Original Article

Physiological characteristics of pubertal schoolchildren with chronic diseases

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Abstract
        During the three academic years, we studied differences and similar trends in the display of physiological characteristics between the same girls as well as the same boys with the chronic cardiovascular system and the musculoskeletal system diseases. During the three academic years, we studied the physiological characteristics of the same 122 girls, 114 boys with the chronic cardiovascular system diseases, and 120 girls, 102 boys with the chronic musculoskeletal system diseases. At the beginning of our study, the age of all children was in the range from 10 years and 9 months to 11 years and 2 months. The biggest differences in girls' groups are established at age 12-13, in boys' groups - at age 11-12. All girls and boys had the functional state of the cardiovascular system and the readiness of the organism for load at the level of the "poor functional condition"; in some cases girls with the cardiovascular system diseases and girls with the musculoskeletal system diseases, as well as boys, although had differed (from p <0.05 to p <0.001) but low values; the blood pressure of all children was within the age norm. Peculiarities of the physiological characteristics display, which we established for schoolchildren with the stated diseases, must be taken into account during physical activity. It is advisable to develop levels of display of such characteristics, considering the disease, sex, and age of the adolescent. Using these levels as a guide for their achievement will increase the motivation of adolescents with chronic diseases to physical activity in their spare time.
Keywords: adolescents, chronic diseases, physiological characteristics, longitudinal research. .

Introduction
        According to the American College of Sport Medicine, at the beginning of studies in high school, 41% of American adolescents play video or computer games three or more hours daily, 32% - watch different TV programs; only 27% exercise daily for 60 minutes, and 29% - attend daily physical education classes (ACSM: Physical Activity in Children and Adolescents, 2017). Very similar is the result of adolescents with chronic diseases (Gontarev, Kalac, 2016; Iedynak, Mytskan, Galamandjuk, 2011; Jürimäe, 2017; Nemet, 2017; Takken, 2017). Thus, at age 15-17, the high level of daily physical activity is observed only for 40% of schoolchildren with chronic diseases and disorders, moderately active - for 30%, and the rest of 30% leads the sedentary way of life (Bar-Or, Rowland, 2004). Therefore, most of these adolescents have a decline of functional capacity, state of health, which leads to an even greater decrease in physical activity (Anneke, Stuart, 2017; Marcus, Williams, Dubbert, & Claytor, 2006; Rowlands, 2017).
        Fundamental studies show that physical activity can increase only if the individual has the proper motivation (D'isanto, Di Tore, 2016; Kipp, 2017; Roberts, Treasure, 2012). However, one of the leading factors in the hierarchy that determines the motivation of the individual is the assessment of his achievements (Deckers, 2016; Heckhausen, 2017). This is largely due to the fact that the assessment is characterized by several functions, including control, education and, important in our case, stimulation for activities (Ryan, Deci, 2016). In physical education, an assessment can perform the following functions only in the case of compliance with the requirements, which prescribe consistency, differentiated and individual character, objectivity, versatility (Mazur, Iedynak, 2014; Roberts, Treasure, 2012). In this regard, issues related to the periodic study of a complex of different characteristics of girls, as well as boys with certain disease or disorder, are actualized. It is entirely related to physiological characteristics, as they are crucial for the dosage of physical activity, the development of physical activity programs for children with chronic diseases and disorders (Bar-Or, Rowland, 2004). The value of such characteristics can and should be used as a guide for their further achievements, as it will enhance the motivation of children to systematic physical activity (Iedynak, Galamandjuk, Ivashchenko, & Sliusarchuk,

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2017). However, data on the physiological characteristics of pubertal girls and boys with a certain chronic disease is close to nonexistent (Mazur, 2013). This fact predetermines the need for such studies.

Material and methods

Participants. The study involved 242 girls and 216 boys, 122 and 114 of whom respectively had chronic cardiovascular system diseases, 120 and 102 - chronic musculoskeletal system diseases. Information about the disease we have received from the medical school employee. The age of girls and boys at the beginning of the study was in the range from 10 years and 9 months to 11 years and 2 months. The research was conducted in compliance with the World Medicine Association declaration of Helsinki: Ethical principles for medical research involving human subjects, 2013. The study protocol was approved by the Ethical committee of the Kamianets-Podilsky Ivan Ohienko national university.

Procedures. Physiological characteristics were studied at the beginning of each of the three academic years of the 2014/17 period. We used well-known functional tests recommended by American College of Sport Medicine (2017), Eurofit (1993), and researchers such as Bar-Or, Rowland (2004), Machado-Rodrigues, Coelho-e-Silva (2014), Mazur, Iedynak (2014), Riner, Sellhorst (2013), Svietlova, Kovalenko, Rybalko (2016) and others. Specifically, we determined: blood pressure (systolic - SBP and diastolic - DBP); heart rate (HR); vital capacity (VC); Ruffier test index (RTI); Robinson index (RI = SBP x HR / 100); Vital capacity index (VCI = VC / body mass) and maximum isometric strength index (IMIS = maximum isometric strength / body mass). Initially we got permission to participate in the study from each child and his/her parents. During the tests we performed all the necessary requirements. We used certified equipment: to determine the blood pressure - Santamedical Adult Deluxe Aneroid Sphygmomanometer, to determine the IMIS - handgrip Camry dynamometer, to determine the VCI - NDD EasyOne Plus System 2000-2 spirometer. Quantitative values of physiological characteristics in the groups of girls and boys in each age group of 11-14 years were used as data. We established the presence or absence of divergence in the values of each characteristic under study separately for girls and boys.

Data analysis. All statistical analyses were performed using SPSS Version 21; for each characteristic, we determined the mean value, standard deviations, Student's t-test for unpaired samples. The 0.05, 0.01, 0.001 levels of probability were used to indicate statistical significance.

Results

For girls with the cardiovascular system and musculoskeletal system diseases we revealed physiological characteristics with the differed values. At age 11 SBP was 106.9 ± 0.97 and 103.1 ± 0.91 mmHg respectively (t = 2.86; p <0.01), DBP - 64.8 ± 0.91 та 60.9 ± 1.04 mmHg (t = 2.82; p <0.01). For children at age 12, we found divergences in the values of other physiological characteristics. HR of girls with the cardiovascular system diseases was 78.9 ± 0.96 bpm, girls with the musculoskeletal system diseases - 76.1 ± 0.46 bpm (t = 2.63; p <0.01), HR after performing the metered load in the Ruffier test was respectively 125.7 ± 0.84 and 125.7 ± 0.84 bpm (t = 3.95; p <0.001), HR at the end of the first rest minute - 95.1 ± 1.02 and 89.1 ± 0.73 bpm (t = 4.8; p <0.001). Regarding the functional state of the cardiovascular system and the readiness of the organism for load, then by the value of RTI for girls with the cardiovascular system and musculoskeletal system diseases, this characteristic corresponded to the average functional condition, since the values were 9.9 ± 0.06 and 9.5 ± 0.09 respectively (t = 3.64; p <0.001).

At age 13, SBP and DBP of girls with cardiovascular system diseases were 115.4 ± 0.89 and 71.4 ± 1.03 mmHg respectively. This was significantly higher than for girls with musculoskeletal system diseases, since their SBP was 110.7 ± 0.85 mmHg (t = 3.98; p <0.001), and DBP was 65.8 ± 1.01 mmHg (t = 3.89; p <0.001). However, the latter had heart work load (according to the RI) within the range of 98.8 ± 0.81, for girls with the cardiovascular system diseases it was within 95.5 ± 0.79. The value of RI in both cases indicated a poor functional condition, but for girls with the musculoskeletal system diseases the tendency was less adequate than in the other group, because t= 2.92 (p <0.01).

At age 14, the number of physiological characteristics with differed values was somewhat lower than at age 13. In particular, we relegated to such characteristics SBP, DBP, and VC. However, all the values of girls with the cardiovascular system diseases were higher than girls with the musculoskeletal system diseases. Thus, SBP was respectively 112.8 ± 1.03 and 107.7 ± 1.08 mmHg (t = 3.42; p <0.001), DBP - 70.5 ± 1.1 and 64.9 ± 1.17 mmHg (t = 3.48; p <0.001), and the values of VC - 2100.6 ± 21.4 and 1985.4 ± 26.3 cm^3 (t = 3.38; p <0.001).

A similar result was obtained for boys, with the exception of the features that were associated with the ranges of the values, and tendencies of the characteristics under study display. Thus, at age 11, boys with cardiovascular system and musculoskeletal system diseases had only SBP (108.1 ± 0.91 and 103.8 ± 0.81 mmHg respectively, t = 4.34; p <0.001) and DBP (63.3 ± 0.89 and 59.3 ± 1.02 mmHg, t = 2.99; p <0.01) values that differed significantly.

At age 12, the result was somewhat different: the values of the five characteristics differed significantly, moreover at least in three of them, they were in favor of boys with the cardiovascular system diseases. Thus, their SBP was 114.1 ± 1.07 mmHg, whereas for boys with the musculoskeletal system diseases it was 108.7 ±

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1.12 (t = 3.48; p <0.001) and DBP was 64.7 ± 0.89 and 59.9 ± 0.74 mmHg respectively (t = 4.14; p <0.001). The HR of the latter was at the level of 81.4 ± 0.74 bpm, whereas for boys with cardiovascular system diseases this value was significantly better, since it was 78.9 ± 0.75 bpm (t = 2.38; p <0.05), HR after performing the dosage loading - 126.4 ± 0.91 and 123.1 ± 0.91 bpm (t = 2.7; p <0.01). As for the heart work load, then due to the RI value for boys with cardiovascular system diseases (95.1 ± 0.76) this characteristic corresponded to the level of "poor functional condition". As for the boys with the musculoskeletal system diseases their heart workload was also at the level of "poor functional condition" (RI = 101.4 ± 1.11), but the tendency to reveal the value was significantly worse than that of boys with the cardiovascular system diseases (t = 4.67; p <0.001).

At age 13, the result was the opposite, as the physiological characteristics, the values of which differed significantly in the experimental groups, were better for boys with the musculoskeletal system diseases. Thus, their HR was 75.1 ± 0.81 bpm, for boys with cardiovascular system diseases it was 78.9 ± 0.93 bpm (t = 3.09; p <0.01), HR after performing the dosage loading was respectively 122.8 ± 0.72 and 126.6 ± 0.84 bpm (t = 3.42; p <0.001). As for the heart workload, the value of RI indicated a level of "poor functional condition" in both groups, but for boys with cardiovascular system diseases the tendency was significantly worse than for boys with musculoskeletal system diseases: the RI value was respectively 93.8 ± 0.92 and 90.2 ± 0.76 (t = 3.03; p <0.01).

At age 14, the result was different, since the values of all characteristics under study, with the exception of DBP were almost identical in the experimental groups. Concerning DBP, then for the boys with the cardiovascular system diseases this value was 68.9 ± 1.05 mmHg, whereas for the boys with the musculoskeletal system diseases - 72.8 ± 0.81 mmHg (t = 2.93; p <0.01).

Discussion

The results obtained were predetermined by a set of causes. Thus, the most cases when the values in experimental groups of girls and boys differed significantly (from p <0.05 to p <0.001) were related to SBP and DBP. But such differences could indicate the peculiarities of the arterial pressure display in case of the cardiovascular system or musculoskeletal system diseases at a certain age of 11-14 years period only to a certain extent. In all cases, SBP and DBP values were within the limits defined by scientists as age norm (Bar-Or, Rowland, 2004; Takken, 2017; Winnick, Porretta, 2017).

We also found out in all experimental groups that the functional state of the cardiovascular system and the readiness of organism for load are at the level of "poor functional condition". To a large extent, this result was due to the fact that only a small number of pubertal schoolchildren with chronic diseases systematically exercising in physical activity (Iedynak, Mytskan, Galamandjuk, 2011; Jürimäe, 2017; Mazur, Iedynak, 2014). This causes hypoactivity, which is one of the leading factors of chronic diseases of adolescents, primarily cardiovascular system diseases and obesity (Gontarev, Kalac, 2016; Nemet, 2017). Low activity causes the further health decline, lowering of conditions, functional abilities of adolescents with already existing chronic diseases (Iedynak, 2007; Rowlands, 2017; Takken, 2017). That is to say, a vicious cycle is formed: a chronic disease causes a hypoactivity, which negatively affects the state of health, the existing conditions and functional capabilities; such situation leads to a further decrease in the physical activity of the adolescent (Anneke, Stuart, 2017; Tsos, Sushchenko, Bielikova, Indyka, 2016).

Besides, it was found out that the results of the study are consistent with the results obtained five years earlier in the same region of the country. These results also related to the physiological characteristics of girls and boys at age 10-14 with the cardiovascular system and musculoskeletal system diseases (Mazur, 2013). Comparing the data, we found no differences in the values of the characteristics, except for individual cases. Above all, the latter concerned SBP and DBP, but all values were within the age norm. This shows the possibility to use the data of both studies, so that to improve the reliability of determining the levels of display of physiological characteristics. Such levels can be used by an adolescent as a guide for self-improvement in the process of physical activity. The feasibility of their usage is conditioned by the fact that the activity assessment is an effective factor in motivating adolescents to improve their results (Deckers, 2016; Heckhausen, 2017), in particular during physical activity (Roberts, Treasure, 2012). The increase of the latter contributes to the elimination of hypoactivity, which in turn creates favorable conditions for the improvement of physiological characteristics (Delas, Lafreničre, & Martin-Krumm, 2017).

Conclusions

In connection with the cardiovascular system and musculoskeletal system diseases and low activity, the physiological characteristics of such girls and boys correspond to the level of "poor functional condition". The exception is SBP and DBP, the values of which are within the age norm at every age of 11-14 years period. The defined peculiarities should be taken into account during the implementation of physical activity for such schoolchildren. Simultaneously, the data obtained allow to determine the levels of display of physiological characteristics, taking into consideration the disease, sex and age of the adolescent. The usage of such levels as a guide for advancing opportunities will strengthen his/her motivation to more frequent and systematic use of physical activity in a spare time.

Conflicts of interest

No conflicts of interest exist.

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