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Original Article

Differentiated correction of attention abilities of students with chronic diseases during physical education

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Abstract
Purpose: To study experimentally the specifics of developing attention abilities of students with chronic diseases as affected by differentiated correction during physical education classes at a university. *Material:* During three academic years, the same students with chronic diseases participated in research into their attention abilities and the way they change under the influence of physical education. *Results:* An integrated final evaluation of the attention abilities parameters at the end of the experiment showed a tendency for the test results to improve. The students from the experimental group (EG) reached an average level. All indicators of the effectiveness of the proposed differentiated correction of the students' attention abilities due to physical education showed that the EG students demonstrated better results than the students from the control group (CG). Differentiated correction of the physical education program resulted in a significantly ($p<0.05$ to <0.001) higher result than that obtained after using a traditional approach of organization, formation and implementation of the physical education content. It has been established that the state of attention abilities of students with chronic diseases is affected by the nature of these diseases, and, therefore, has its essential specifics. *Conclusions:* The peculiarities of manifestation of attenuation abilities established in the students with certain chronic diseases should be taken into account during their physical education. The use of systematic control of the psychological and physiological functions of students during physical education is the reason for the appropriate correction of pedagogical actions and improvement of physical education (PE) programs, which will help ensure effectiveness of PE..
Key Words: students, physical education, chronic diseases, attention abilities, university.

Introduction

The dominant task of the transition to a new educational paradigm is to take care of the health of participants in the educational space. Thus, the quality of modern higher education is identified with the thorough preparation of able-bodied professionals, demonstrated by their good health and a high level of performance capacity (Anikieiev, 2015). Given that the state of students' health is one of the pressing problems of modern pedagogy, the issue of its preservation is relevant. This leads to a significant effort that is put into finding the best solutions.

The issue of improving health of young people cannot be considered outside the PE context, which takes the proper place in pedagogical theory and practice. In essence, as a function of general pedagogy, this is a technology of health care at higher school (Koryahin, et al., 2018). Unfortunately, the number of university students with chronic diseases is steadily increasing. This is a significant evidence of the deterioration of health among the intellectual potential of the country due to the inadequate state social policy. In the context of pedagogical support of such students, the search for the ways to increase their PE efficiency is particularly urgent. Historically, the effective PE of young people has been one of the priorities among the pedagogical problems (Anikieiev, 2015). Furthermore, this determines the need to address the problem of pedagogical control, which is explained by its theoretical and practical significance in ensuring the effectiveness of PE process.

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Largely, this is due to the fact that control is characterized by several functions, in particular, educational and stimulating (Adyrkhaiev, 2014). Control in physical education performs these functions only in case of its compliance with the requirements that are systematic, differentiated and individual in nature (Koryagin & Blavt, 2013). In this case, the control provides the regulation of pedagogical actions in the PE course, which is the basis of the effectiveness of this process. Therefore, issues related to the periodic study of the complex of different characteristics of students with chronic diseases during PE classes during their studies at the universities become relevant. This applies to the students' psychological and physiological functions as indicators of their health conditions (Adyrkhaiev, 2014).

The appropriate organization of psychological and physiological functions determines the quality of intellectual activity (Korobeinikov, 2002). The main factor that provides for the effectiveness of perception and processing of information is attention abilities. The development of attention abilities is considered from the position of the regulatory function (Andreassi, 2009), in terms of successful learning, ensuring its efficiency and further professional activity. The development of attention abilities of students is important throughout the educational process at higher school (Overton, et al., 2016). Performing psychological and pedagogical research in the field of physical education is essential today because the improvement and preservation of the health of participants in the educational space is a complex interdisciplinary scientific problem. Today, a systematic approach to study attention abilities, which involves the use of the techniques from related sciences, becomes increasingly widespread (Korobeinikov, 2002). An example of such an interdisciplinary integration can be the study of the attention abilities characteristics in the context of physical education because physical activity implies the general activation of brain. However, currently, practically no control is carried out on the development of attention abilities of students with certain chronic diseases during PE classes. There is no data related to these studies at the universities. Simultaneously, the data from psychological and pedagogical literature (Adyrkhaiev, 2014; Anikieiev, 2015; Overton, et al., 2016) show that the individual properties of attention abilities, which determine the course of educational activity, and subsequently the professional activity of students, are caused by the state of their health.

Research is necessary to improve the content of PE programs for students with chronic diseases to solve the problems of their preparation for efficient professional activity. On the other hand, the results of the control of psychological and physiological functions are a significant factor in the correlation of pedagogical influences during physical education, as the basis of its effectiveness (Ayers, 2004). Proceeding from the principle of heterochronous development of psychological and physiological functions (Ribot, 2017), it is possible to consider the peculiarities of their development in a specific range of ontogenesis. Our study supplements the lack of such data.

Materials and methods

Participants: The first-year students from Lviv Polytechnic National University suffering from chronic diseases were selected for research. The number of participants in both experimental and control groups (EG and CG) was the same: 80 males and 80 females in both groups, of which there were 40 persons with the diseases of cardiopulmonary system, musculoskeletal system, nervous system, digestive and metabolic systems. The research sample was formed according to the chronic diseases of students in the state of remission. Control groups and experimental groups were formed based on cluster analysis to distribute the sample into homogeneous groups. It is important that the number of students in the research groups was sufficient for the demonstrable evaluation of the experiment's results. Information about the disease was received from the medical officer of the university. The requirements for the adequacy of the information volume at the level of $p<0.05$ were met.

Procedure: To obtain the necessary data, a battery of tests was performed. These tests met the established requirements and were selected using data from research on psychophysiology (Ribot, 2017). Psychological and physiological characteristics were studied at the beginning of each of the three academic years of 2014 – 2017. During the tests, all of the necessary requirements were fulfilled. We established the presence or absence of discrepancies in the values of each characteristic being studied separately for males and females. Students were tested at the end of each semesters of the academic year. The effectiveness of the corrections introduced into physical education classes for students, the content of which was formulated and implemented by taking into account the specifics of the students' diseases, was verified using the molding experiment.

During the study, the following approaches were used: the Munsterberg Technique (Munsterberg, 1915), the Benjamin B. Bourdon proof test and the E. Krepelin test (Andreassi, 2000). The selected techniques do not require the use of special measuring equipment, training and automated processing of the obtained results. In addition, the techniques are mobile, time-limited, and easy to implement. Interpretation of the received data is also easy. Thus, a large number of participants can be tested. The informative test indicators (i.e., the parameters of attention) are extrapolated to the state of attention abilities (Ilyin, 2003). All of the studied parameters represent a functional unity, and their division is purely experimental. Dynamics of the investigated parameters became criteria of the study effectiveness. During the experiment, artificial laboratory conditions were not used. This fact ensured the conformity of the study to all the basic parameters of pedagogical science.

Data analysis: All statistical analyses were performed using SPSS Version 21. For each characteristic, average values, standard deviations, and Student criterion for unrelated samples were determined. The 0.05, 0.01, and 0.001 levels of probability were used to indicate statistical significance (Vincent, 2005)

Results

At the beginning of the experimental study, the formed experimental groups were homogeneous in terms of the values of the indicators under investigation. The results of attention abilities tests of both EG and CG students were not significantly different, which was statistically confirmed to be at the level of $p>0.05$ (Tables 1-4). The study of changes in the investigated indicators at the end of PE process allowed to reveal similar tendencies and peculiarities of changes in the parameters of attention abilities of students with different diseases. The peculiarities can be explained by differences in diseases. The major peculiarities are due to different number of the investigated indicators, in which the values significantly changed during the research or changed to different degrees. In general, the results of the EG students with diseases of the nervous system are marked by significant changes. Thus, 100% of these students demonstrated low attention concentration (K) before the beginning of the study. At the same time, 53.6% of EG students with other diseases showed an average level of attention concentration. At the end of the study, we observe an increase of this parameter to a good level in 87.8% of EG students, while the other students (12.2%) demonstrated a very good concentration of attention. The students with diseases of the nervous system showed the attention concentration, which, on average, reached a good level.

Table 1

The results of attention abilities tests students with cardiorspiratory diseases

Investigated parameters		EG (n=20)						CG (n=20)					
		before		after		+ (%)	p	before		after		+ (%)	p
		X	*S*	*X*	*S*			*X*	*S*	*X*	*S*		
A, *points*	m	8,60	0,93	11,42	1,33	32,3	<0,001	8,90	0,95	9,06	0,93	1,7	>0,05
	f	9,03	0,71	12,98	1,06	31,4	<0,001	9,17	0,89	9,88	1,04	0,6	>0,05
T, *%*	m	80,4	2,00	88,9	3,18	11,4	<0,05	81,3	3,35	83,2	3,01	2,4	>0,05
	f	84,8	2,19	93,5	2,64	10,6	<0,05	85,1	3,21	87,1	3,88	2,3	>0,05
E, *signs*	m	1555	72,7	1901	102,1	22,1	<0,05	1489	115,1	1530	78,3	2,1	>0,05
	f	1598	94,4	1977	97,8	24,6	<0,05	1600	83,4	1660	91,1	2,9	<0,05
K, *%*	m	53,81	4,9	68,41	5,18	25,9	<0,05	52,64	4,7	54,16	5,9	2,8	<0,05
	f	57,16	3,2	74,21	6,13	29,8	<0,01	55,33	5,9	58,23	5,2	5,5	<0,05
Pr, *%*	m	62,6	3,3	69,6	3,7	11.2	<0,05	60,1	4,1	62,1	3,8	3,1	<0,05
	f	65,4	4,1	73,4	3,5	12,3	<0,05	65,1	3,6	66,7	4,0	2.4	>0,05
K_u, *RU*	m	75,5	3,3	85,1	5,2	13,1	<0,05	77,1	4,6	80,4	4,5	3,8	<0,05
	f	80,1	3,8	90,4	6,7	12,5	<0,05	79,9	4,2	82,1	5,1	3,2	<0,05
t, *s*	b	175,7	17,4	150,2	8,9	14,2	<0,05	178,1	20,7	173,3	19,1	2,8	>0,05
	g	166,4	21,4	130,9	25,7	21,6	<0,05	168,9	19,6	160,7	17,8	4,7	<0,05

Legend: A – attention switch; T – attention precision; E – mental productivity coefficient; K –attention concentration; K_u – attention span; Pr – performance efficiency; t – attention selectivity; RU – relative unit; EG – experimental groups, CG – control groups, *m – male students; f – female students*

Table 2

The results of attention abilities tests students with musculoskeletal system diseases

Investigated parameters		EG (n=20)						CG (n=20)					
		before		after		+	p	before		after		+ (%)	p
		X	*S*	*X*	*S*	(%)		*X*	*S*	*X*	*S*		
A, *points*	m	5,99	0,52	8,42	1,01	33,5	<0,001	5,91	0,42	5,76	0,63	0	>0,05
	f	6,51	0,61	9,08	1,14	36,1	<0,001	6,97	0,73	7,08	0,54	0,2	>0,05
T, *%*	m	70,23	2,11	85,11	2,88	20,8	<0,05	71,57	3,15	73,63	2,28	2,7	>0,05
	f	74,15	3,09	90,53	2,16	21,6	<0,05	72,73	4,11	75,31	3,01	4,1	>0,05
E, *signs*	m	1301	102,3	1770	88,4	36,2	<0,001	1299	111,5	1315	99,9	1,2	>0,05
	f	1403	155,7	1865	92,3	32,1	<0,01	1431	123,1	1501	103,8	4,8	<0,05
K, *%*	m	38,48	5,2	48,76	4,4	25,6	<0,01	37,62	6,1	38,63	5,1	1,7	>0,05
	f	41,63	4,6	54,15	5,3	33,3	<0,001	40,88	5,8	42,46	4,9	2,4	<0,05
Pr, *%*	m	43,51	4,7	56,2	4,2	29,2	<0,05	42,79	5,1	43,30	3,2	1,4	>0,05
	f	41,22	3,8	55,2	3,3	33,1	<0,05	42,12	4,8	42,32	4,5	0,04	>0,05
K_u, *RU*	m	51,45	5,2	68,7	6,4	32,6	<0,05	53,6	6,1	55,8	5,1	3,7	>0,05
	f	60,68	4,6	76,1	7,1	26,3	<0,05	59,5	5,8	61,5	4,9	3,1	>0,05
t, *s*	b	240,1	37,3	156,6	22,1	30,1	<0,05	238,5	22,3	213,4	15,4	9,1	<0,05
	g	223,2	25,2	133,4	18,7	40,2	<0,001	225,4	18,3	200,8	7,2	11,1	<0,05

Concerning similar tendencies, analysis of attention indicators in students with the nervous system diseases [i.e., attention span (Ku), performance efficiency (Pr) and attention selectivity (t)] demonstrated that these indicators are characterized by a significant lag. However, a similar tendency was observed in students with cardiorespiratory diseases. While working relatively fast, these students made many mistakes. This indicates a low level of development of attention span and distribution of attention

Table 3

The results of attention abilities tests students with nervous system diseases

Investigated parameters		EG (n=20)						CG (n=20)					
		before		after		+ (%)	p	before		after		+ (%)	p
		X	*S*	*X*	*S*			*X*	*S*	*X*	*S*		
A, *points*	m	10,13	1,02	12,40	0,59	22,6	<0,01	9,86	1,05	10,07	0,59	1,01	>0,05
	f	11,01	0,86	13,55	1,03	22,7	<0,01	10,99	0,78	10,98	0,66	0	>0,05
T, *%*	m	71,27	1,88	81,29	3,13	14,1	<0,05	74,11	3,01	75,14	3,31	1,3	>0,05
	f	75,13	3,03	87,72	3,08	16,8	<0,05	77,48	2,19	79,05	3,14	2,5	>0,05
E, *signs*	m	1491	92,8	1720	108,1	16,4	<0,05	1477	120,2	1501	108,4	1,7	>0,05
	f	1599	101,3	1805	102,1	13,6	<0,05	1615	93,9	1633	100,1	1,2	>0,05
K, *%*	m	73,33	5,8	80,27	3,6	9,4	<0,05	72,22	4,6	74,16	4,3	0,06	>0,05
	f	76,16	3,2	84,31	5,9	10,5	<0,05	77,18	5,3	78,44	5,1	0,1	>0,05
Pr, *%*	m	65,15	4,3	75,44	3,2	16,4	<0,05	62,93	5,3	63,02	3,9	1,5	>0,05
	f	69,72	2,7	79,38	3,9	14,6	<0,05	69,28	4,4	70,83	4,1	2,1	>0,05
K_u, *RU*	m	95,18	5,9	108,3	6,9	13,6	<0,0	98,1	5,4	100,8	3,5	2,0	>0,05
	f	100,7	6,1	116,5	7,4	16.1	<0,05	99,9	5,9	103,3	5,1	2,9	<0,05
t, *s*	b	125,4	13,9	101,7	12,0	19,2	<0,05	128,8	10,1	123,2	13,1	3,9	<0,05
	g	113,7	11,4	97,9	8,1	14,1	<0,05	115,2	8,9	110,2	8,1	4.3	<0,05

Regarding the attention switch indicator (A): before the beginning of the experiment, the EG students showed low values of this indicator, according to the assessment tables. At the end of the experiment, we observe its growth as well as the increase of achievement of the average functional level by these students. At the same time, it is noted that in case of attention switch and attention precision there are some differences in concentration, productivity and stability of their manifestation among students from different disease groups. It is noted that the students with cardiorespiratory diseases have the greatest difficulty in switching attention. The probability level of changes in the attention switch values among the EG students during the experiment was determined to be relatively high ($p<0.001$).

Table 4

The results of attention abilities tests students with digestive and metabolic systems diseases

Investigated parameters		EG (n=20)						CG (n=20)					
		before		after		+	p	before		after		+ (%)	p
		X	*S*	*X*	*S*	(%)		*X*	*S*	*X*	*S*		
A, *points*	m	9,03	0,83	12,02	1,33	32,8	<0,01	9,11	0,57	9,28	0,99	0,2	>0,05
	f	10,15	1,01	13,14	1,03	29,5	<0,01	10,07	0,89	10,08	0,48	0	>0,05
T, *%*	m	83,1	2,76	89,2	3,08	7,2	<0,05	81,2	3,55	82,1	2,58	1,2	>0,05
	f	88,4	2,19	93,1	3,63	5,6	<0,05	88,7	3,51	90,1	2,81	1,55	>0,05
E, *signs*	m	1489	72,6	1830	108,1	22,4	<0,05	1439	118,7	1592	78,9	3,2	<0,05
	f	1555	110,1	1933	102,7	23,1	<0,05	1600	93,5	1657	100,8	3,07	<0,05
K, *%*	m	64,74	5,8	78,37	6,1	20,3	<0,05	63,46	4,5	65,16	5,3	2,3	>0,05
	f	72,01	5,3	87,05	5,8	20,8	<0,05	71,55	5,9	72,07	5,8	1,3	>0,05
Pr, *%*	m	66,6	4,2	76,3	3,2	15,1	<0,05	65,4	4,9	68,6	3,8	3,6	<0,05
	f	69,5	4,7	79,1	3,9	14,8	<0,05	70,1	4,3	72,1	3,5	2,7	>0,05
K_u, *RU*	m	85,6	4,5	98,3	5,9	15,1	<0,05	85,6	5,9	87,1	5,9	1,7	>0,05
	f	90,3	5,9	105,1	6,6	16,4	<0,05	92,2	6,1	93,9	5,6	1,6	>0,05
t, *s*	b	140,5	20,1	110,6	10,9	21,4	<0,05	138,1	23,3	135,6	10,4	2,1	>0,05
	g	125,4	12,8	101,3	11,8	19,3	<0,05	126,8	21,1	120,8	17,9	4,7	<0,05

At the end of the experiment, the qualitative values of the attention precision factor (T) are approaching the unit values. Prior to the study, only in the group of students with musculoskeletal disorders this indicator was within the age average rate, while all the other students demonstrated a "weak" level of attention precision. The level of positive dynamics at the end of the study was up to 22.8% ($p<0.05$). According to the scale of estimation of the abstract values of qualitative assessments, the level of attention span (K_u), which before the study was at an average of 5 points, during the experiment increased by 2.7 times and amounted to 10–14 points on average.

Discussion

The conducted experimental research is substantiated by the fact that the students' age is a period of formation of integral intelligence as a dynamic structure (Ilyin, 2003). Attention abilities reflect the course of any kind of activity and serve as a mechanism for its control (Korobeinikov, 2002). Thus, attention is one of the most significant tools of psychological and pedagogical influences on the success of academic activity of university students. Given the multidisciplinary nature of the issue, the research on attention was performed in the context of physical education, which is a significant factor in influencing the development of attention abilities by the action of activated motor activity (Kipp, 2017). Furthermore, as a physiological state, attention includes a complex of vascular, respiratory, motor and other reactions (Korobeinikov, 2002).

On the other hand, we support scientific approaches to ensure the effectiveness of the process of physical education for students with chronic diseases (Overton, et al., 2016; Koryahin, et al., 2018). Therefore, the states of psychological and physiological functions are important criteria of the effectiveness of this process (Adyrkhaiev, 2014), and their study provides additional information about the functional state of the students' organisms. In our case, the states of psychological and physiological functions are limited by the reserves of the organism, by pathological deviations in the state of students' health (Anikieiev, 2015; Koryagin, & Blavt, 2013).

Thus, the results of our research can be considered substantiated. The development of attention abilities is determined by the state of the physiological systems of the body (Korobeinikov, 2002). In addition, the nature and localization of diseases affect attention abilities (Andreassi, 2000). Thus, there is a need to study the attention abilities of students with various chronic diseases. The results of the experiment are consistent with those available in the literature (Adyrkhaiev, 2014, p. 65). It is believed (Korobeinikov, 2002; Andreassi, 2000) that the most common causes of low levels of attention abilities are general weakening of the nervous system and deterioration of health. At the same time, any deviation in the state of health is a signal of a nervous system disorder (Iedynak, et al., 2017). As a result, attention abilities are disrupted as well. It was found that in cases when the values in experimental groups were significantly different (from $p<0.05$ to $p<0.001$), it was due to the nature of the students' health deterioration.

In addition, in the early stages of ontogeny, the development of attention abilities is dependent on structural and functional maturation of the central nervous system, and diseases of the central nervous system cause various disorders of attention (Ilyin, 2003). This has been confirmed by the results of the study in a group of students with the nervous system diseases.

It has been proven that different properties of attention are independent of each other (Ribot, 2017). In particular, the distribution of attention depends on the psychological and physiological state. The attention switch depends on the mobility of the nervous system. The attention span is dependent on the individual physiological features of the organism and its overall condition at the given time (Ribot, 2017; Korobeinikov, 2002). This is reflected in the results of the control, namely, in the diversity of the numerical values of the obtained results.

The control results obtained for sample students at the beginning of university studies were compared with those received during the experiment, and the following conclusions were made. Dysfunctions of attention accompany various diseases (Andreassi, 2000). In particular, for students with cardiopulmonary diseases, this is a vascular pathology and disorder of the respiratory function. Metabolic disorders and problems with carbohydrate metabolism are factors of low development of attention abilities in students with metabolic diseases. Among the possible mechanisms of appearing attention dysfunctions during musculoskeletal system diseases, the most common disease among students is scoliosis, which causes the disturbance in all organs and systems of the organism. It is noted that violations in different parameters of attention are expressed in different categories of students in different ways.

It has been proven that the state of attention abilities is gender dependent (Ribot, 2017; Korobeinikov, 2002). The most significant differences are defined by sexual dimorphism. The tendency that EG female students demonstrated significantly higher changes ($p<0.05$) in the studied parameters is quite natural, considering the sexual aspects of individual ontogenesis.

Another reason for the discrepancy in the development of attention abilities prior to university studies was related to the individual typological peculiarities of the students, namely, to the properties of their nervous system. Thus, the use of PE program for students with the same chronic diseases does not lead to the same result in the development of their attention abilities. This happens if, prior to the start of PE classes at university, the level of the students' attention abilities development was different. The main reason for this is the individual activation of the brain associated with the activity of the reticular formation (Andreassi, 2000). However, the overall positive tendency is observed because attention develops well under the influence of and depends on motor activity (Ribot, 2017).

Taking into account the abovementioned considerations during formation and realization of the PE content for students with chronic diseases ensures increase of its efficiency in solving basic tasks (Adyrkhaiev, 2014; Iedynak, et al., 2017) and rationality of realization of a psychological and pedagogical approach. At the

heart of this is the fact that the degree of development of attention abilities is individual dependent (Ribot, 2017). The latter must be taken into account in order to select appropriate development strategies in each particular case. Thus, the formation of psychological and physiological organization of attention abilities of students with various diseases occurs heterochronically and is subject to correction during physical education. This is possible to achieve by ensuring high performance of all organs and systems and by increasing motor and sensory activity of students. The search for a mechanism to develop attention abilities in students with different diseases using a specific form of motor activity will contribute to solving the problem (Anikieiev, 2015; Overton, et al., 2016).

Conclusions

To date, an important role in the concept of education development is assigned to the psychological health of students in educational institutions, its strengthening and preservation as an integrated indicator of physical health. High level of functional state of psychological and physiological characteristics of students provides an opportunity for the effective realization of their psychomotor and intellectual potentials, which ensure the effectiveness of students' learning and, subsequently, professional activities.

It has been found that if the pedagogical process of physical education of students with chronic diseases is properly organized, the students' attention abilities are improved under the influence of appropriate motor activities due to training and accumulation of appropriate skills. Differentiated correction of the PE program provided a significantly ($p<0.05$ to<0.001) higher result than that obtained after using a traditional approach of organization, formation and implementation of PE content without taking into account experimental factors.

The obtained data allow us to determine the possibilities for correcting students' attention abilities during physical education by taking into account students' diseases. The use of systematic control of students' psychological and physiological functions during physical education is the reason for the appropriate correction of pedagogical actions and improvement of PE programs, which will help ensure PE effectiveness.

The conducted study does not pretend to cover all aspects of the identified problem in the field of psychological and pedagogical research because this is a multi-vector topic. Therefore, further research on the related aspects is needed.

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