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Original Article

Effect of yoga exercises on the senior schoolchildren's biological age during physical education

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Abstract
Background. In connection with the problem of deteriorating Ukrainians' health scientists provide a number of recommendations among which the most relevant one is to create conditions for regular physical activity in order to strengthen health, considering the interests, desires, abilities and individual characteristics of every student and to develop a new scientific, methodological and educational support for the process of the younger generation's motor activity. They emphasize the positive impact of non-traditional means on pupils' health and recommend they should be introduced into the physical education process. One of such means is yoga. The objective. The aim of the article is bringing out the results of the research on revealing the expediency and effective impact of yoga on the senior schoolchildren's health using interesting and non-traditional diagnostic methods – determining the biological age as health indicator.Methods. The success of the experimental research was ensured by the clarity of the construction of the process of physical education of schoolchildren and the selection of informative research methods. Results. After the implementation of experimental yoga exercises into the process of senior schoolchildren's physical education a higher improvement of the biological age in EG rather than in CG was revealed. In EG schoolchildren the lowest rate of biological age was 20 years, and the highest – 42 years, i.e. the indicators decreased. The lowest biological age indicator was recorded in CG – 22 years, and the highest – 51.Conclusion. Such results testify the effectiveness of the influence of experimental yoga exercises, the use of which has positively brought the senior schoolchildren's biological age to the calendar one.
Key words: health, yoga, senior schoolchildren, physical education, biological age.

Introduction

Deterioration in health of the population is a global problem nowadays. A healthy person has more opportunities to succeed in education and in the desire to take a worthy place in society, to develop physically well and to have a balanced psycho-emotional state. However, it is scientifically and statistically proved that health of Ukrainian citizens' health has weakened sharply within recent years (Moiseenko, 2009; Risks ..., 2010; Balakireva et al., 2011). Besides the objective causes of this phenomenon there are subjective ones – inattention to their own health, lack of healthy lifestyle skills, low level of physical activity, etc.

The rising generation prefers passive activities, such as watching tv shows and using electronic devices, which can lead to a large outbreak of non-infectious diseases of wide-ranging etiology. Apparently, children lack knowledge and practical skills concerning components of a healthy lifestyle and, most importantly, the realization of the need to balance physical and mental states for sustainable development and chronic disease prevention. All said above testifies the need for a more effective approach to the development of educational work in this field in educational institutions of the country (Drachuk, 2003; Romanenko, 2004).

Scientists (O.M. Balakireva, T.V. Bondar, O.R. Artyukh, I.P. Vasilashko, O.V. Onoprienko, O.O. Patrikeeva, N.O. Ryngach, G.O. Slabky, S.V. Sydyak, Ya.O. Sazonova, B.M. Shiyan, T.Yu. Krutsevych, Ye.G. Bulych, I.V. Muravov, O.V. Andreeva, I.M. Grygus, O.P. Shestakovsky and others) (Diachenko-Bohun et al., 2019a; Hrytsai et al., 2019; Diachenko-Bohun et al., 2019b; Lavrin et al., 2019a; Lavrin et al., 2019b; Diachenko-Bohun et al., 2019c; Diachenko-Bohun et al., 2020; Sereda et al., 2020; Shevtsiv et al., 2020; Savliuk et al., 2020a; Kashuba et al., 2020a; Grygus et al., 2020; Hrytsai et al., 2020; Novopysmennyi et al., 2020; Nesterchuk et al., 2020; Kashuba et al., 2020b; Savliuk et al., 2020b; Momot et al., 2020; Kashuba et al., 2020c; Tomanek, Lis, 2020;

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Gozhenko et al., 2018a; Gozhenko et al., 2018b) developed a number of recommendations for educating schoolchildren and students' attitude to their own health.

Most of them agree that regular physical activity and sports are essential components of a healthy lifestyle. Therefore, in connection with the problem of deterioration of the younger generation's health, they recommend, firstly, to create conditions for regular physical activity in order to strengthen health, considering the interests, desires, abilities and individual characteristics of every student (Bulich, Muravov, 2003; Krutsevych, 1999; Shiyan, 2008). Secondly, to develop recommendations for conducting classes using modern, non-traditional methods and teaching aids. In addition, it is important to diagnose the state of health regularly for the timely detection of violations and correction of these states in the process of secondary schoolchildren and university students' physical education (Andreeva, 2002; Krutsevych, 1999).

In connection with the issues raised, the **purpose** of the article is bringing out the results of the study on reveling the feasibility and effectiveness of yoga impact on the health of senior schoolchildren training in main group. Considering the recommendations for regular diagnosis of the younger generation's health, it is worth looking for new and interesting ways of its estimation. V. Voitenko, I. Sereda, G. Lavrin, T. Kucher, V. Arefiev, T. Krutsevych, O. Andreeva and other scientists believe that one of the indicators of health is correlation between biological and calendar ages (Arefiev, 2000; Krutsevych, 2003; Sereda et al., 2017). They emphasize the informativeness of this indicator in assessing the health of school and student youth as well as their increased interest in this diagnostic method. That is why the paper evaluates the impact of yoga on the senior schoolchildren's biological age as an indicator of their health.

Material and methods

The basic research methods: analysis of scientific and methodological literature, pedagogical observation, "Battery of tests" to determine the biological age according to V. Voitenko, pedagogical experiment, methods of mathematical statistics.

Participants. **Presenting the main material**. The implementation of the experimental study took place through the introduction of yoga complexes with various asanas, stretching, self-massage into the process of physical education of senior schoolchildren. These means were used alone or in combination with means from the curriculum, depending on the stage of the experiment (motivational and reproductive-creative). The experiment involved boys and girls aged 16-17 years. The experimental study lasted from September 2019 to March 2020.

Procedure / Test protocol / Skill test trial / Measure / Instruments. The task of the first stage was to create schoolchildren's interest in classes as well as to prepare their bodies for independent performance of experimental asanas. To realize this task stretching was used as an integral element of yoga, joint gymnastics, hatha yoga exercises to improve posture, self-massage. Traditional types of walking, running, jumping, strengthening the feet, exercises on improving coordination, spatial orientation, general developmental exercises, means from the program material were used as additional means.

The essence of stretching in the experimental process was that with the help of very slow and smooth movements (flexion and extension), aimed at stretching a particular muscle group, schoolchildren were able to take and hold a certain posture for some time. Thus, stretching was a method of fixed stretching. The main conditions for performing the exercises were as follows: regularity and gradual stretching, its absolute painlessness. It is important to do all the exercises to music matching the nature of the exercises.

The motor skills, developed during the classes, allowed schoolchildren to feel inner freedom and self-confidence. They gradually got rid of complexes associated with experiencing physical imperfection of their own body, inability to control it. Instead, there appeared muscular joy, positive emotions which became the biggest motive for further memorization of more and more new asanas. The classes were held both in a clean ventilated gym and in the fresh air, the weather permitted. Pupils trained on the mat, wearing light sportswear and socks.

The introductory stage of the lesson usually consisted of warming-up (various types of walking, running, jumping for gaining proper posture, strengthening the feet, improving coordination and orientation in space), general developmental exercises or self-massage exercises. The following motor actions, used during the lesson, were introduced into the set of exercises for foot massage (done standing or sitting): warming-up of both feet toes; foot massage (stroking and rubbing with the palms of the same-name hands in the longitudinal direction); bone massage (massage with circular movements of the palms); shin massage (stroking); knee massage (rubbing with circular motions); thigh massage (stroking); buttocks massage (stroking and warming up the gluteal muscles with the same-name hands).

The main part of the lesson on the first stage of the study was filled with a variety of exercises from the curriculum in combination with stretching. One set of stretching exercises was performed for two weeks. At the first lesson, schoolchildren consolidated their skills to perform already known movements and got acquainted with the new ones. At the following lesson they improved their technique of performing the exercises.

On the reproductive and creative stage yoga complexes with various asanas were directly used. One complex was learned for two weeks, then the asanas changed.

Asanas from the starting position were performed standing, sitting and lying. All poses in the initial standing position were performed vertically. In this case, in the "straight" and "reverse" poses (with twisting of the upper girdle of the torso by 180 degrees, or without twisting), both shoulders touched the plane. In addition, it was important to maintain the plane of the torso in the plane of the legs. It was recommended to lean the hand on the leg (e.g. in "triangles") and stay in this position, that is better than to reach the floor with the hand getting a skew of the body and strain in the hamstrings.

Until the body got used to the asanas, schoolchildren had to perform them with some support – leaning on the wall, furniture, etc., to be able to fix the pose and not overstrain. After the pose had been mastered the support was abandoned.

They began to learn asanas from a sitting and lying position which did not cause maximum body tension. Then they went to the asanas with support and standing without support.

An important point in performing yoga exercises was proper breathing. Due to breathing exercises complete relaxation was achieved and body tension was reduced.

An important condition set for schoolchildren in any yoga asanas was – to breathe freely and naturally. The abdominal muscles (unless they are directly involved in the power "pattern" of a particular posture) should remain relaxed. Such breathing limited the sharpness and speed of yoga movements, there was a smooth transition from one position to another. Preservation of naturalness and freedom of breathing led to an increase in the time of holding the poses and the comfort of being in the asanas. If schoolchildren felt tired while standing in the starting position they were asked to lie down in "Shavasana" for a few minutes.

Sometimes excessive physical tension, when doing asanas, was manifested in schoolchildren's "yawning". To get rid of the initial accumulation of fatigue children were asked to inhale without opening their lips to make a full "inner yawn". This technique was repeated several times and the fatigue disappeared.

Important attention was paid to the position of the feet in vertical asanas. It was emphasized that both feet soles should always fit to the floor tightly, without any skews. At the beginning it was not very successful but regular practice provided such an opportunity in the future.

The sets of exercises included various asanas, such as: full breathing of yogis sitting, lying or standing, Akapalabhati, Kapalabhati, Kumbhaka, Bhastrika, Anuloma Viloma, Sukh Puraka, Yoga-mudra with Simhasana, Ardha Salabhasana, Salabhasana, Ardha Matsiendrasana, Trikonasana and its varieties, Sirshasana etc.

For effective implementing the purpose of the study we followed the defined pedagogical conditions: correct direction of the complexes of asanas – from top to bottom (head, neck, arms, torso, legs), as well as sequence of starting positions (initial exercises in the starting position – standing, then sitting and lying); keeping the correct dosage of exercises, taking into account children's well-being and level of physical fitness; gradual increase of workload: mastering one complex during (no less than) two weeks of regular classes; conducting lessons in nature or in a well-ventilated room; eating was not allowed earlier than half an hour after the classes; conscious concentration when doing exercises; teacher's professionalism; methodically correct organization of classes.

Data collection and analysis / Statistical analysis. The effectiveness of the means was ensured by following the principles: gradualness (you always need to move from simple to complex); regularity (you need to practice regularly, trying not to miss a single lesson); moderation.

Biological age is determined by various methods. There are very complex options, they use modern medical equipment. To determine the biological age in the experiment, the V. Voitenko's method was chosen, which involves the assessment of physiological parameters and self-assessment of children's health (Voitenko et al., 1989).

Assessment of physiological parameters for boys was carried out according to the formula:

BV = 44.3 0.68 • SAQ + 0.40 • SBP - 0.22 • DBP - 0.22 • APP -0.004 • VCL - 0.11 • HBI 0.08 • HBE. - 0.13 • SB.

For girls:

BV = 17.4 0.82 • SAQ - 0.005 • SBP 0.16 • DBP 0.35 • APP - 0.004 • VCL 0.04 • HBI - 0.06 • HBE. - 0,11 • SB, where:

SBP – systolic blood pressure, mm;

DBP – diastolic blood pressure, mm;

APP – pulse pressure, the difference between systolic and diastolic, mm Hg;

VCL – vital capacity of the lungs, ml;

HBI – holding the breath on inspiration, s;

HBE – holding the breath on exhalation, s;

SB – static balancing with closed eyes on the left leg without shoes, arms lowered along the torso;

SAQ – self-assessment of health by questions, scores;

Self-assessment of health took place through a questionnaire on the following questions:

1. How do you estimate your health as compared to your peers' health? Excellent (1), good (2), satisfactory (3), bad (4).

2. How can you estimate your health at the moment?
Excellent (3), good (2), satisfactory (1), bad (0), no answer (-).
3. Do you consider your health excellent (1), good (2), satisfactory (3) or bad (4)?
4. Do you feel healthy? Yes (1), no (2).
5. How do you estimate your health today? Very good (1), good (2), so-so (3), mediocre (4), bad (5).
6. Can you say that during the last 12 months your health was good (1), mostly satisfactory (2), so-so (3)?

After the introduction of yoga in the process of physical education a re-assessment of the correlation of EG and CG schoolchildren's biological age with the calendar one was held. The use of an experimental program of yoga classes had a positive effect on the improvement of previously identified indicators of EG schoolchildren's biological age as compared with CG ($P < 0.05$).

Thus, the average blood pressure in EG schoolchildren decreased as compared with those in CG and was 116/72 beats per minute against 120/66 beats per minute in boys and 112/64 beats per minute against 103/56 beats per minute in girls, respectively. The indicators of VCL and holding breath in EG schoolchildren became slightly better. VCL in EG boys after the experiment was recorded in the range of 4050 ml, in girls – 3000 ml. In CG this figure remained practically unchanged and was 3050 ml, and in girls – 2350 ml. EG boys improved the duration of holding breath on inspiration to an average of 62 sec., on exhalation – 36 sec. The girls improved the averages to 52 sec. and 28 sec., respectively. In CG the delay time remained unchanged (girls – 46 sec. on inhalation and 22 sec. – on exhalation, and boys – 52 sec. on inhalation and 23 sec. on exhalation).

Such changes in physiological parameters, in a relatively short time, are associated with a constant emphasis on proper breathing during the exercises, which had a positive effect on the functions of schoolchildren's cardiovascular and respiratory systems.

The use of yoga exercises had a positive effect on the index of static balancing. At the end of the experiment EG schoolchildren improved the holding time of the appropriate pose: girls – up to 54 sec., and boys – up to 29 sec. In CG boys and girls this indicator has not practically changed (19 sec. and 44 sec.).

The analysis of the health self-assessment questions shows EG schoolchildren's better well-being (62% estimated it as excellent, 36% – good, 6% – satisfactory). In CG most schoolchildren indicated their fine well-being, although physiological indicators proved the opposite. This testifies that EG schoolchildren have become more aware of their body.

Thus, if at the beginning of the experiment the lowest indicator of biological age was recorded 23 years, and the largest 56 years, and no student was found whose biological age would correspond to the calendar, then after introducing experimental yoga into the process of senior schoolchildren's physical education the indicators of biological age in EG schoolchildren became better than those in CG. The lowest indicator of EG schoolchildren's biological age was 20 years, and the highest – 42 years, i.e. the indicators still decreased. In CG the lowest biological age indicator was recorded 22 years, and the highest – 51.

Discussion

Modern development of fitness systems creates quite wide opportunities for using them in the system of physical education of the younger generation. In addition, the common tasks of fitness and physical education of schoolchildren specified in its programs have been revealed, namely: increasing vitality, health strengthening, improving general and special efficiency, development of physical qualities, formation of proper posture and correction of its defects, increase of psycho-emotional state, counteraction to daily stresses (Krutsevych, 2003; Krutsevych, 1999; Mazurchuk, Navrotsky, 2011; Sereda, 2017; Savliuk et al., 2020b).

Many scientists have dedicated their work to revealing the appropriateness and effectiveness of the impact of modern non-traditional fitness means on the health of the younger generation. In particular, Ye.Yu. Shapoval, Sh.A. Imnaev studied the use of various non-traditional breathing exercises in the process of physical education of schoolchildren either in main or special medical groups (Shapoval, Donets, 2017).

O. Mazurchuk developed a program of non-traditional types of health gymnastics which significantly increased interest in physical education, enabled to create new emotional forms of lessons which pronounce the orientation on the development of endurance and efficiency (Mazurchuk, Navrotsky, 2011).

I.O. Sereda, S.V. Synytsia, L.Ye. Shesterova developed theoretical and practical recommendations for teachers as for conducting classes using various types of health aerobics (yoga, fitball-aerobics, taibo, step-aerobics, etc.) (Sereda, 2018a; Sereda, 2017; Sereda, 2018b; Synytsia, 2010; Sereda et al., 2017).; Sereda et al., 2020).

O.V. Buleychenko's researches are devoted to training on the non-traditional Tabata system (Buleychenko, 2016).

I. Goloviychuk, O. Pidvalna, O. Buleychenko made attempts of implementing yoga exercises in the process of physical education of schoolchildren in special medical group (Drachuk, 2003).

Regular and properly organized classes increase the human's activity, improve the work of all body systems, prevent age-related diseases (Sereda, 2018; Sereda, 2017; Synytsia, 2010; Anon, 2005; Sereda et al., 2020; Telles et al., 1994; Telles et al., 1995).

The analysis of the literature has also revealed that one of the popular directions of health fitness is fitness-yoga and yoga-aerobics – effective training programs for physically active people that help to find harmony between body and mind. Regular and properly organized classes increase human activity and prevent age-related diseases (Sereda, 2018; Sereda, 2017; Synytsia, 2010; Anon ..., 2005; Sereda, et al., 2020).

Constant use of yoga exercises (asanas) helps to maintain muscle strength, tone, bone density, joint mobility, to improve posture and balance, to reduce body weight, as well as to overcome stress, anxiety and depression, helping to maintain mental health of people of different ages (Anon ..., 2005; Chaya et al., 2006; Sereda et al., 2017).

Analyzing the above mentioned, we can prove that yoga has a positive effect on all systems of the human body – circulatory, respiratory, digestive, nervous, endocrine, immune, integumentary, musculoskeletal system and it also reduces the aging process.

The results of the conducted study revealed the feasibility and effectiveness of yoga on the health of high school students training in the main group.

The analysis of the results of diagnostics of physiological indicators in V. P. Voitenko's method has confirmed the information that the use of the offered yoga asanas in the process of schoolchildren's physical education has a positive effect on their cardiovascular and respiratory systems (Telles et al., 1994; Telles et al., 1995).

Improving the time of static balancing of schoolchildren confirm the opinion of scientists about the positive influence of experimental asanas on maintaining muscle strength, tone and balance of the whole body (Anon, 2005; Chaya et al., 2006; Sereda et al., 2017).

The results of the students' self-assessment of their own health prove that regular and properly organized yoga classes increase activity, have a positive effect on well-being, reduce the threshold of morbidity and stress (Sereda, 2017; Synytsia, 2010; Sereda, et al., 2020).

Experimental research has revealed the need to approximate the biological age to the calendar one at school age. As a result of overcoming the problem the statement of scientists was confirmed (Chaya et al., 2006; How ..., 2005; Sereda et al., 2017; Sereda et al., 2020), that doing yoga is one of the important steps to reduce the students' biological age and therefore the ability of all body systems to function properly. After all, the asanas, offered in the experiment, had a positive effect on the indicators of the students' biological age.

It has been proved that the introduction and use of V. P. Voitenko's method of assessing the conformity of biological and calendar ages helps to increase students' interest in their own health.

The data on the peculiarities of studying yoga asanas and self-massage with students are new. Considering the fact that the means were new and unknown types of physical activity for the students, participated in the experiment, the study has proved the possibility of their assimilation and self-implementation during the lessons and at home.

According to the results of the assessment of conformity of schoolchildren's biological age to the calendar one, it has been established that including yoga means in the program of physical education of secondary schools will allow to maintain and improve the students' physiological indicators, and thus positively solve the problem of deteriorating health.

Conclusions

The above material allows to draw the following **conclusions**:

1. The success of the experimental study was ensured by the clarity and logic of the process of physical education of schoolchildren. Namely: determining the stages of the process (motivational and reproductive-creative); introduction of experimental yoga complexes with various asanas were directly used (Akapalabhati, Kapalabhati, Kumbhaka, Bhastrika, Anuloma Viloma, Sukh Puraka, Yoga-mudra with Simhasana, Ardha Salabhasana, etc); following the pedagogical conditions (keeping the correct dosage of exercises, taking into account children's well-being and level of physical fitness; gradual increase of workload: mastering one complex during (no less than) two weeks of regular classes; conducting lessons in nature or in a well-ventilated room etc); following the principles of applying the exercises (gradualness (you always need to move from simple to complex); regularity (you need to practice regularly, trying not to miss a single lesson); moderation; informativeness of the diagnostic method of determining the correlation between biological and calendar ages (V. Voitenko's method, which involves the assessment of physiological indicators and self-assessment of schoolchildren's health).
2. After introducing experimental yoga into the process of senior schoolchildren's physical education the indicators of biological age in EG schoolchildren became better than those in CG. The lowest indicator of EG schoolchildren's biological age was 20 years, and the highest – 42 years, i.e. the indicators still decreased. In CG the lowest biological age indicator was recorded 22 years, and the highest – 51.
3. The results testify the effectiveness of the influence of experimental yoga exercises, the use of which has positively approached the senior schoolchildren's biological age to the calendar one.

Prospects for the further research is introduction and testing the effectiveness of yoga exercises while dealing with children of other ages.

Conflict of Interest The authors declare that they have no conflict of interest.

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