemiologiczny, 61, s. 585-592.
15. Pieszko-Klejnowska M., Stankiewicz M., Niedożytko M., Kozanecka I., Łysiak-Szydłowska W. (2007), *Ocena sposobu odżywiania się gimnazjalnej młodzieży zamieszkującej wieś i miasto*. *Pediatrics Współczesna Żywnienie Dzieci*, 9/1, s. 59-62
16. Piórecka B., Jagielski P., Wójcik K., Żwirska J., Schlegel-Zawadzka M. (2007), *Zachowania żywieniowe młodzieży gimnazjalnej w Małopolsce*. *Żywnienie Człowieka Metabolizm*, 34, ½, s. 620-628.
17. Plewa M., Markiewicz A. (2006), *Aktywność fizyczna w profilaktyce i leczeniu otyłości*. Endokrynologia Otyłość i Zaburzenia Przemiany Materii. tom 2, nr 1, s. 30-37.
18. Połom A., Sińska B. (2003), *Postawy młodych konsumentów wobec produktów typu Fast food*. *Bromatologia i Chemia toksykologiczna*, supl. 36, s. 167-172.
19. Smorczevska-Czupryńska B., Ustynowicz-Farbiszewska J., Karczewski J. (2004), *Diet of Junior High School Students – Energy Value and Basic Nutritional Components In the Respective Seasons of the Year*. *Polish Journal of Environmental Studies*, supl II, 13, s.508-511.
20. Smorczevska-Czupryńska B., Ustynowicz-Farbiszewska J., Karczewski J. (2002), *Jakościowa i ilościowa ocena żywienia młodzieży gimnazjalnej z Białegostoku i okolic*. *Wiadomości Lekarskie*, 55, supl. 1, 1: s. 550-555.
21. Suliga E. (2006), *Częstotliwość spożycia i wartość energetyczna śniadań wśród dzieci i młodzieży w wieku szkolnym*. *Roczniki PZH*, 57, 1, s. 73-80.
22. Wojnarowska B., Komosińska K. (2000), *Samoocena zdrowia i obraz własnego ciała u młodzieży szkolnej w Polsce*. *Pediatrics Polska*, 75, s. 25-34.
23. Zawadzka B. (1999), *Zachowania zdrowotne młodzieży wyzwaniem dla zreformowanej edukacji*. *Wychowanie Fizyczne i Sport*, 46, 5, s. 181-186

Submitted: 28.01.2014

Accepted: 05.02.2014