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Medical and biological fundamentals of young athletes' training

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Abstract.

Background and Study Aim. The social and pedagogical effectiveness of the training process, ensuring the normal physical development of young athletes, and the formation of their somatic and psychological health directly depends on the extent to which the anatomical and physiological features of the child's body are taken into account, which justify the medical and biological bases of the system of training young athletes. The article presents a review of scientific literature on the issues of medico-biological substantiation of young athletes' preparation.

Material and Methods Analysis and generalization of data of scientific-methodical literature and information sources of the Internet; study of documentary materials; method of copying.

Results. A brief characteristic of the complex of interrelated tasks – health improvement, education, and physical perfection of the younger generation in their sports training is given. Determination of biological age conformity to the chronological age is one of the actual problems in the practice of sports medicine and preparation of young athletes, especially of puberty age. After the first Summer Youth Olympic Games held in Singapore in 2010, coaches and experts in sports medicine concluded that the formation of teenage competition teams should be based on the indices of their physical development and sexual maturation at the same chronological age.

Conclusion. A mismatch between physical loads and the functional capacities of the body of a child, adolescent are the main causes of the development of chronic physical overexertion of body system functions and sports injuries, in particular. Speaking about women's sports, it should be remembered that all the problems in the initial stage of athletic training, for girls and girls who have not yet reached not only social, but also physical maturity.

Key words: Youth Olympic Games, the chronological and biological age of adolescents, sports preparation.

Анотація.

Медико-біологічні основи підготовки юних спортсменів

Лариса Шахліна, Сергій Футорний, Тереза Соха, Олена Маслова, Марина Чистякова, Ольга Чернікова, Максим Гопей, Аліна Гопей

Передумови та мета дослідження. Соціально-педагогічна ефективність тренувального процесу, забезпечення нормального фізичного розвитку юних спортсменів, формування їх соматичного та психологічного здоров'я безпосередньо залежить від ступеня врахування анатомо-фізіологічних особливостей дитячого організму, які обґрунтовують медико-біологічні основи системи підготовки юних спортсменів. У статті представлено огляд наукової літератури з питань медико-біологічного обґрунтування підготовки юних спортсменів.

Матеріали і методи. Аналіз та узагальнення даних науково-методичної літератури та інформаційних джерел мережі Інтернет; вивчення документальних матеріалів; метод копіювання.

Результати. Надано коротку характеристику комплексу взаємопов'язаних завдань - оздоровлення, виховання та фізичного вдосконалення підростаючого покоління в процесі їх спортивної підготовки. Визначення відповідності біологічного віку хронологічному є однією з актуальних проблем у практиці спортивної медицини та підготовки юних спортсменів, особливо пубертатного віку. Після перших літніх юнацьких Олімпійських ігор, що відбулися в Сінгапурі в 2010 році, тренери та фахівці зі спортивної медицини дійшли висновку, що формування змагальних команд підлітків має базуватися на показниках їхнього фізичного розвитку та статевого дозрівання в одному хронологічному віці.

Висновок. Невідповідність фізичних навантажень функціональним можливостям організму дитини, підлітка-юнака є основними причинами розвитку хронічного фізичного перенапруження функцій систем організму і спортивного травматизму, зокрема. Говорячи про жіночий спорт, слід пам'ятати, що всі проблеми на початковому етапі спортивної підготовки, для дівчаток і дівчат, які ще не досягли не тільки соціальної, а й фізичної зрілості.

Ключові слова: Юнацькі Олімпійські ігри, паспортний та біологічний вік підлітків, спортивна підготовка.

Problem definition

Unfortunately, the structure that provides recommendations, rules, and regulations for youth sport has very little scientific substantiation [1].

A mismatch between sports fitness and skill development level can lead to unfavorable physical and psychological effects on the child [2].

Many specialists indicate the biological variability in the development of young athletes. Therefore, grouping children and adolescents according to their chronological age sometimes leads to a mismatch of their biological age and, consequently, different physical and functional capacities [3].

Sports training of children and adolescents envisages solving a complex of closely interrelated tasks - health promotion, education, and physical improvement of the younger generation [4]. Means and methods in their training should correspond to the age peculiarities of the athlete's body, which is still at the stage of incomplete morphological and functional

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formation [5].

Summary of previous research

Determination of the correspondence between the chronological and the biological age of adolescents represents one of the topical issues in sports medicine, pediatrics, pedagogics, age physiology [6]. It is known that the biological age reflects the ontogenetic maturity of an individual, the character of the adolescent's adaptive responses, and work capacity to a greater extent than the chronological age [7].

Biological age is a notion that characterizes the actual level of morphological and functional maturity of the body systems and the body as a whole [8].

Research objective: to characterize the biological peculiarities of the body of adolescents for the scientific substantiation of their sports preparation.

To achieve the objectives, the following research methods were used: analysis and generalization of data of scientific-methodical literature and information sources of the Internet; study of documentary materials; method of copying.

During human life, the body morphofunctional development has a heterogeneous character with periods of acceleration and deceleration of these processes. It gave rise considering separate age periods during ontogenesis, which are characterized by specific features of body maturation: functional, morphological, and psychological (Fig. 1).

Physiological peculiarities of the adolescent body are characterized by a pronounced instability of mechanisms of biological regulation (nervous and humoral links) due to the continuing maturation and functional development of internal secretion glands, which conditions the instability of somatic functions [10].

While taking into account quantitative and qualitative morphofunctional changes in the body of an adolescent (boys aged 3-16 years; girls aged 12-15 years), this period of development is considered as "pubertal" - adolescent [11] - a period of transition from childhood to maturity. For the pubertal period, it is typical that "... it is an existing period in human life, when he/she is no longer a child, but not yet an adult" [11].

The WHO Committee of experts in 1977 proposed that adolescence be considered as 10-20 years of age, which is accepted almost all over the world. At the same time age of adolescence includes two important periods - puberty, from the appearance of secondary sex characteristics to the acquisition of the ability of efficient reproductive function and the stage of social maturation, when a person chooses a profession and masters it [12].

Adolescence is referred to as the "critical" (difficult) age. It is due to the fact that during this period the development of the body continues, but this process is characterized by the processes of accelerated physiological, morphological, mental, and social development [13]. It is in the adolescent (puberty) period that the individual, genetically determined program of body development with the formation of a certain constitutional type is finally realized; morphological and functional maturation of body systems is completed; morphofunctional development of the reproductive system, which determines reproductive health in the future, is accomplished [9].

The transition from one age period to another is a critical stage in body development, which changes one qualitative state into another [12]. Spasmodic moments of accelerated development of the body, its organs, and tissues are called "critical". They are strictly controlled genetically. Sensitive periods - periods of special increased susceptibility to the influence of the environment - coincide with these periods, however are less controlled genetically [5, 14].

Critical periods transfer the body to a new level of ontogenesis, increasing the body morphofunctional capacities, whereas sensitive periods provide adaptation of functional systems and the body as a whole to new conditions of life activity, including physical and mental loads at a new level of body existence [10].

In the practice of sports training of adolescents, the efficiency of the training process in sensitive periods is the highest - the development of physical qualities is more pronounced, the adaptation processes to physical loads are characterized by optimal body capacities, causing the increase of body functional reserves [7, 10, 11].

According to L. Levina, Kulikov A., 2006 [12], the health during the age of adolescence determines the human health in all subsequent age periods, and the health of a person determines the health of society.

Explanation of the subject, contradictions, problems

Considering general regularities of growth and development of adolescents, it should be emphasized once again that continuation of ongoing development and growth are the two most characteristic biological peculiarities of the adolescent body. The process of growth is a general biological property of living matter that is expressed in an increase of mass and body surface area, which is caused by the development of tissues, organs, and body systems [14]. Along with growth as a quantitative process, the functional differentiation, development, improvement of functional body systems, their functional coordination and integration occur [15].

Sexual dimorphism in adolescents is manifested in the dynamics of morphological and functional development of children and adolescents of different sexes.

Important indices of the state of physical development of adolescents are the annual increase in body length and weight.

Sexual differences are manifested in the increase of

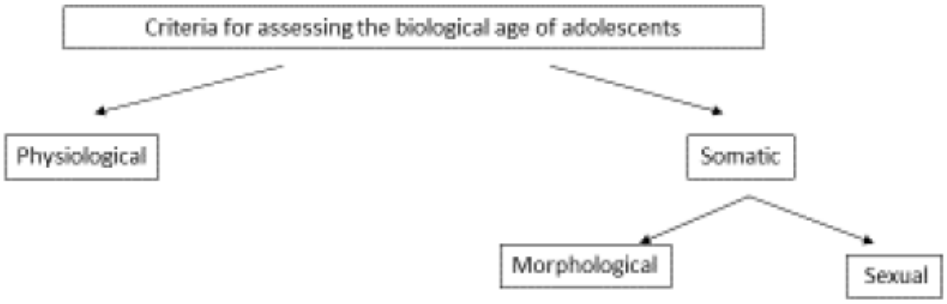

Figure 1. Criteria for assessing the biological age of adolescents [9]

body length [12].

The beginning of puberty is accompanied by an increase in gonadotropic hormones of the anterior pituitary gland influencing the development of gonads (ovaries) in girls and testicles in boys.

Specialists note that boys and girls under the age of 6 years belong to the "neutral" (asexual) age or the period of hormonal rest in terms of sexual development [16]. This period is characterized by a low blood sex hormone concentration, which is mainly due to the sex hormones of the adrenal cortex in both boys and girls.

Boys reach sexual maturity two years later than girls on average. Chtetsov V.P., Nikityuk B.A. analyzed the peculiarities of age periodization and concluded that 13-year-old boys correspond to 11-year-old [17, 18]. During puberty, the growth rate increases, and a pubertal growth spurt of indices is observed (Fig. 2). The greatest increase in body length (by 5-7 cm) is observed in girls aged 11-12 years, whereas that of body weight (by 4-6 kg) between 12 and 13 years. In boys, body length increases by 8-10 cm at the age of 13-14 years, and body weight increases by 5-7 kg between ages 14 and 15 [9, 10]. Body growth continues until the age of 17-19 years for girls and 19-20 years for boys [12].

According to data of Mishchenko V. (1969), Kolchinskaya A. (1973) the oxygen consumption by adolescents at the age of 12-13 years increases due to the highest rate of increase in body length and weight. At the age of 13-15 years during puberty, the intensity of oxygen consumption continues to increase, indicating a high functional cost of physical loads in the pubertal period [19, 20].

The increase of the body oxygen demand in the process of ontogenesis is met by the development of the functional respiratory system - (respiratory system, circulation, blood system, and mechanisms of biological regulation) - FRS - and its constituent part - the circulatory system [9].

The absolute heart volume increases with age, however it decreases relative to the body weight. The heart mass at the age of 15-16 years practically reaches the indices of an adult - 220.0-300.0 g in men and 180.0-220.0 g in women [18]. The heart volume in adolescents aged 13-14 years averages 400.0 ml and increases to 500.0-600.0 ml by the age of 19 years.

The functional peculiarities of the adolescent heart include a more frequent and less regular heart rate [20]. The author indicates that HR in an untrained adult is equal to 70-75 bt min^{-1}, whereas at the age of 8-10 years it constitutes 90-85 bt min^{-1}, and by 16 years is close to the adult HR. At the same time, resting HR in girls is 2-6 bt min^{-1} higher than in boys. According to Mishchenko V. (1969), Kolchinskaya A. (1991), the minute blood volume (MBV) at the age of 13-20 years changes slightly, at 12 years it ranges from 2.9 to 5.3 L × min^{-1} with individual variations; at 14 years - from 3.7 to 5.7 L × min^{-1}; at 16 years - from 3.4 to 6.7 L × min^{-1}. At 20-30 years of age, it averages 4.6 L × min^{-1} (3.5 to 5.4 L × min^{-1}) [19, 21]. By the age of 16-18 years, the blood pressure of girls and young men is practically the same as that of adult women and men [21]. The author emphasizes that the age-related increase of the MBV is associated with the need to meet the body oxygen demand.

It is known that the BOC (blood oxygen capacity) plays a major role in meeting the body oxygen demand due to the amount of hemoglobin, which transports oxygen in the form of oxyhemoglobin (HbO_2). According to the results of studies, girls have a lower BOC compared to boys due to a lower number of erythrocytes and, consequently, a lower hemoglobin concentration. For similar reasons, men have a higher BOC than women due to the fact that androgens, and testosterone, in particular, stimulate erythropoiesis [15, 20].

The maturation of the internal secretion glands in adolescence changes the endocrine profile of the adolescent body, especially sex hormones, which at this age significantly alter the metabolism, leading to pronounced changes in anthropometric and functional indices of the adolescent, largely determining the work capacity of the growing body. Differences in the physical work capacity of boys and girls become more expressed [9, 21].

In the process of training and competitive loads, changes in the body system functions are caused both by the nature of physical loads and the adaptive capacities of the growing body. At the same time, the character of the adaptation responses to a particular muscle load depends on the fitness of the adolescent body to the suggested physical load [9, 10, 22].

The linear skeletal growth and muscle mass tend to increase at the beginning of puberty under the influence of hor-

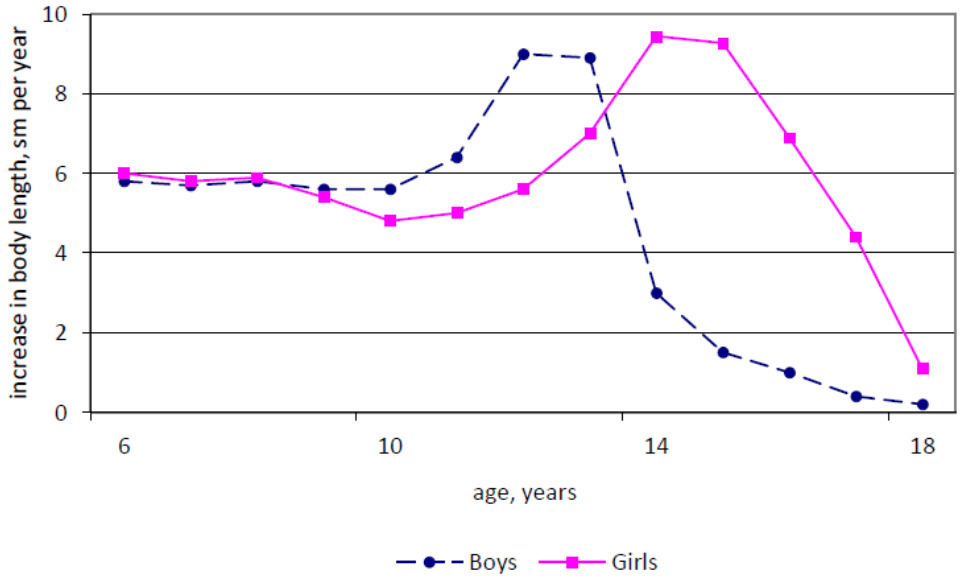

Figure 2. The pubertal growth spurt of indices during puberty [17, 18]

monal rearrangements, especially sex steroids (Fig. 3) [5].

By the age of 12, the development of the peripheral innervation of the skeletal muscles is completed. From the age of 13, the total muscle mass increases rapidly in boys, while in girls this increase occurs two years earlier [22]. Muscle strength reaches its maximum 1.0-1.5 years after the pubertal growth spurt.

There is a concept of "physiological maturity". "Physiological maturity is the correspondence of physiological age to chronological age; physiological immaturity is a retarded discrepancy of physiological age to chronological age" [23].

According to O.O. Lagoda (2005), the specifics of body development during the puberty period, its morphological, functional, sex differences should be the basis for planning the training load corresponding to the functional capacities of the growing body [4, 22].

The author Lagoda O., Makarova N., Loktev S., (2005) presents a general characteristic of the body during the puberty period:

· high level of excitability, increased reactivity;

· relative weakness of internal inhibition;

· relatively low functional capacities of the circulatory system, still imperfect mechanisms of its biological regulation;

· insufficiently economical energy supply of functions;

· low (as compared to adult body) capacities of meeting the oxygen demand, a low level of maximum oxygen consumption, and shorter time of its retention;

· lower ability to perform work in anaerobic conditions;

· more pronounced changes in vegetative functions during physical exertion;

· longer period of post-load recovery [4, 22].

Body functions are especially unstable from 11 to 15 years, during puberty, which requires great caution and an individual approach in planning training and competitive loads.

In the course of research, it was established that hormonal changes in the body of young female athletes, having a cyclical nature, affect the manifestation of not only general physical qualities, but also the level of special preparation. In athletes with constant menstrual function and in girls without it, but with cyclical changes in the body's estrogen saturation, the specific work capacity changed in accordance with the concentration of estrogens and phases of the menstrual cycle (Table 1).

In the process of motor activity, the musculoskeletal system (MSS) is conditionally the "major" body functional system with all vegetative (internal) systems, according to Folbort

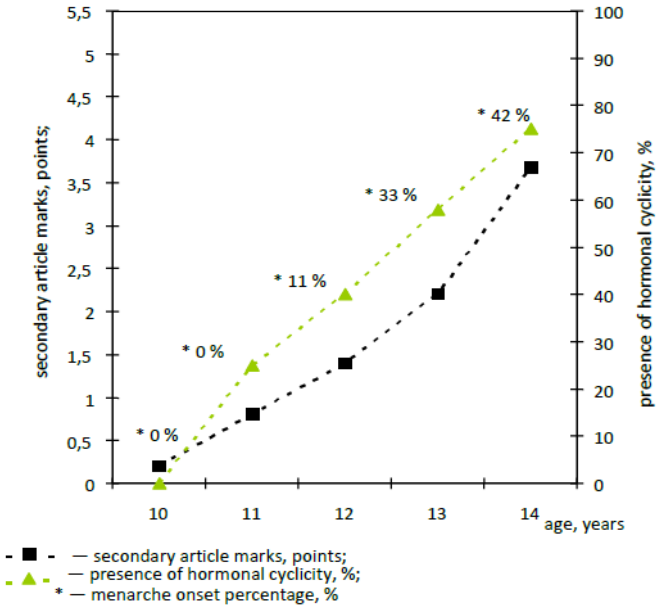

Figure 3. The development of secondary sexual characteristics, the presence of hormonal cycles and the age of menarche for young basketball players (girls) [5]

Table 1. Results of pedagogical testing of young basketball players (age 11-12 years old, n=13) [5]

Tests	Body's estrogen saturation/the menstrual cycle` phases	Mean	SD	p-value
Test 1. Variable speed running (98 м), s	low (−)/menstrual	17,22	0,009	< 0.05
	high (++)/postmenstrual	16,35	0,024	
	low (+++)/ovulatory	16,59	0,038	
	middle ((+)+)/postovulatory	16,41	0,010	
	low/(+) premenstrual	17,09	0,079	
Test 2. Driving the ball around the perimeter of the basketball three-second zone, s	low (−)/menstrual	4,09	0,012	< 0.05
	high (++)/postmenstrual	3,93	0,036	
	low (+++)/ovulatory	3,97	0,013	
	middle ((+)+)/postovulatory	3,86	0,031	
	low/(+) premenstrual	4,01	0,013	
Test 3. Making 15 throws into the basket, three shots each from five points from a distance of 4.5 m, the number of hits	low (−)/menstrual	9,00	0,55	< 0.05
	high (++)/postmenstrual	10,00	0,51	
	low (+++)/ovulatory	8,00	0,48	
	middle ((+)+)/postovulatory	10,00	0,50	
	low/(+) premenstrual	8,00	0,58	

Y. (1962) being the "serving" system and providing an optimal state of the body under certain physical loads to achieve the final adaptive result [24]. Already in the works of the famous physiologist M.R. Mogendovich it was shown that during motor activity the proprioceptors of the musculoskeletal system send impulses through the afferent neurons to the central nervous system, from where they irradiate to all internal systems of the body through the emerging nerve efferent pathways to internal organs (cardiovascular system, respiratory system, blood system, bile-excreting system, etc.) [24].

As a result, motor and visceral reflexes are formed, which explain the training effect of physical loads both on the MSS and all internal systems of the body, increasing the adaptive capacities of each functional system and the body as a whole [24]. It should be noted that recovery processes occur more intensively in the MSS in comparison with the "serving" systems that, according to Putilin N., Folbort G. (1975), control of steady recovery processes should be carried out not only in "main", but the "serving" systems as well, as far as the suggested mode of physical loads, which is training for the "major" functional system, can cause overfatigue of other systems [25].

Modern elite sport has "... an enormous educational influence on the younger generation, a significant part of which aspires to be like their sports idols. First of all, it refers to a huge number of young people actively engaged in sports in children's sports schools, sports groups of schools and universities, sports boarding schools and schools of the Olympic reserve" [26].

The idea of the Youth Olympic Games originated in 1998 and belonged to Johann Rosenzopf, an Austrian sales, and supply specialist. It was a response to concerns about the obesity prevalence among children and the increasing number of adolescents who quit the sport, especially in developed countries [27]. In addition, according to Johann Rosenzopf, several schools have begun to exclude sports and physical education from their curricula in the pursuit of academic achievement.

On July 6, 2007, at the 119th session of the IOC, held in Guatemala, the IOC members unanimously approved the "Youth Olympic Games" project [26]. It was decided that the Summer Youth Olympic Games will be held once every four years. All the attributes and rituals will be fully consistent with those of the "adult" Olympics. At the opening ceremony, the athlete and the judge of the organizing country make the Olympic oath like at the "adult" Olympics [28].

The IOC President Jacques Rogge's support of the project is largely due to the successful experience of the World Youth Games, as well as the European Youth Olympic Festivals since 1991, suggested by him at the time when he headed the European Olympic Committees (EOC), the continental organization of the national Olympic committees of the European countries [29].

Athletes compete in the 14-18 age categories, with age determined as of December 31 of the year of participation in the Games [27].

The first Summer Youth Olympic Games were held in Singapore on August 14-26, 2010, and attracted 3,600 athletes representing 205 countries.

The main objective of the Youth Olympic Games is the involvement of sports youth in the Olympic movement, its preparation for the complex psychological conditions of international starts, the selection of young talents to participate in the future Olympic Games (Table 2) [30].

In order to successfully prepare and conduct the I Summer Youth Olympic Games, a coordinating committee of the IOC was established, which was headed by Sergei Bubka, the IOC member, president of the NOC of Ukraine, Olympic champion, and world record holder in pole vaulting [26].

Peculiarities of the Youth Olympic Games:

· the program may include non-Olympic sports disciplines and events;

· records are not registered as the victories and skills of athletes are emphasized;

· participation of athletes in cultural and educational events, which are held along with the program of sports competitions, is mandatory [26].

Experts believe that the introduction of a cultural and educational program for the multifaceted development of young participants of the Youth Olympic Games is one of the most successful innovative projects of the International Olympic Committee.

In connection with the conduct and analysis of the results of Youth Olympic Games participants, questions about biological variability in youth sport began to arise among coaches and sports medicine specialists [31, 32]. Differences between the chronological and biological ages of adolescents between the ages of 11 and 16 began to be noticed more frequently. Specialists in sports medicine and coaches have concluded that the formation of competitive teams of children and adolescents according to chronological (passport) age sometimes leads to a discrepancy according to biological age. At the same time, more biologically mature adolescents get a greater advantage in achieving sports results [33]. The authors emphasize that in the initial multifaceted process of selecting promising athletes, indices of their physical development and sexual maturation are important.

As articulated earlier, at the beginning of the puberty period, under the influence of hormonal rearrangements, especially the increased concentration of sex steroids in the blood, muscle mass increases rapidly in boys from the age of 13, whereas in girls it occurs two years earlier [22]. Strength capacities reach their maximum values 1.0-1.5 years after the pubertal growth spurt.

It has been proven that during the period of menstrual cycle establishment, it is inadvisable to use heavy loads for

Table 2. Chronology of the Summer and Winter Youth Olympic Games

Summer games					Winter games				
No.	Year	Venue	Number of participants	Number of participating countries	No.	Year	Venue	Number of participants	Number of participating countries
I	2010	Singapore (Singapore)	3594	205	I	2012	Innsbruck (Austria)	1059	67
II	2014	Nanjing (China)	3600	201	II	2016	Lillehammer (Norway)	1000	71
III	2018	Buenos Aires (Argentina)	3998	206	III	2020	Lausanne (Switzerland)	1872	79

young female athletes, otherwise there will be a violation of forming a specific biological age [34].

It should be noted that physiological parameters in puberty age largely depend on the degree of sexual maturation therefore, when selecting young athletes, it is important to determine the level of sexual maturation of an adolescent, which largely determines his physiological and morphological characteristics, and, consequently, physical work capacity [9, 10].

A number of studies dealing with sports training of children and adolescents show that the motivation of the young athlete in the process of training sessions is important. Malina R.M. (2010) believes that fitness for a sports activity is a matter of time, requiring years of adaptation to loads of high intensity and volume as well as to stressful situations. The author believes that the current trends of early sports specialization, i.e., to start specialized training before reaching puberty increases the risk of injury and does not guarantee success [3].

Interesting, from our point of view, are the practical recommendations - the "coach's dozen"6 12 fundamental principles for "creating" young and healthy athletes [35].

Here are some of them:

· Young athletes are not adults in miniature. Therefore, no matter how big, strong, and coordinated young athletes are, coaches must understand that they are still in a stage of growth, development, and maturation. The training philosophy of adult sports (e.g., "no pain, no gain") should not be imposed upon them.

· Avoid sports specialization until puberty age. Children's engagement in several sports events probably reduces the risk of musculoskeletal disorders, to which they are more susceptible in the case of early sports specialization [36].

· Increase of physical literacy. In a young athlete, fundamental skills need to be improved earlier than athletic ones.

· It is better to undertrain than overtrain.

Optimally planned loads in the training process for young athletes of any age and participation in competitions will ensure full-fledged development throughout their athletic careers.

· Accentuating positive education. Public praise of young athletes for performing an element or exercise can increase their confidence in their abilities, improve the quality of the training session, and increase motivation to overcome difficulties in sports training.

· Maximization of the recovery process. The coach should explain to the young athlete and regularly emphasize the importance of optimal recovery and its components (nutrition, sleep). The principle "the more, the better" is incorrect and can cause injury, illness, and "burnout.

· Establishment of continuous coach-athlete communication. Successful coaches of young athletes know how to listen to their students and understand their individual needs, abilities, and individual peculiarities.

· Never stop learning. Constant enhancement of coach professional skills is the foundation of an athlete's long-term development. By deepening his knowledge of the art and science of the training process of children, the coach increases the opportunity to discover his potential in designing training sessions with account for the chronological and functional age, and sports experience of each athlete [37].

Despite the results of numerous studies indicating that sports achievements in early childhood are not a reliable prognostic factor of future success in chosen sports events, many parents encourage early specialization of their children [38, 39].

The authors emphasize that parents can cause high levels of stress and anxiety in young athletes. They can unintentionally "program" a child to fail by setting unrealistic goals and forcing them to engage in sports regardless of their functional fitness and interest. A child who is unable to show the results expected by parents may lose faith in his or her abilities and quit the sport altogether [40].

With regard to the psychological state of young highly skilled athletes, according to Capranica L., Millard-Stafford M.L. [41], it is necessary to pay close attention to the study of their mental tension - stress - to determine the optimal rest intervals while recovering between competitions during such championships as the Youth Olympic Games [42]. Observing the participants of the European Youth Olympic Festival 2007 in Belgrade, Kristiansen E. and Roberts G.C. [43] noted the influence of competitive stressors, conditioned by the competition scale and significance. The authors identified a number of organizational stressors - conditions and character of accommodation, food, travel to the competition venue. The listed stressors have a negative impact on the state of young athletes and should be taken into account by the Organizing Committee and the NOC in planning and preparing for the next Youth Olympic Games.

The winning results are somehow determined by the athlete's age, which, contrary to many prevailing concepts of age most suitable for sports training, may be the fourth decade of life for female athletes [44].

Conclusion

Optimal loads for adolescents have a favorable effect on the growth and development of the growing body and the improvement of sports results.

Coaches should not force the sports preparation of the young athlete, who should enjoy the training sessions. During the period of establishment of the menstrual function, it is not advisable to apply heavy loads that will interfere with the formation of the menstrual cycle.

In sports preparation of children and adolescents, contact between the coach and parents is extremely important, since unreasonable demands of the coach and high expectations of the parents are often the reason why the young athlete quits sports.

A mismatch between physical loads and the functional capacity of the child's body, an insufficient interval of post-load recovery, unbalanced nutrition are the main causes of chronic physical overstrain of the functions of the growing body systems and, in particular, sports injuries.

Conflict of interest. The authors declare no conflict of interest.

References

1. Donna L. Merkel. Youth sport: positive and negative impact on young athletes. *Journal Sports Medicine*. 2013; 4: 151–160. https://doi.org/10.2147/OAJSM.S33556
2. Breunner C.C. Avoidance of burnout in the young athlete. *Pediatr Ann.* 2012; 4: 335–339. https://doi.org/10.3928/00904481-20120727-14
3. Malina R.M. Early sport specialization: roots, effectiveness, rísks. *Current Sport Medicine Report.* 2010; 9 (6): 364–371. https://doi.org/10.1249/JSR.0b013e3181fe3166
4. Lagoda O.O. Organization peculiarities of physical culture and sports engagement during childhood and adolescence. Medical guide for coach. 2005; 177–195.
5. Shakhlina, L.G., Maslova, O.V. Medical and biological

bases of the training system of young athletes. Scientific journal [National Pedagogical University named after MP Drahomanov]. Series 15: Scientific and pedagogical problems of physical culture (physical culture and sport). 2015; (11): 173-177.
6. Polyaev B.A., Polyakov S.D., Loktev S.A. Peculiarities of medico-biological support of children and youth sport. Sports medicine: national guide. 2012; 332–381.
7. Sharapova O.V. Adolescents' health. Guide for physicians. 2007; p. 436.
8. Shakhlina L.Y.-G., Kogan B.G., Tereshchenko T.A., Tishchenko V.P., Futorny S.M. Sports medicine. Textbook for students of physical education and sports institutions. 2016; *Kyiv*: Science thought, 151–173.
9. Shakhlina L.Y.-H., Kohan B.H., TereshchenkoT.O. Tishchenko V.P., Futorny S.M. Sports medicine. Textbook for students of physical education and sports institutions. 2018; *Kyiv*: Olympic Literature, 142–162.
10. Solodkov A.S., Sologub E.B. Human physiology. General. Sports. Age-related: Textbook. 2008; 198–237; 435–444.
11. Gurkin S.A. Gynecology of adolescents / Guide for physicians. 2000; 9–50.
12. Levina L.I., Kulikov A.M. Adolescent medicine. Guide. 2006; 26–32, 486–498.
13. Tikhvinsky S.B., Kgrushchev S.V. Children's sports medicine. 1991; p. 559.
14. Maslova, O., Gopey, M. Justification of the need to develop innovative technologies to optimize the process of physical education of children with hearing impairments. *Theory and methods of physical education and sports*. 2017; 3: 78-85.
15. Shakhlina L.Y.-G. Medico-biological bases of female sports training. *Kyiv*: Science thought. 2001; p. 325.
16. Shardin S.A. Sex, age and diseases. Introduction in inflogenitology. 1994; p. 171.
17. Chtetsov V.L. Human body composition and constitution. *Human morphology*. 1990; 45–107.
18. Nikityuk B.A. Human constitution. *Outcomes of science and technics*. 1991; 4: 152.
19. Mishchenko V.S. Respiration change in adolescents and youth under the impact of athletic training: author's abstract for Ph. D. in Biology. *Kyiv*. 1969; p. 24
20. Kolchinskaya A.Z. Oxygen regimes of children and adolescent bodies. *Kyiv:* Naukova dumka. 1973; p. 320.
21. Kolchinskaya A.Z. Oxygen, physical state, work capacity. *Kyiv*: Naukova dumka. 1991; p. 208.
22. Makarova G.A. Guide of children's sports physician. Clinical aspects. 2008; 9–17.
23. Arshavsky I.A. Physiological mechanisms and regularities of individual development. 1982; p. 270.
24. Folbort G.V. Selected works. *Kyiv:* Health. 1962; 40.
25. Putilin N.I. Folbort G.V. *Kyiv*: Health. 1975; p. 69.
26. Platonov V.N. Olympic sport – *Kyiv:* Olympic Literature. 2009; 2: 194–197, 561.
27. International Olympic Committee. Factsheet Youth Olympic Games. 2009. *International Olympic Committee. Internet resource.* the access mode: *https://stillmed.olympic.org/Documents/Reference_documents_Factsheets/YOG-Facts_and_Figures.pdf*
28. Summer Youth Olympic Games Nanjing 2014. *Internet resource.* the access mode: https://olympics.com.nanjung.2014.
29. Olympic Games. *Internet resource.* the access mode: https://olympics.com;olympic-games.
30. International Ski and Snowboard Federation. FIS in favor of Youth Olympic Games. *International Ski and Snowboard Federation.* 2017; 102. *Internet resource.* the access mode: https://assets.fis-ski.com/image/upload/fis-prod/assets/Gangwon2024_QS_FIS_SJP_v01.2.pdf
31. Carling C., Le Gall F., Malina R.M. Body size, skeletal maturity and functional characteristics of elite academy players on entry between 1992 and 2003. *Journal Sports Science.* 2011; 1–11. https://doi.org/10.1080/02640414.2011.637950
32. Malina R.M. Skeletal age and age verification in youth sport. *Sports Medicine*. 2011; 41: 925–947. https://doi.org/10.2165/11590300-000000000-00000
33. Carios E.B. Goncalves, Luis M.L. Rama and António B. Figueiredo. Talent Identification and Specialization in Sport. *International Journal of Sports Physiology and Perfomance*. 2012; 7: 390–393. https://doi.org/10.1123/ijspp.7.4.390
34. Mulyk, V. Modern aspect of formation of training process of female sportsmen. *Slobozhanskyi Herald of Science and Sport*. 2016; (5(55): 57–62. https://doi.org/10.15391/snsv.2016-5.010
35. Faigenbaum, O.D., Meadors, L. A coaches Dozen: 12 FUIY damental Principles for Building Goung and Healthy Atletes. *Finish First Sport Performance.* 2010; 89. https://doi.org/10.1519/SSC.0000000000000282
36. Auvinen J., Tammelin T., Taimela S., Zitting P., Mutanen P., Karppinen J. Musculoskeletal pains in relation to different sport and exercise activities in youth. *Med. Sci. Sports Exercise.* 2008; 40: 1890–1900. https://doi.org/10.1249/MSS.0b013e31818047a2
37. Rowland T. Childreńs Exercise Physiology. *Champaign, IL*: Human Kineties. 2007; 21–42.
38. Callender S.S. The early specialization of youth Sports. *Athletic Training and Sports Health Care.* 2010; 2: 255–257. https://doi.org/10.3928/19425864-20101029-03
39. Goncalves C.E.B., Rama L.M.L, Figueriredo A.B. Talent identification and specialization in Sport: an overview of some unanswered questions. *International Journal of Sports Physiology and Perfomance*. 2012; 7: 255–257. https://doi.org/10.1123/ijspp.7.4.390
40. Gould D., Wilson C., Tuffey S., Lochbaum M. Stress and the young athlete: the child's perspective. *Pediatr Exercise Science*1993; 5: 286–297. https://doi.org/10.1123/pes.5.3.286
41. Capranica L., Millard-Stafford M.L. Youth sport specialization: how to manage competition and training? *International Journal of Sports Physiology and Perfomance*. 2011; 6: 572–579. https://doi.org/10.1123/ijspp.6.4.572
42. Youth Olympic Games. *International Olympic Committee*. 2014; 28. https://stillmed.olympic.org/media/Document%20Library/OlympicOrg/Games/YOG/Summer-YOG/YOG-Nanjing-2014-Youth-Olympic-Games/Official-Report-Nanjing-2014.pdf
43. Kristiansen E., Roberts G.C. Young elite athletes and social support: coping with competitive and organizational stress in "Olimpic" competition. *Journal Medical Science Sport*. 2010; 20: 686–695. https://doi.org/10.1111/j.1600-0838.2009.00950.x
44. Morys M., Socha T., Borysiuk Z. Analysis of the age of the world elite women fencers. *Movement and health*. 2006; 388.

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