

Original Article

Effects of physical activity on aging processes in elderly persons

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Abstract:

Aging is inevitable part of a human life. However, there are a number of factors which can affect the rate of aging. One of these factors is physical activity. An increase in physical activity improves the health status, functional abilities in activities of daily living, slows the aging process, and delays the development of premature aging in elderly persons. Regular physical exercises can delay age-related changes in the body and are important and necessary to maintain good health and keep a high working capacity for a long time. Physical activity is of paramount importance to good health, increasing work capacity, and extended longevity. The aim of our study was to examine the effects of physical activity on aging processes in elderly persons on the basis of comparison between the biological and chronological age of the elderly, and assessment of their rate of aging. Material: The study involved two groups of respondents. The first group (n=38) consisted of the members of either Sportlife or Titan fitness clubs. The second group (n=35) included people who continued their education at the Kolping University of the Third Age in Chernivtsi. The respondents of the last group were not engaged in health-enhancing physical activity. A total of 63 people aged 60-73 years participated in the study. Results: It was found that the respondents of the experimental group had physiological indicators compared to those of the control group and their chronological age was 8.7 years ahead of the biological, whereas in the control group, the biological age of the respondents was 5.5 years ahead of the chronological age. The aging rate was substantially slowed down in 10.5% of the respondents of the experimental group and accelerated in 5.7% respondents of the control group.

Keywords: physical activity, prevention, biological age, aging processes

Introduction

Aging of the population today became one of the key factors affecting the age structure of the population of all countries of the world. In accordance with world trends, this process is gaining momentum in Ukraine. Already, Ukraine is among the countries, which face population aging: the proportion of people aged 60 and over now exceeds 19%, and it is projected that this number can reach 24% in 2030 (Hakman A., Balatska L. & Liasota T., 2016). These demographic processes have led governments in many countries to realize the need to develop and implement special measures that will help address the issues of elderly people and of aging, and to provide conditions for a successful and active longevity.

An important component of the concept of active aging is the creation of conditions that allow elderly people to maintain a healthy and active lifestyle. Experts of the World Health Organization (WHO) consider a low level of physical activity as one of the most important health risk factors and one of the major causes of mortality (Hakman A., Balatska L. & Liasota T., 2016). WHO experts stress the need for regular physical exercise and sport participation for all population groups regardless of age. At the same time, WHO experts recommend to pay special attention to the development of special measures to promote and support the regular participation in physical activity of senior people, who are, as a rule, the least physically active age group (Lisitskaya T. S., 2004).

Data on the lifestyle of elderly people indicate that only a small percentage of them participate in regular physical exercise and sports activities. Research shows that today, physical activity of retired people is mainly accumulated through various types of work (paid work, work on a private plot, babysitting, fishing, hunting, etc.), but not at the expense of participation in sports and physical exercise.

According to a sociological survey, the proportion of retired people, who are engaged in any kind of sports or physical activity, was about 17.6% for men and 16.8% for women (Hakman A., 2017). The most popular types of physical activity for elderly men aged 60 and over were walking (11%), cycling (2.7%), jogging, skiing, and skating (2%), exercises on machines (1.6%), and swimming (1.2%). Senior women also preferred walking (11%), swimming (2.6%), exercises on machines (1.4%), and cycling (1.2%) (Andreeva O., Hakman A., L. Balatska, 2016).

Thus, regular physical activity is one of the important and necessary components of active longevity, which can significantly improve the quality of life of senior persons and bring benefits to society as a whole.

Methods

To achieve the objectives defined in the study, the following methods were used: theoretical analysis and generalization of the data of scientific and methodological literature; pedagogical methods (pedagogical observation and pedagogical experiment); measurement of physiological indicators, methods for assessing biological age and the rate of aging (using V.Voitenko method); methods of mathematical statistics.

During the study, the main physiological indicators were measured in respondents of two groups that made possible to assess such health status indicators as: systolic and diastolic blood pressure (SBP and DBP), heart rate reserve (the difference between resting heart rate and maximum heart rate), skin folds body fat test, body weight, dynamometry, and spirometry.

The most important consequences of aging processes are reduced life expectancy (increased likelihood of death), disturbances of vital body functions, reduced adaptation range, and the development of health conditions. Two characteristics are necessary and sufficient to describe the specifics of aging: its relationship with the chronological age and its disruptive effects. An absolute measure of the viability of the human body (the amount of the individual's health) is the expected duration of life. In fact, such an assessment of the amount of the individual's health is possible, which makes possible to predict the time from the moment of the examination to the natural death of the individual on the basis of the set of informative parameters (V.P. Voitenko, A.V. Tokar, Rudaya E.S., 1989). In other words, the measure of health is the expected duration of life (under ideal stable conditions).

To calculate the biological age, the following equations are used:

$$BA=27.0 + 0.22*SBP-0.15*BHI+0.72*HSA-0.15*SB, \text{ for men} \quad (1) \text{ and}$$

$$BA=-1.46 + 0.42*PBP+0.25*BW+0.70*HSA-0.14*SB, \text{ for women} \quad (2),$$

where BW is body weight in kg; HSA is health self-assessment in points; BHI is time of breath hold at inhale in s; SBP is systolic blood pressure in mmHg; PBP is pulse blood pressure in mmHg; SB is static balance on one leg test, s.

The biological age is calculated using the above mentioned equations. To determine the difference between the biological and chronological age, it is necessary to compare their values. The value of the appropriate biological age (ABA) is calculated using the following equations:

$$ABA=0.629*CA+18.6, \text{ for men} \quad (3)$$

$$HBB=0.581*CA+17.3, \text{ for women} \quad (4),$$

where CA is chronological age.

To determine the biological age (BA), test batteries of different degrees of difficulty are used. Furthermore, the logical scheme of assessment of aging effects includes the following steps: 1) calculation of the true value of the individual's BA (based on a set of clinical and physiological indicators); 2) calculation of the appropriate value of the individual's BA (based on their chronological age); 3) comparison of the actual and appropriate value (how many years the examined person is ahead of or behind the peers in terms of the rate of aging). The estimates obtained are relative to a certain population, because the reference point is the population norm, i.e. the average of the degree of aging in a certain chronological age (CA) for this population. This approach allows to rank the persons of one age in terms of "age-related deterioration" and, consequently, a "reserve" of health.

It is suggested to rank the values of health, which were estimated on the basis of the determined values of BA, depending on the magnitude of the deviation of the latter from the population norm: class I: from 15 to 9 years, class II: from 8.9 to 3 years, class III: from -2.9 to +2.9 years, class IV: from +3 to +8.9 years, class V: from +9 to +15 years.

Thus, the class I corresponds to a substantially slowed rate of aging and the class V corresponds to a substantially accelerated rate of aging; the class III includes the persons whose biological and chronological ages are the same. The people of the classes IV and V should be included in the group of those with an affected health state.

Thus, the use of the ideas of a systematic approach in studying the effects of physical activity on aging processes in elderly persons requires applying the appropriate methods of mathematical analysis, which can reveal the significance of the results.

The study involved two groups of respondents. The first group (n=38) consisted of the members of either Sportlife or Titan fitness clubs. The second group (n=35) included people who continued their education at the Kolping University of the Third Age in Chernivtsi. The respondents of the last group were not engaged in health-enhancing physical activity. A total of 63 people aged 60-73 years participated in the study. The study was an effort to identify the psycho-physiological characteristics of physical activity of senior persons.

Results

The analysis of the quality of life of the citizens of Ukraine and the near abroad shows that the last decades have been marked by a significant deterioration in the health of all age groups of the population. In particular, all authors pay attention to premature "deterioration" and aging of the body (Abramov R., Bolotova I., 2008; Andrieieva O.V, Patsalyuk K. G., 2012; Hakman A., 2017; Andreeva O, Hakman A, Balatska L., 2016).

The degree of this “deterioration” can be estimated by the biological age and the rate of aging of the body calculated on its basis (Kovalenko O. G., 2014).

Biological age (BA) is an indicator of the degree of deterioration of the structure and function of a certain structural element of the body, a group of the elements, and the body as a whole, expressed in terms of time through the comparison of individual values of the measured biomarkers with the reference values from the average population distribution curves of these biomarkers at different calendar ages (Voitenko V.P., Tokar A.V., Rudaya E.S., 1989).

Despite the availability of a methodology for assessing biological age, there are a few published studies discussing the issue of biological age. As is known, the means of physical exercise can significantly affect the rate of aging (deterioration of the body), by retarding the aging process. Previous studies have found that:

- different rates of aging of subjects in many respects depend on one or another pathology;
- the aging rate is closely related to high arterial blood pressure, obesity, and type 2 diabetes;
- mechanisms of aging alone and mechanisms of development of a particular form of chronic condition can have either the same or different natures, thus accelerating or not affecting the rate of the body’s aging processes.
- the acceleration of the rate of aging under the influence of ionizing radiation is combined with the earlier development of chronic conditions (especially in younger persons) (Voitenko V.P., Tokar A.V., Rudaya E.S., 1989).

A considerable number of studies have been conducted to address the problems of premature aging of the body. However, the reasons for this phenomenon in relation to the body of elderly people have not, in our opinion, been adequately studied and require further research.

We assessed the physiological indicators of the respondents of the two groups. The first group of subjects (n=38) consisted of the members of either Sportlife or Titan fitness club. They have exercised regularly three times a week for the last 6 months mainly recreational swimming, aqua fitness, and fitness classes at the club. The second group (n=35) included people with a sedentary lifestyle who continued their education at the Kolping University of the Third Age in Chernivtsi. As seen from the Table 1, the physiological indicators of respondents of the first group are significantly better than those of the second group. This trend can be clearly demonstrated with the heart rate reserve values, which were an average of 75.7 mmHg for the first group and 25.7 mmHg for the second group. In our opinion, this is primarily due to the amount of physical activity and the systematic participation in physical exercise for a long time, and suggests the high responsiveness of the cardiovascular system, which is very important for the persons of this age group. An active lifestyle with a higher level of physical activity in senior persons may slow down involuntional changes in the body. Physically active elderly people have almost twice lower risk of hospitalization, spend less time in hospitals, and have almost two and a half times lower medical expenses than individuals with a sedentary lifestyle. A sedentary lifestyle is associated with greater health risks. The mortality risk in physically inactive people may be up to 35% higher than that in people who exercise regularly (Vuillemin, 2012).

Table 1. Physiological indicators of senior persons of the control and experimental groups

No	Physiological indicator	EG (n=38)	CG (n=35)
1.	SBP, mmHg	85.01±0.32	94.01±0.22
2.	DBP, mmHg	127.4±0.37	138.43±0.76
3.	Heart rate reserve, bpm	75.7±0.21	25.7±0.41
4.	Skin fold, mm	22.48±0.74	43.44±0.4
5.	Body weight, kg	68.85±0.53	84.05±0.31
6.	Grip strength, kg	43.25±0.11	31.25±0.41
7.	Vital capacity, L	3.9±0.43	2.2±0.37

The World Health Organization has published Global recommendations on physical activity for health, including ones for people over the age of 65 (World Health Organization, 2010). Adherence to this recommendation can bring health benefits, such as improving cardiorespiratory and muscular fitness, musculoskeletal system function and general health, including reducing non-communicable diseases and depression.

We assessed the biological age of respondents of both groups according to V.Voytenko's method (Table 2). The average chronological age of respondents of the experimental and control groups was about the same: 72.8 and 73.4 years. However, they differed substantially in biological age. Elderly people of the experimental group had a biological age of 64.1 years, which is 8.7 years younger than the chronological. In contrast, the biological age of subjects of the control group was 78.9 years, which is 5.5 years older than the chronological age.

Table 2. Relationship between the biological (BA) and chronological ages (CA) in subjects of experimental and control groups (n=73)

Group	CA, years	BA, years	Difference, years
Experimental group (n=38)	72.8	64.1	-8.7
Control group (n=35)	73.4	78.9	5.5

During the study, we determined the rate of aging in subjects of experimental and control groups (Table 3). Thus, in the experimental group, there is the largest number of respondents who had a slowed down aging process (60.5%) and a significant number of subjects whose biological age corresponds to the chronological: 8 persons (21.1%). The substantially slowed aging process is identified in 4 people of the group (10.5%). However, it should also be noted that three persons of this group have an accelerated aging process.

Table 3. The rate of aging of subjects of experimental and control groups (n=73)

Difference, years	Rate of aging	The number of persons		%	
		EG (n=38)	CG (n=35)	EG (n=38)	CG (n=35)
from -15 to -9 years	substantially slowed	4	-	10.5	-
from -8.9 to -3 years	slowed	23	2	60.5	5.7
from -2.9 to +2.9 years	BA=CA	8	10	21.1	28.6
from +3 to +8.9	accelerated	3	21	7.9	60.0
from +9 to +15	substantially accelerated	-	2	-	5.7

In the control group, the results were significantly worse than in the experimental one: 57% of persons had a slowed rate of aging, in 28.6% of subjects there were no difference between the biological and chronological ages, 60% and 57% of subjects had an accelerated or substantially accelerated rate of aging, respectively. It should be noted that among the respondents of the control group, there were no persons with a substantially slowed aging process.

The data of our study confirm the current view of researchers that the decline in physical activity level with age may have a significant impact on the functional state of the body of senior people [Abramovich S., 1999; Belozerovala L.M., 2002; Hakman A, & Baidyuk M., 2017; Desjatnikova N.V., 2012, etc.]. Accelerated aging is manifested by the earlier and faster development of the age-related changes, which reduce the person's life expectancy. It is known that physical activity has a positive effect on the body of elderly people as a whole and on its individual systems. Regular physical exercise makes you feel good, your body is rejuvenated and you can get rid of some ailments. It improves the working capacity and delays the onset of senility.

Discussion

A sedentary lifestyle and the lack of physical activity result in a substantially accelerated rate of aging characteristic of people of all age groups, that reflects the general trend towards deterioration in quality of life and health, and the low level of physical fitness of Ukrainian people as well as set the objective of preventing premature aging that is stated as one of the strategic goals.

The estimation of the rate of aging for people of different age groups showed that the aging process is slowed down with the age, that is, when the person is older, the slower it ages. Since the biological age of a person depends on the physiological, functional and adaptive capabilities of the body, physical activity aimed at mobilizing the mechanisms of vitaut to ensure longevity and prevention of premature aging should be considered as the most rational anti-aging means.

Unfortunately, in Ukraine today, there is practically no special policy focused on promoting physical activity of senior people. Nevertheless, Ukraine, together with other UN member states, signed the Madrid International Plan of Action on Aging in 2002, which recommends, in particular, to pay increased attention to factors aggravating the health status of elderly people, such as a sedentary and unhealthy lifestyle (A. Arbab-Zadeh, E. Dijk, A. Prasad, 2004).

However, the implementation of measures to increase physical activity of elderly people is still episodic and has not yet become an integral part of social policy either at the national or regional level. In developed countries, considerable experience has been accumulated in this field, and mechanisms for implementing such programs have been developed both at the national and territorial levels.

When analyzing the impact of physical activity on quality of life, most researchers emphasize the benefits of active lifestyle for individual's physical health. In the studies, it is reported that regular physical activity reduces the risk of premature mortality as well as reduces or prevents a number of functional disorders associated with aging (Fedinak N.V., 2013).

Scientists also gained convincing evidence that people participating in physical exercise has a lower risk of development of cardiovascular and cancer diseases, and various chronic diseases. Regular exercises result also in an increase in bone density, a decrease in fat deposits, improved body mass index, and reduced risk of musculoskeletal system disability [Hakman A, 2017; Lisitskaya T., 2004].

In recent years, there have been empirical studies that have demonstrated the positive effects of physical exercises on human mental health. Some studies indicated a reduction in the risk of depression in elderly people who are engaged in physical exercise (Kovalenko O.G., 2015). It is also noted that participation of elderly people in physical exercises results in sleep normalization and an increase in satisfaction with life and quality of life in general. Furthermore, the improvement of mental health often occurs indirectly due to the improvement of the general state of health of a person (Desjatnikova N.V., 2012).

In addition to individual benefits, regular physical activity can bring tangible benefits to society as a whole, which are expressed in reduced health care costs associated with medical assistance and disability (Balatskaya L., Hackman A., Nakonechny I., Vasnan I., 2016).

As experts note, prevention of non-communicable diseases through physical activity combined with a healthy way of life is the most efficient and consistent approach to reducing the incidence of diseases (Krusevich T., Imas T., 2013).

According to WHO estimates, every dollar spent on physical activity promotion will save the healthcare system \$3.2 in costs associated with providing medical care. Possible economic effect of increased physical activity among elderly people was also demonstrated by other studies. For example, British scientists evaluated the potential costs and benefits of implementing a program for physical activity promotion among elderly population of the United Kingdom for 10 thousand participants. The authors found that the financial costs of organizing and creating the necessary conditions for regular (twice a week) participation of elderly people in physical exercise would prevent about 80 deaths and avoid 230 cases of in-patient treatment, thereby reducing the cost of the national health system by 600 thousand pounds sterling annually (Markina LD, 2001; Pristoupa E., Zhepka A. & Lara V., 2007; Smirnov S.I., 2011; Fedinak N.V., 2013, etc.).

An interesting result was obtained in another study of British researchers (Nicholl et. Al., 1994). The authors investigated the balance of costs and benefits associated with the implementation of measures that promote physical activity of people of different age groups. As a result of the study, it was found that the annual savings of medical expenses from the implementation of measures aimed at increasing physical activity of persons aged 45 years and older is approximately three times higher than the financial costs of their organization.

Conclusion

Regular physical activity contributes to the maintenance of functional independence of individuals, can prevent the emergence of a number of diseases, improve functional abilities, and reduce the risk of falls and injuries. Thus, according to our study results, the respondents from the first group had better physiological parameters, namely: their arterial blood pressure was more stable and within the normal range for adult population (127/85 mmHg), heart rate reserve had a wide range between the maximum heart rate and resting heart rate (75.7 bpm), the skin fold did not exceed 22 mm that is within the normal range for early adulthood, and vital lung capacity amounted to 3.9 L for the respondents of the first group in contrast to 2.2 L in the second group. We associate these results directly with participation in swimming and physical exercises as well as a higher level of physical activity in general. The comparison between the biological and chronological age showed that the persons with higher physical activity levels had the biological age much lower than the passport age (-8.7 years), while the respondents of the control group has the biological age 5.5 years larger than the chronological age. Furthermore, the majority of respondents of the experimental group (60,5%) had a slowed rate of aging, while in the control group, 60% of respondents had an accelerated rate of aging.

Conflict of interests The authors declare that there is no conflict of interests.

References

- Abramov R., Bolotova I. (2008). Innovative social practices of everyday life and consumption in the context of a new culture of self-care: as exemplified by Moscow fitness clubs. *Herald of Omsk University. Series Sociology*. No.1-2. P. 37-62.
- Abramovich S. G. (1999). Biological age of a person. *Siberian Medical Journal*. No 19. P. 4–7.
- Andrieieva E., Blagiy A. (2013). Recreational games in the structure of recreational activity of adult persons. *SportyvnyivisnykPrydniprovia*. No2. P. 37-41.
- Andrieieva O., Hakman A., Balatska L. (2016). Factors which determine the involvement of elderly people in health and recreational physical activity. The VI th Edition international scientific conference “Trends and perspectives in physical culture and sports” (Suceava, 26th-27th of May 2016). Suceava: University “Ștefancel Mare”. P. 41-46
- Andrieieva O., Hakman A., Balatska L., Moseychuk Y., Vaskan I. & Kljus O. (2017). Peculiarities of physical activity regimen of 11-14-year-old children during curricular and extracurricular hours. *Journal of Physical Education and Sport*, 17(4), 2422 – 2427. doi:10.7752/jpes.2017.04269
- Andrieieva, O.V., Patsalyuk K. G. (2012). Socio-pedagogical conditions of organization of recreational activity in bowling clubs. *Physical education, sport and health culture in modern society*. No 4. P. 223-229.
- Andrieieva, O., Galan Y., Hakman, A., & Holovach, I. (2017). Application of ecological tourism in physical education of primary school age children. *Journal of Physical Education and Sport*, 17 (1), 7-15. DOI:10.7752/jpes.2017.s1002
- Arbab-Zadeh A. Dijk E., Prasad A. (2004). Effect of aging and physical activity on left ventricular compliance. *Journal of the American Heart Association*. Vol. 13. P. 1798–1805.
- Balatskaya L., Hackman A., Nakonechny I., Vasnan I. (2016). Socio-economic development of the country as a means of influencing the Olympic movement and physical culture. “Sport. Olimpism. Sănătate”

- :Consacratfniversării a 65-a organizăriiînvăământului superior de culturăfizică din Republica Moldova :
CongresȘtiințific Internațional, 5-8. octomrie 2016.Vol.2. Chișinău : USEFS, 2016. - P. 137-141
- Barbosa B.T., Santos R.L., Chaves A.B, Brindeiro-Neto W., Pereira T., Silva A.I., Soares L.I., &Brasileiro-
Santos M.S. (2019). Self-related quality of life of elderly submitted to a 12-week aquatic training program.
Journal of Human Sport and Exercise. Vol. 14(2), in press. Doi:10.14198/jhse.2019.142.03
- Belozerova L.M. (2002). Methodology for studying age-related changes.Clinical gerontology. Vol. 8 (12). P. 3–
7.
- Desiatnikova N.V. (2012). Effect of various means of physical culture on the biological age of the population.
Theory and practice of physical education. No 2. P. 197–203.
- Doro M.R., Nascimento-Carvalho B., Ruaro M., HirotaV.B., Rodrigues B., Fukushima A.R., Sanches I.C.,
CaperutoE.C. (2018). Higher levels of physical activity reduce spending on medicines in the elderly.
Journal of physical education and sport. Vol. 18(1).P. 157-162. Doi:10.7752/jpes.2018.01020
- Fediniak N.V. (2013). Anti-aging effects of swimming. Newsletter of Precarpathian University. Physical culture.
No 18. P. 108–116.
- Fediniak N.V. (2014). Effects of participation in health-enhancing swimming on biological age and functional
abilities of people aged 30-35 years. Pedagogics, psychology, medical-biological problems of physical
training and sports. No 4. P. 63–68.
- Hakman A.&Baidyuk M. (2017). Foreign experience of recreation and health-enhancing activity in leisure for
elderly people. Young Scientist. Vol.3(43). P. 116-120
- Hakman A. (2017). Fitness club as a form of activation of the life attitude of an elderly person.
SportyvnyivisnykPrydniprovia.No3. P. 25-30
- Hakman A. Role of recreational-health activity for elderly people. Intern. Conf. on the 70th Anniversary of
sports medicine in the Republic of Moldova (Chisinau, 12-14 October, 2017). P. 19-20
- Hakman A., Medved A., Moseychuk Yu., Muzhychok V.(2017). Analysis of features of motivational priorities
to recreation and recreational activities of different groups of people.Physical education, sports and health
culture in modern society. No 2 (38). P. 85-91
- Hakman A., Nakonechniy I., Moseychuk Y., Liasota T., Palichuk Y. &Vaskan I. (2017). Training methodology
and didactic bases of technical movements of 9-11- year-old volleyball players. Journal of Physical
Education and Sport, 17(4), 2638-2642. doi:10.7752/jpes.2017.04302
- Hakman A.V. (2017). Features of the management of recreational and health-enhancing activity of elderly
people in the environment of a fitness club.Proceed. of the Xth intern. conf. “The youth and Olympic
movement”, May 24-25, 2017 [Electronic resource]. Kyiv. P. 241
- Hakman A.V., Balatska L.V.&Liasota T.I. (2016). Effects of recreational and health-enhancing activity on the
slowing of the body’s aging. Visnyk of Kamianets-Podilsky Ivan Ohienko National University. Physical
education, sport, and human health. No 9. P. 91-98
- Iedynak G., Galamandjuk L., Kyselytsia O., Nakonechnyi I., Hakman A. &Chopik O. (2017). Special aspects of
changes in physical readiness indicators of young men with different somatotypes between 15 and 17 years
of age. Journal of Physical Education and Sport, 17(4), 2690-2696. doi:10.7752/jpes.2017.04311
- Kashuba, V., Khmel'nitska, I. &Krupenya, S. (2012) Biomechanical analysis of skilled female gymnasts'
technique in «round-off, flic-flac» type on the vault table. Journal of Physical Education and Sport, 12(4),
431–435.
- Kashuba, V., Kolos, M., Rudnytskyi, O., Yarenenko, V., Shandrygos, V., Dudko, M. &Andrieieva, O. (2017)
Modern approaches to improving body constitution of female students within physical education classes.
Journal of Physical Education and Sport, 17(4), 2472-2476.
- Korobeinikov G., (2010). Biological mechanisms of aging and human physical activity. Physical activity, health
and sport. No2. P. 3–13.
- Korobeinikov G., Adirkaiev S., Mazmanian K., Medvidchuk K., Zhytovoz M. (2007). Biological age and
physical activity.Theory and methods of physical education and sports. No1. P. 60–63.
- Kovalenko O. G. (2014). Interpersonal communication as a component of mental activity in elderly people.
Applied psychology and social work. No 2. P. 61–64.
- Kovalenko O.G. (2015). The model of interpersonal communication in older age.Problems of modern
psychology: Collected scientific papers of Kamianets-Podilsky Ivan Ohienko National University, Kostiuk
Institute of psychology of the NAPS of Ukraine. No 28. P. 191–202.
- Kozina, Z., Iermakov, S., Bartík, P., Yermakova, T., & Michal, J. (2018). Influence of self-regulation
psychological and physical means on aged people’s functional state. Journal of Human Sport and Exercise,
Vol. 13(1), P.99-115. doi:10.14198/jhse.2018.131.10
- Krusevich T., Imas T. (2013). Value orientations of adult persons in leisure activities.
SportyvnyivisnykPrydniprovia. No2. P. 5–11.
- Lisitskaya T. S., Kuvshinnikova S.I. (2004). Sociological analysis of the dominant motivations of fitness clubs
clients. Theory and practice of physical culture. No2. P. 37-38.

- Markina L. D. (2001). Assessment of the individual's biological age using Voitenko method: study guide for unsupervised work of medical and psychological students. Vladivostok, 2001. 29p.
- Martínez-Vidal A., Martínez A. P., Del Pino Díaz Pereira M., Martínez-Patiño M. J. (2011). Effect of a combined program of physical activity and intellectual activity in the cognitive functioning of the elderly. *Journal of human sport & exercise*. Vol. 6 (2). P. 462-473
- Mavrovouniotis A., Argiriadou E., Mavrovouniotis F., Mavrovouniotis C., Mountakis C., Nikitaras N., Deligiannis A. (2016). The evaluation of physical health of elderly participants or non-participants in a Greek dances program. *Journal of physical education and sport*, 16 supplement issue (1), P. 713 – 719. Doi:10.7752/jpes.2016.s1116
- Monteiro, A.M., Silva, P., Forte, P., & Carvalho, J. (2019). The effects of daily physical activity on functional fitness, isokinetic strength and body composition in elderly community-dwelling women. *Journal of Human Sport and Exercise*. Vol. 14(2), in press. doi:10.14198/jhse.2019.142.11
- Moreira D.G., Molinari A.B., Fernandes A.A., Sillero-Quintana M., Brito C.J., Doimo L.A., Marins J. C. M. (2017). Skin temperature of physically active elderly and young women measured using infrared thermography. *Journal of physical education and sport*. Vol. 17(4), P. 2531-2537. Doi:10.7752/jpes.2017.04286
- Nunes, R., Castro, J., Silva, L., Silva, J., Godoy, E., Lima, V., Venturini, G., Oliveira, F., & Vale, R. (2017). Estimation of specific VO₂max for elderly in cycle ergometer. *Journal of Human Sport and Exercise*, 12(4), 1199-1207. doi:10.14198/jhse.2017.124.06
- Pristoupa E., Zhepka A. & Lara V. (2007). Concepts of the individual's leisure time as a category of recreation. No 1. P. 106-112.
- Rentería, I., García, P.C., Cantón, E., Grandjean, P., & Jiménez, A. (2018). Salivary Immunoglobulin A responses to 6-minute walk test in elderly women. *Journal of Human Sport and Exercise*, Vol. 14(1), in press. doi:10.14198/jhse.2019.141.19
- Ruiz-Montero P.J., Castillo-Rodríguez A. (2016). Body composition, physical fitness and exercise activities of elderly. *Journal of physical education and sport*. Vol. 16(3). P. 860-865. Doi:10.7752/jpes.2016.03136
- Smirnov S.I. (2011). Analysis of the services quality assessment by visitors of fitness centers. *Uchenyeyapiskiuuniversitetaimeni P.F. Lesgafta*. No 12(82). P.23-27.
- Vitalii Kashuba, Olena Andrieieva, Nataliia Goncharova, Victoria Kyrychenko, Ion Karp, Serhii Lopatskyi, Mykola Kolos (2019). Physical activity for prevention and correction of postural abnormalities in young women. *Journal of Physical Education and Sport*. Vol 19 (Supplement issue 2), pp 500 – 506
- Vitalii Kashuba, Sergey Futorny, Olena Andrieieva, Nataliia Goncharova, Ion Carp, Olena Bondar, Nataliia Nosova (2018). Optimization of the processes of adaptation to the conditions of study at school as a component of health forming activities of primary school-age children. *Journal of Physical Education and Sport* 18(4), pp.2515 – 2521
- Voitenko V.P., Tokar A.V., Rudaya E.S. (1989). Method for the assessment of biological age. *Voprosy gerontologii*. No 11. P.9 – 16.
- Yarmak, O., Galan, Y., Hakman, A., Dotsyuk, L., Blagii, O. & Teslitskyi, Yu. (2017). The use of modern means of health improving fitness during the process of physical education of student youth. *Journal of Physical Education and Sport*, Vol. 17 (3). P. 1935-1940. doi:10.7752/jpes.2017.03189
- Yarmak, O., Galan, Y., Nakonechnyi, I., Hakman, A., Filak, Y. & Blahii, O. (2017). Screening system of the physical condition of boys aged 15-17 years in the process of physical education. *Journal of Physical Education and Sport*, Vol. 17 Supplement Issue 3, P1017-1023. doi:10.7752/jpes.2017.s3156