

Factors that influence somatic health of 10-11-year-old schoolchildren at the beginning and end of an academic year

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Abstract:

Purpose: to determine main factors, which influence of school age boys' somatic health at the beginning and at the end of academic year. Material: In the research 140 boys of 10 yrs age (n=70) and 11 years (n=70) participated. All participants had no health problems. Results: analysis of twenty indicators showed the most significant indicators, which determine factorial structure of schoolchildren's somatic health. Weakening of somatic health is accompanied by noticeable reduction of heart beats rate, blood pressure, mental and physical workability, mental accuracy, indices of Rouffiet and Robinson. Conclusions: the least changes and influence on total dispersion at the beginning and at the end of academic year have the following indicators: body length and weight; vital capacity of lungs; life index and flexibility. Substantial increase of not organized factors at the end of academic year can be explained by increasing influence of indefinite factors. It results from mental load at this stage of learning process.

Key words: boys, factors, health, workability, somatic.

Introduction

Schoolchildren's somatic health depends on many factors, which can both: positively influence on pupils and be a significant threat with negative after effects. It was found that 17.5% of pupils complain on organism's functional disorders [Khokhlova, Bondar', & Sutula, 2010]. It was also found that long term sitting is a risk factor for cardio-vascular diseases (CVD) [Hamilton et al., 2008; Bliznevsky et al., 2016]. Scientists determined four factors of backbone pains in adolescents [Steinberg, & Morris, 2001; Kristjansdottir, & Rhee, 2002; Nosko, Razumeyko, Iermakov, & Yermakova, 2016]. They are: age, fatigue because of heavy satchel, eating and absence of parents support. It was determined that in educational establishments of new type, among hygienic factors teaching process's pressure plays important role [Grebniak, 2002].

Ling term usage of information-communication technologies causes strong emotions and results in cognitive fatigue [Marjut et al., 2010; Kudryavtsev, Kramida, & Iermakov, 2016]. It was proved that physical education differs depending on type of schools [Greenfield, Almond, Clarke, & Edwards, 2015], while increase of hours for mental disciplines at the account of physical education creates a threat for health [François, & Shephard, 2008]. Scientists found factorial structures of schoolchildren's functional and nosological state [Omel'chenko, 2011]; their adaptation for learning [Felsten, 2009; Samokish, 2010; Davydenko, & Bileckaia, 2011; Liasota, 2012]. Parameters of physical health for primary school children were obtained [Tiukh, 2007; Ivashchenko et al., 2016]. Risk factors in manifestation of gender distinctions in school were determined [Kratenová, Zejglicová, Malý, & Filipová, 2007; Andersson, 2010; Idowu, 2011] as well as negative mood [Jones et al., 2003; Emily, Manel, & Emmanuel, 2007; Solveig et al., 2014] and kidneys diseases and eating deficiency [Tatala, Kihamia, Kyungu, & Svanberg, 2008; Sáez-Torres et al., 2013]; puberty [Dorn, Dahl, Woodward, & Biro, 2006] and influence of sport loads [Iermakov et al., 2016; Kozina et al., 2016; Pryimakov et al., 2016]. Thus, the mentioned works are mainly devoted to general aspects of health.

Hypothesis: schoolchildren's health depends on morphological-functional indicators, which show reaction to intensification of general educational load in modern school.

The purpose of the works is to determine main factors, which influence of school age boys' somatic health at the beginning and at the end of academic year.

Material and methods

Participants: In the research 140 boys of 10 yrs age (n=70) and 11 years (n=70) participated. By their health all pupils were in main health group (having no health problem). For every pupil written consent from parents for their child's participation in the research was received. Besides, we received permission from administration of gymnasium (dt. 25.11.2016 № 354-A). The age of the tested was chosen intentionally, because this age is intermittent between primary and secondary schools. Just in this age pupils start to complain on health and feel discomfort in learning. From practical experience it was noticed that most of complaints are received from boys.

Procedure: the study was conducted on the base of recommendations on children's health testing [Kruceвич, 1999]. Somatic health was assessed by the following indicators: in relaxed state: vital capacity of lungs (VCL), blood pressure (BP), heart beats rate (HBR), body weight and length, hand strength. The Rouffiet's test was compulsory. For this purpose, after 5 minutes' rest we made first measurement of HBR (sitting during 15 seconds). The, during 45 seconds, pupil made 30 squats and immediately after it he took sitting position. After this, second HBR registration was fulfilled in first 15 seconds after load. The third HBR registration was made in the last 15 seconds of the first minute after load. Rouffiet's index was calculated by formula [Kruceвич, 1999]:

$$IR = [4(f_1 + f_2 + f_3) - 200] / 10,$$

Where f_1 is HBR of first registration; f_2 – HBR of second registration; f_3 – HBR of third registration.

Life index was determined by formula [Kruceвич, 1999]:

$$I = V/P, \text{ ml} \cdot \text{kg}^{-1},$$

Where V – vital capacity of lungs; P – body weight.

Index of strength was calculated by the following formula [Kruceвич, 1999]:

$$IS = (D/P) \times 100,$$

Where, D – hand dynamometry; P – body weight.

Robinson's index was calculated by the formula [Kruceвич, 1999]:

$$RI = (f_s \times A_s) / 100, \text{ conv.un.}$$

Where, f_s – HBR in relaxed state (beats per minute); A_s – systolic blood pressure (mm.merc. col.)

Determination of physical workability PWC_{170} was fulfilled with the help of steps. Their height was selected individually, depending on length of leg. Pupils fulfilled two loads, power of which was found by formula [Kruceвич, 1999]:

$$W = 1.3 \cdot P \cdot n \cdot h \text{ (kgm} \cdot \text{min}^{-1}\text{)},$$

Where, P – body weight (kg); h – height of step (cm); n – quantity of steps per one minute; 1.3 – coefficient, which consider the scope of work, when descending the steps. Pulse was calculated at the end of each load. Calculated was carried out by formula [Kruceвич, 1999]:

$$PWC_{170} = N_1 + (N_2 - N_1) \times [(170 - f_1) / (f_2 - f_1)],$$

Where, N_1 and N_2 – power of first and second loads; f_1 and f_2 – values of pulse.

Index of quickness was found by relation of 60 meters run quickness to body length.

Index of explosive power was found by relation of long jump from the spot result (cm) to body length (cm).

Mental workability was determined with the help of Bourdon's – Anfimov's correcting tests [Andronnikova, & Zaika, 2011]. The test implies crossing out of pre-set letters and shall be fulfilled in regime of overcoming of obstacles in movements (duration – five minutes). Pupil receives standard form of correcting test. By signal "go" pupil shall vertically mark every indicated letter of text. The task shall be fulfilled quickly and accurately. Besides, by signal "mark" pupils shall put vertical mark in the letter, in which he heard the signal. Then he shall continue the task up to the following signal. Signal "mark" sounds every 30 seconds. Since second and up to the end of fourth minute of the test operator provides obstacles: every 15 second he shouts letters of alphabet in random order. Thus, indicators of mental efficiency were determined. Indicator was calculated by formula:

$$E = N \cdot T \text{ [Andronnikova et al., 2011]},$$

Where, N – total number of crossed out symbols, T – accuracy of work.

$$T = (M - O) / (M + P) \text{ [Andronnikova et al., 2011]},$$

Where, M – total number of crossed out symbols, O – quantity of mistakes in crossed out symbols, P – quantity of omissions.

Statistical analysis: the received data were processed with mathematical statistic methods [Nachinskaia, 2005; Kamaev, & Proskurov, 2012; Proskurov, 2015, 2016]. Results were processed with the help of factorial analysis [Borovikov, 2003; Khalafian, 2007]. Factorial analysis permitted to compare two kinds of health condition, determined at two stages. The first stage permitted to determine actual health and its factors at the beginning of academic year (after long summer rest).

Results

On the base of analysis of pupils' functional, anthropometrical and physical indicators we found the most significant indicators, which determine factorial structure of boys' somatic health at the beginning and at the end of academic year. At the beginning of academic year 5.7% (4 pupils) of 10 yrs age with high somatic health indicators were registered and 25.7% (18 pupils) with low health level. At the end of academic year the quantity of pupils with low somatic health increased by 83.6% (47.2% - 33 pupils). It shows that pupils with high somatic health at the beginning of academic year could not retain it up to the end of academic year. At the beginning of academic year total dispersion was 64.72%, and at the end – 63.21%. Thus, by the end of academic year the quantity of not organized and not defined factors increased by 4.25%. Total dispersion was determined by four factors. The most important indicators of the first factor at the beginning of academic year were: body length ($r=0.753$) and body mass ($r=0.626$), heart beats rate – HBR ($r=0.526$). This factor was 21.31% from total dispersion (see fig. 1). At the end of academic year the volume of first factor was 19.3% (see fig. 2). Its significance was determined by body weight and length ($r=0.949$; 0.593), indicators of vital capacity of lungs and life index ($r=0.835$; 0.730). Contribution of second factor into total dispersion at the beginning of academic year was 17.64% (see fig. 1). This indicators was determined by indicators of physical and mental workability ($r=0.908$; 0.900); mental accuracy ($r=0.819$) and volume of heart ($r=0.818$). At the end of academic year the second factor was formed by the following indicators: index of explosive power ($r=0.483$); HBR ($r=0.775$); power index ($r=0.641$); systolic BP ($r=0.521$) and chest circumference ($r=0.484$). It was 15.16% from total dispersion (see fig. 2). The volume of third factor at the beginning of the research was 15.13% (see fig. 1). The following data were found: power index ($r=0.697$); maximal oxygen consumption ($r=0.685$); HBR ($r=0.682$); diastolic BP ($r=0.660$); Rouffiet's index ($r=0.557$) and Robinson's index ($r=0.546$). At the end of academic year the third factor was 14.55% from total dispersion (see fig. 2). Significant components of this factor were: diastolic BP ($r=0.859$); quickness ($r=0.765$); MOC ($r=0.711$); Robinson's index ($r=0.508$). By results of medical examination at the beginning of academic year contribution of forth factor in total dispersion was 10.64% (see fig. 1). It was determined by the following indicators: respiratory system; life index ($r=0.734$); VCL ($r=0.659$) and chest circumference ($r=0.549$). By the end of academic year the volume of forth factor was 14.2% (see fig. 2). The following data were determined: mental accuracy and efficiency ($r=0.813$; 0.746); physical workability and volume of heart ($r=0.758$; 0.748).

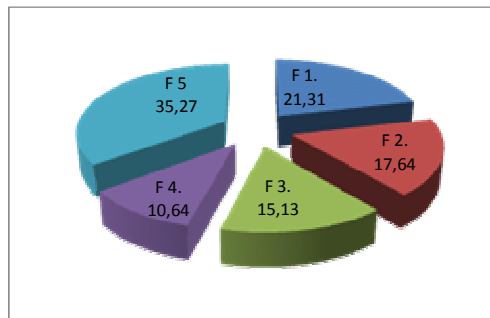


Fig. 1. Factorial structure of 10 yrs pupils' somatic health, physical and mental workability at the beginning of academic year. F1- first factor, F2- second factor, F3- third factor, F4- forth factor, F5- not considered factors.

At the end of academic year the quantity of 10 yrs pupils with low somatic health indicators increased (from 18 to 33). It is explained by weakening of influence on total dispersion of mental efficiency, accuracy and physical workability indicators. Increased mental fatigue and reduction of mental accuracy are also witnessed by increase of not organized, not considered factors. By the end of academic years they increased by 4.25%. Such changes can be explained by increase of mental load: Olympiads by disciplines, preparation for exams; increase of every teacher's requirements in respect to his/her discipline. It results in mental fatigue's progress.

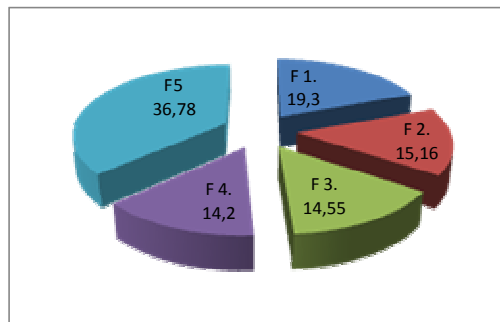


Fig. 2. Factorial structure of 10 yrs pupils' somatic health, physical and mental workability at the end of academic year. F1- first factor, F2- second factor, F3- third factor, F4- forth factor, F5- not considered factors.

At the beginning of academic year in group of 11 yrs boys we found 9 boys with high level of somatic health (12.8%) and 10 boys (14.3%) with low indicators. By the end of academic year the quantity of pupils with low somatic health increased four times (54.2% - 38 persons) and no pupil with high level of somatic health remained. Analysis of 4 groups of main factors for somatic health showed that general dispersion was 70.61% from total dispersion at the beginning of academic years and at the end – 65.73%. In this connection the quantity of not considered, not organized factors was 29.39% and 34.26%. Thus, by percentage, increase of not considered factors was 16.6%. The volume of first factor at the beginning of academic year was 19.33% (see fig. 3). We found the following: body weight and length indicators ($r=0.988$; 0.584); vital capacity of lungs (VCL) and life index ($r=0.834$; 0.687). At the end of academic year first factor was 21.65% from general dispersion (see fig. 4). The main components were: body length and weight ($r=0.738$; 0.696); chest circumference; VC: and life index ($r=0.593$; 0.555 ; 0.536); systolic and diastolic blood pressure ($r=0.556$; 0.514). Such increase of first factor indicators by 2.32% at the end of academic year is explained by more sensitive mobilization of cardio-vascular and respiratory systems, directed on sustaining health level.

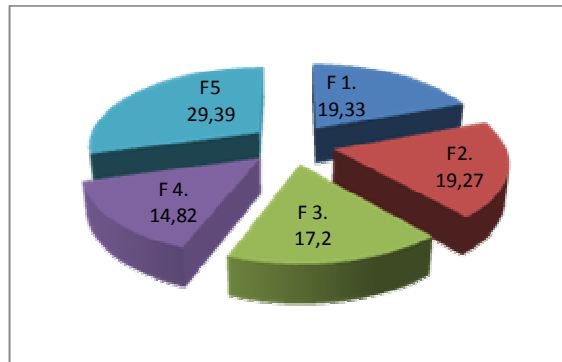


Fig. 3. Factorial structure of 11 yrs pupils' somatic health, physical and mental workability at the beginning of academic year. F1- first factor, F2- second factor, F3- third factor, F4- forth factor, F5- not considered factors.

At initial stage of 11 yrs pupils' testing the second factor was formed by the following indicators: mental accuracy ($r=0.814$); mental and physical workability ($r=0.627$; 0.555); systolic and diastolic blood pressure ($r=0.712$; 0.525). The volume of this factor was 19.27% from general dispersion (see fig. 3). It should also be noted that at the end of academic year significance of second factors was also determined by indicators: mental and physical workability and mental accuracy ($r=0.717$; 0.715 ; 0.614). Volume was 16.42% from total dispersion (see fig. 4). It is a reduction, comparing with the beginning of academic year. The third factor of 17.2% volume, at the beginning of academic year was determined by the following indicators: heart volume ($r=0.822$); heart beats rate (HBR) ($r=0.675$); chest circumference ($r=0.543$) and explosive power index ($r=0.751$) (see fig. 3). At the end of academic year the third factor took 14.21% from total dispersion (see fig. 4), composed by the following data: HBR ($r=0.742$); MOC ($r=0.586$); quickness ($r=0.563$); Robinson's index ($r=0.556$). The forth factor, which was 14.82% from total dispersion, was formed by the following indicators: MOC ($r=0.718$); power index ($r=0.658$); Rouffiet's index ($r=0.642$); Robinson's index ($r=0,516$) and quickness ($r=0.558$) (see fig. 3). At the end of academic year the forth factor took 13.45% from total dispersion and was determined by the following data: Explosive power index ($r=0.782$); power index ($r=0.597$); quickness ($r=0,562$) and Rouffiet's ($r=0.516$) (see fig. 4).

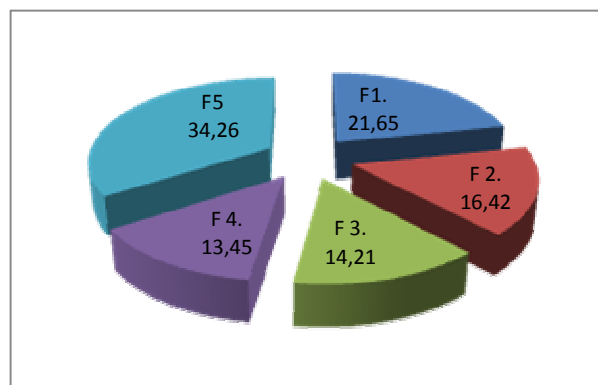


Fig. 4. Factorial structure of 11 yrs pupils' somatic health, physical and mental workability at the end of academic year. F1- first factor, F2- second factor, F3- third factor, F4- forth factor, F5- not considered factors.

Discussion

The data of factorial structures at the beginning and at the end of academic year show, that teaching pressure plays important role in worsening of pupils' health. It supplements and confirms the data of other works [Grebniak, 2002; Kristjansdottir, & Rhee, 2002; Marjut et al., 2010]. Increase of first factor indicator at the end of academic year in 11 yrs pupils is connected with mobilization of cardio-vascular and respiratory systems. In this connection percentage of factorial weight from total dispersion noticeably reduces. At the same time percentage of the factor itself increases. It confirms and expands the works [Hamilton et al., 2008; Khokhlova et al., 2010]. The authors found that the main factor of pupils' self feeling worsening was high mental load. Just this load forces organism to mobilize the required resources. In other work [Davydenko et al., 2011] changes after physical loads were studied in children's organisms. Substantial contribution to the first factor was made by anthropometrical indicators. The weight of other factors was determined by functional indicators. Main changes to the side of worsening took place in the following indicators: heart beats rate, blood pressure, mental and physical workability, mental accuracy, indices of Rouffiet and Robinson. We also found simultaneous change of mental and physical workability indicators. Factor 4 (10 yrs pupils) and factor 2 (11 yrs. pupils) supplement other researches [Liasota, 2012; Omel'chenko, 2011; Greenfield et al., 2015]. These authors found the following correlations: between motor functioning and adaptation to learning; between statistically significant and psychophysiological indicators. We found the tendency to health worsening in both ages during academic year. Our data supplement the data of other works [Tiukh, 2007; Samokish, 2010; Platonenko, 2013]. In our study we determined increment of not considered factors' weight in respect to total dispersion. It influences on indicators' change, which are components of other factors. It is witnessed by dynamic of factorial structures' changes in both ages. In 10 yrs. Pupils, at the beginning of academic year general dispersion was 64.72%, and at the end – 63.21%. The quantity of not considered, not organized factors at the beginning of academic year was 35.27% and at the end – 36.28%. In 11 yrs. pupils, at the beginning of academic year general dispersion was 70,61% from total dispersion and at the end – 65.73%. The quantity of not considered, not organized factors at the beginning of academic year was 29.39% and at the end – 34.26%. All these are evidences of educational loads' negative influence on pupils' somatic health.

Conclusions

The least changes and degree of influence on general dispersion at the beginning and at the end of academic year have the following indicators: body length and weight; vital capacity of lungs; life index and flexibility. These indicators form first factor at both stages of the research.

The most expressed somatic health worsening at the end of academic year is accompanied by noticeable reduction of the following indicators: heart beats rate, blood pressure, mental and physical workability, mental accuracy, indices of Rouffiet and Robinson.

Substantial increase of not organized factors' indicators at the end of academic year can be explained by increase of nor organized factors' influence. It results from high mental load at this stage of educational process.

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