
COMPUTER SYSTEMS FOR MONITORING OF HARD HEARING SCHOOLCHILD'S MOTORICS

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Резюме. Обґрунтовано розробку комп'ютерних систем моніторингу моторики школярів з вадами слуху. У результаті дослідження розроблено прикладне програмне забезпечення: «БіоВідео» для вимірювання та аналізу рухів людини і «Індивід» для оцінювання психомоторних характеристик дітей з вадами слуху.
Ключові слова: комп'ютерні системи, моторика, моніторинг, слабкочуючі школярі, фізичне виховання.

Резюме. Обоснована разработка компьютерных систем мониторинга моторики школьников с нарушениями слуха. В результате исследования разработано прикладное программное обеспечение: «БиоВидео» для измерения и анализа движений человека и «Индивид» для оценки психомоторных характеристик детей с нарушениями слуха.

Ключевые слова: компьютерные системы, моторика, мониторинг, слабослышащие школьники, физическое воспитание.

Problem definition. Nowadays school programs for physical education for hard hearing are “a simplified version” of overall educational programs in fact, whereas the problem of physical development under hearing loss is the large number of possible movement disorders caused by primary and secondary factors of the hearing organ's infringement [1, 6]. Experimental researches proved the development of physical qualities slows for students with partial or complete hearing loss [1, 3, 4]. The literature analysis on the physical training organization in adaptive physical education for hard hearing children showed that the scientific and methodological support of educational process is still insufficient [1, 2, 5]. The most important methodological approach in the adaptive physical education is the accounting of the individual development of their motor skills. To solve this problem the first place must be given to the selection of methods and tools to diagnose the features and degree of movement disorders [1, 4]. The development of modern measurement technologies, the introduction of computer systems into research practice extend significantly the use of corrective exercises in the adaptive physical education process. However, effective diagnostic computer technologies for the organization of adaptive physical education process for hard hearing children are not enough now. The above mentioned position indicates both a pedagogical and social value of urgent problem.

The research is coordinated to the «Summary Plan for Scientific Researches in the field of physical culture and sports for 2011–2015» of Ukrainian Ministry of Education & Science on the theme 3.7

«Perfection of biomechanical technologies in physical education and rehabilitation in view of individual peculiarities of human body motor skills».

Research objective is the development of computer monitoring systems for motorics of schoolchildren aged 7–10 with hearing impairments.

The following **research methods:** generalization of the scientific & methodical references and experience of the advanced practice, the biomechanical videocomputer analysis, psychophysiological and pedagogical tests, pedagogical experiment, and mathematical statistics were used in the researching. The research involved 59 schoolchildren of 7–10 years from Kiev specialized boarding school No 9 of I-III degree for children with the hearing loss. The research of 111 schoolchildren with normal hearing from Kiev public school No 229 was carried out to analyze comparatively the motorics of schoolchildren with hearing impairments to their healthy schoolchildren of the same age.

The data of scientific and methodological literature about the features of the physical condition of children of 7–10 years with hearing impairments have been analyzed and summarized. Numerous studies [1, 3, 6] found that children with hearing deprivation have individual disorders in the development of motor skills. As noted by many authors [4, 7], the most comprehensive quantitative characterization of the human motor function can be based on modern biomechanical information technologies. Analysis of scientific and methodological literature suggests that nowadays there is an objective need in computer systems of motorics monitoring for students with hearing deprivation during the adaptive physical education.

Material: 59 students of 7–10 years old from Kiev special secondary boarding school No 9 for hard hearing children have been involved in pedagogical experiment. Comparative analysis of physical preparedness tests for hard hearing children and 111 healthy students with normal hearing function testifies that children of 7-10 years with hearing deprivation have fallen behind their fellows with normal hearing in the development of every motor quality. The most pronounced statistically significant differences ($p < 0,05$) have been observed in the indicators characterizing the coordination abilities of both boys and girls of primary school age.

Results of the research confirmed the published data about the retard of primary school children with hearing deprivation from their fellows with normal hearing in terms of the physical development and physical fitness. At the same time, the experimental research showed that testing system, which was used traditionally in special boarding schools, might not to obtain adequate quantitative evaluation of motorics disorders. This condition must be taken into account in the organization of correction-

al and recreational activities. As noted by several authors [1, 3], the scientific substantiation of differentiated programs in adaptive physical education have to base only on the information on quantitative indicators of student's motorics. The abovementioned gave rise to the search for new tools to measure and evaluate the performance of student's motorics with hearing impairments.

The developed computer systems for human motorics monitoring include the «BioVideo» and «Invidiv» software.

«BioVideo» is used to determine the biomechanical characteristics of separate biolinks and the entire human body in each frame and in the separate phase of motor actions [7]. «BioVideo» software includes four modules (fig. 1):

- Module for the development of models of human support-motional apparatus (SMA) (the 14-segment biokinematical branched chain which link's coordinates correspond to the coordinates of human body link's position in space by the geometric characteristics, and the points of reference – to the coordinates of the major joint's centers was used as

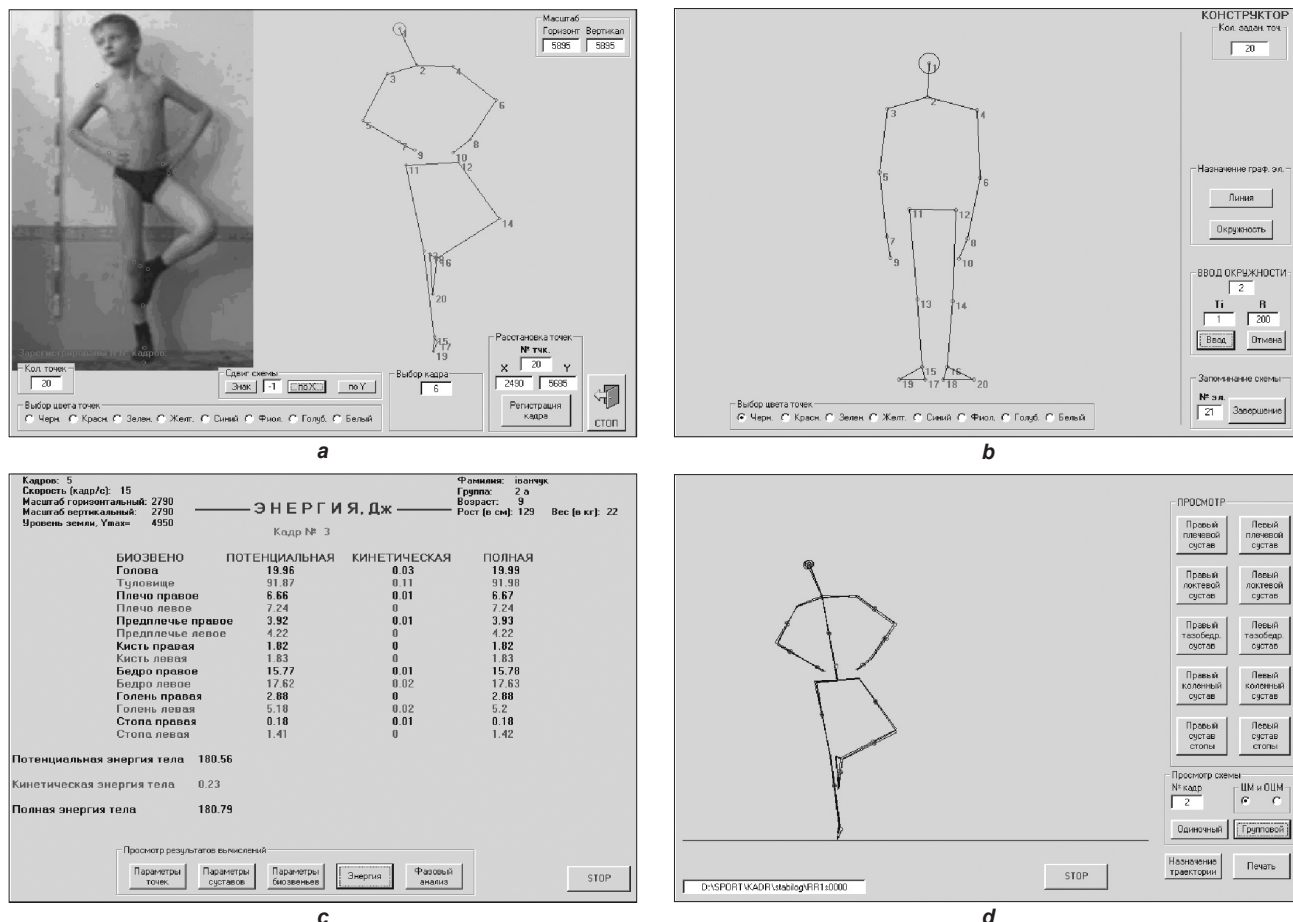


Fig 1 – The Windows of «BioVideo» Modules: **a** – the construction of human SMA models; **b** – the determination of point's coordinates about the reference of somatic system; **c** – the calculation of kinematic and dynamic characteristics of the motor action; **d** – the construction of biokinematical scheme of the human body by videogram of motor actions

a SMA model). This module allows you to create the SMA with multi links which contain up to 100 reference points.

- Module for the determining of point coordinates relative to somatic reference system.

- Module for the calculation of biomechanical characteristics of motor action on the coordinates of human SMA model. This module allow you to calculate the localization of the biolink's centers of mass (CM) and general center of mass (GCM) of the human body.

- Module for the construction of biokinematical scheme of the human body on the videogram of motor actions with the definition of the joint center's trajectory, and biolink's CM and GCM of the human body.

As the references [3], attention to psychomotor development properties should pay in the study of motor younger students. Computer systems using the monitor interface as the most viable option for children with hearing impairments, as in conditions of deprivation of auditory analyzer must use visual compensation.

The developed software for the «Individ» automated system allows you to define the following psychomotor characteristics: sensorimotor response, speed of the attention switching, visual memory, perception of the time, balance of the nervous processes, the response to a moving object. The «Individ» software consists of 10 modules: «Table», «Pendulum», «Triangle», «Square», «Complex sensorimotor response: triangle – circle figures», «Complex sensorimotor response: square circle figures», «Balance of the nervous processes», «Visual memory», «Switching of the attention», «Perception of the time». «Individ» software was developed by an object-oriented C + language in the operating system MS DOS, what implemented software timers to determine the time intervals up to 0.1 ms.

Biomechanical analysis of the coordination abilities of younger schoolchildren with hearing deprivation (which have been obtained by «BioVideo» using) revealed the disorders of rhythm and spatial orientation of the child's body biolinks ($p < 0,05$). Thus, the error in tempo and rhythm structure playing of the separate phases in the exercise with equal rhythm in the frontal plane for schoolchildren of 7–10 years old with hearing deprivation reaches 67, 60, 56 and 48 %, respectively in 7–9 and 10 year-old age.

The results of the biomechanical analysis of the motorics characteristics for younger schoolchildren with hearing deprivation show the individual differences in motorics disorders, which indicate the need for a differentiated and individual approach in the organization of adaptive physical education.

Comparative analysis of psychomotor characteristics for children of 7–10 years old with hearing deprivation (which have been obtained by «Individ» automated system using) testified that this nosology led to development delays in: sensorimotor response on average by 30 %, amount of attention – 24 %, the speed of attention switching – by 28 %, resistance to fatigue – 29 %, response to a moving object – by 34 %, the perception of time – 31 %, balance of the nervous processes – by 49 % ($p < 0,05$). The exception was the short-term visual memory, the differences in its values are 0,48 % and are not statistically significant ($p > 0,05$). Thus the application of author's physical exercises program which have been developed with «Biovideo» and «Individ» software, improved statistically authentically ($p < 0,05$) the sense of a rhythm, orientation in space and ability to keep a balance of junior schoolchildren with hearing deprivation.

Conclusions

1. According to the references analysis, the scientific & methodical maintenance of adaptive physical education process of younger schoolchildren with hearing deprivation is still insufficient as opportunities of modern information technologies for a definition and an estimation of infringements in child's motor function have not been taken into account.

2. It was experimentally confirmed that children of 7–10 years old with hearing deprivation were behind their fellows with normal hearing in terms of physical development and physical fitness.

3. The «BioVideo» biomechanical videocomputer analysis and «Individ» psychomotor test software was developed as a result of researches. The «BioVideo» software is served to define the kinematic and dynamic (energy) characteristics of both separate bioparts and whole human body in each image, and in separate phases of human motor action. The «Individ» software is required to determine the following psychomotor parameters: sensory-motor responses, speed of attention switching, a visual memory, time perception, balance of nervous processes, response to moving object.

The use of computer monitoring systems for hard hearing schoolchild's motorics in the process of adaptive physical education opens up new perspectives for the effective programming of physical cultural exercises to correct the disorders of their motor function on the basis of the differentiated and individual approaches.

The practical importance of the received results consists of recommendations for professionals in adaptive physical education and defectologists working with schoolchildren who are hearing deprived, about the application of motorics control computer technology to the physical education.

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