

FUNCTIONAL INDICATORS AND PHYSICAL FITNESS IN COMPREHENSIVE ASSESSMENT OF THE HEALTH OF CHILDREN WITH DISABILITIES OR SPECIAL HEALTH NEEDS

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In the context of declining birth rates, maintaining the health of children with disabilities and special health needs (SHN) is one of the state's tasks. A comprehensive assessment of children's health is essential for solving this problem. The study aimed to justify the inclusion of quantitative indicators of functional state, physical development and physical fitness in the comprehensive assessment of the health of children with disabilities and SHN. A cross-sectional study was conducted in September 2025 at the boarding school for disabled children and children with SHN ($n = 69$) and the ordinary school ($n = 69$). Students aged 7–17 years were matched by gender, age, and body length. During the study we assessed physical development, psycho-functional state, physical fitness, and nutrition. The cluster analysis (k-means) was performed based on 11 indicators in a combined sample ($n = 138$). As a result, two clusters were allocated: "dysfunctional" (64 children, among them 35.9% from the ordinary school) with poor adaptation, excess body weight, high fat consumption; "functional" (74 children, among them 37.8% from the boarding school) with good adaptation, normal body weight, but low caloric intake. Contradictions have been identified between health groups and medical groups for physical education. The data obtained indicate that children with disabilities have various psycho-functional states that change during their stay in an educational organization, comparable in some cases to those of children from the ordinary school. It is recommended to supplement the comprehensive health assessment of children with disabilities and children with SHN by defining quantitative indicators of physical development, body's functional state, and data on the children's physical fitness. Furthermore, the child's lifestyle, typical for children of his/her age, should be taken into account.

Keywords: comprehensive health assessment, health groups, medical groups for physical education, functional state, disabled children, children with special health needs, schoolchildren, cluster analysis

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Compliance with ethical standards: the study was approved by the Ethics Committee of the Omsk State Medical University (Minutes No. 10 of September 19, 2023, No. 13 of October 22, 2025). Parents (guardians) of the participants submitted written informed consent forms.

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ФУНКЦИОНАЛЬНЫЕ ПОКАЗАТЕЛИ И ФИЗИЧЕСКАЯ ПОДГОТОВЛЕННОСТЬ В КОМПЛЕКСНОЙ ОЦЕНКЕ ЗДОРОВЬЯ ДЕТЕЙ-ИНВАЛИДОВ И С ОГРАНИЧЕННЫМИ ВОЗМОЖНОСТЯМИ ЗДОРОВЬЯ

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В условиях спада рождаемости сохранение здоровья детей-инвалидов и с ограниченными возможностями здоровья (ОВЗ) является одной из государственных задач. Значимой для решения этой задачи является комплексная оценка здоровья детей. Целью исследования было обосновать включение количественных показателей функционального состояния, физического развития и физической подготовки в комплексную оценку здоровья детей с инвалидностью и ОВЗ. Поперечное исследование проведено в сентябре 2025 г. на базе школы-интерната для детей-инвалидов и с ОВЗ ($n = 69$) и обычной школы ($n = 69$). Учащиеся в возрасте 7–17 лет были подобраны по полу, возрасту и длине тела. В ходе исследования оценивали физическое развитие, психофункциональное состояние, физическую подготовленность и питание. Выполнен кластерный анализ (k-средних) по 11 показателям на объединенной выборке ($n = 138$). В результате выделены два кластера: «неблагополучный» (64 ребенка, из них 35,9% из обычной школы) с плохой адаптацией, избытком массы тела, высоким потреблением жиров; «благополучный» (74 ребенка, из них 37,8% из школы-интерната) с хорошей адаптацией, нормальной массой тела, но низкой калорийностью рациона. Выявлены противоречия между группами здоровья и медицинскими группами для занятия физическим воспитанием. Полученные данные свидетельствуют о том, что дети-инвалиды имеют различные изменяющиеся в процессе пребывания в образовательной организации психофункциональные состояния, сопоставимые в ряде случаев с таковыми у детей из обычной школы. Рекомендовано дополнить комплексную оценку здоровья детей-инвалидов и детей с ОВЗ определением количественных показателей физического развития, функционального состояния организма, данными по физической подготовленности детей. Помимо этого следует учитывать образ жизни ребенка, свойственный детям его возраста.

Ключевые слова: комплексная оценка здоровья, группы здоровья, медицинские группы физического воспитания, функциональное состояние, дети-инвалиды, дети с ограниченными возможностями здоровья, школьники, кластерный анализ

Вклад авторов: Ж. В. Гудинава — научное руководство, концепция исследования, развитие методологии, анализ и систематизация данных, критический пересмотр и редактирование текста рукописи, формулировка выводов; А. А. Рыбкин — сбор, анализ и обобщение данных литературы, сбор данных, применение статистических и математических методов для анализа данных, интерпретация результатов исследования; написание текста рукописи, работа с графическим материалом; Л. В. Демакова — сбор, анализ и обобщение данных литературы.

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In the context of declining birth rates, maintaining the health of every child, including children with disabilities and children with special health needs (SHN), is an important state task [1–5]. A major role in solving this problem is played by a comprehensive assessment of children's health, the basis of which, based on well-known methodology and techniques, was provided back in 1965 by S.M. Grombach [6], carried out in our country for a long time and currently regulated by the regulatory documents of the Ministry of Health of the Russian Federation [7]. However, in our opinion, regarding children with disabilities and children with SHN, there are still certain methodological difficulties in the comprehensive assessment of health, including in determining the health group (HG) and medical groups (MG) for physical education (PE) classes [8].

To clarify the comprehensive assessment of the health of children with disabilities and SHN, it is proposed to define additional informative health parameters: children's functional status, physical development, and the main indicators of their physical fitness. The indicators were selected considering the specifics of the educational environment of boarding schools (possible stress — illness, being at school 24/7, separation from family), accessibility and ease of use of these methods in the context of the educational institution by a doctor and a PE teacher at school. It is also important that all the indicators are quantitative, which always facilitates the assessment of the state, and also increases the possibility of using indicators during statistical analysis of data.

The study aimed to justify the inclusion of quantitative indicators of functional state, physical development, and physical fitness in the comprehensive assessment of the health of children with disabilities and SHN.

METHODS

The cross-sectional study was conducted in September 2025 at the Municipal Autonomous Educational Institution (MAOU) "Ishim Boarding School" for children with SHN and disabilities (hereinafter, boarding school) and the secondary comprehensive school No. 4, Ishim (hereinafter, control school). The study involved 138 children aged 7 to 17 years: 69 from the boarding school (the sample was limited to the population of schoolchildren, who studied at the boarding school in the academic years 2023–2025) and 69 from the control school. Children who attended the boarding school had 2–8 established diagnoses. The two leading disorders that all children had were disorders of the nervous system and sensory organs (hearing loss), as well as mental disorders. Children from the control school were selected by pairwise comparison with the index group by gender, age, and body length. Inclusion criteria: age 7–17 years, studying at the MAOU "Ishim Boarding School" or the secondary comprehensive school No. 4, Ishim, availability of the parents' (legal representatives') informed consent, for boarding school — "disabled child" or "child with SHN" status, for control school — no such status. Exclusion criteria: failure to meet any of the inclusion criteria, no informed consent, attending any other educational institution, for boarding school — no "disabled child" or "child with SHN" status, for control school — "disabled child" or "child with SHN" status.

Physical development was assessed based on the anthropometric measurements performed by the medical specialist at school in accordance with the body mass index (BMI) estimates and the World Health Organization (WHO) tables [9]. The index method was selected due to the need for a quantitative indicator for subsequent statistical processing of data (cluster analysis).

To assess the children's body psychofunctional state, the estimated criteria based on anthropometric (body length, body weight) and functional measurements (heart rate, blood pressure, pulse blood pressure) performed by the medical specialist at school were selected. The following were calculated: adaptive potential of the cardiovascular system according to R.M. Baevsky (AP) [10]; stress level according to Yu.R. Shejkh-Zade [11]; maximum oxygen consumption (MOC) according to the method by S.A. Dushanin [12].

Physical fitness was assessed based on the questionnaire survey results and excerpts from the PE teacher's journal, as well as based on three indicators included in GTO standards: two footed standing long jump, cm — speed-strength capabilities; standing forward bend on a gymnastic bench (for healthy schoolchildren) and seated forward bend on the floor with both legs straight (for children with health problems [13]), cm — flexibility; 30 m and 60 m run — speed capabilities. All the tests were conducted by the PE teacher at school during classes and estimated for each child as a percentage of the "silver" GTO standard [13, 14].

The hygienic assessment of nutrition is based on the analysis of menu layouts, diet control sheets, and technical cards. The children's actual nutrition was assessed by the questionnaire survey (34 questions, including a table of the frequency of food and dish consumption throughout the month, developed by the researchers of the Federal Research Center of Nutrition, Biotechnology, and Food Safety) and the 24-h dietary recall method. The data on nutrition were processed using the Diet Calculation Module software (Institute of Physiology of the Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences, Boyko ER, Eseva TV, Evdokimov AV; Russia). The standards established by sanitary legislation were taken as standard values [15].

Statistical processing of the research results was performed by the descriptive statistics methods, cluster analysis (k-means) in the Statistica 6.0 software package (StatSoft; USA); the differences were considered significant at $p < 0.05$ [16]. Clustering was performed on a combined sample of children (boarding school and control school, $n = 138$). All indicators were standardized according to the cluster analysis method in the corresponding option of the Statistica 6.0 software package (StatSoft; USA) based on the following characteristics:

- MOC: the higher, the better;
- AP: the higher, the poorer adaptation;
- stress level: the higher, the worse, the more likely stress;
- GTO test "Standing long jump": the higher the better (jump range);
- GTO test "Flexibility": the higher, the more flexible;
- GTO test "30/60 m run": the higher, the worse (slower running speed);
- BMI;
- caloric content, percentage of normal consumption;
- proteins, percentage of normal consumption;
- fat, percentage of normal consumption;
- carbohydrates, percentage of normal consumption.

RESULTS

Based on the questionnaire survey results and excerpts from the boarding school PE teacher's journal it was determined that 100% of children with disabilities and SHN study at the boarding school. Among them 46.4% attend sports sections (and 4.3% attend sports sections with high-intensity training twice a week or more often), 23.2% have passed

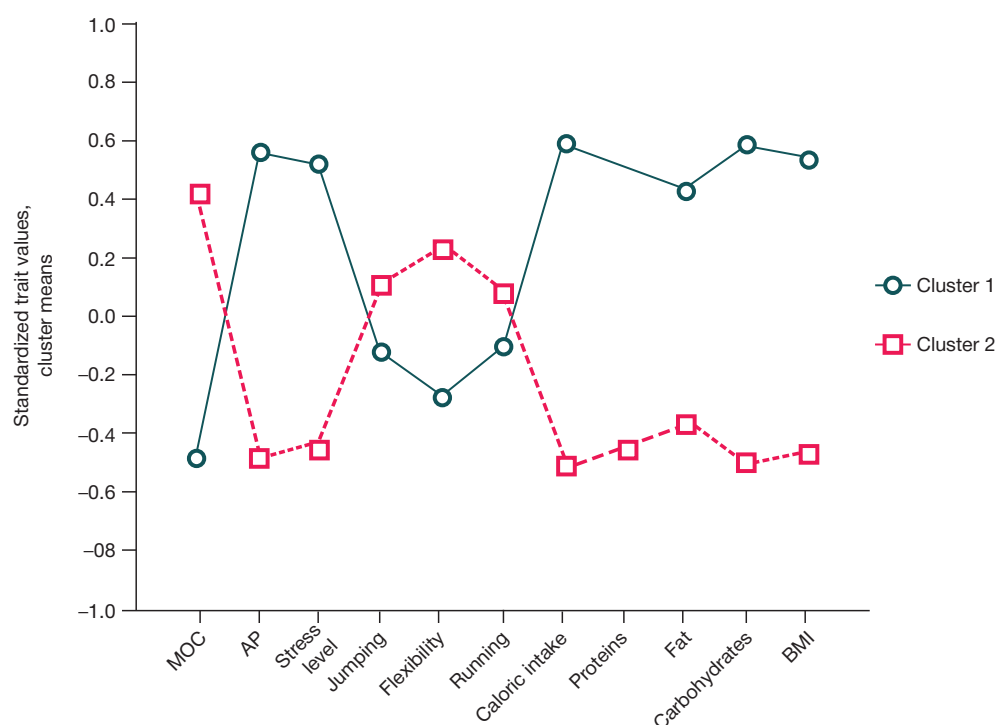


Fig. Clustering of mean values of the functional state and physical fitness indicators

the GTO tests and received the "silver" badge (standards adapted for disabled children).

Catering in both schools is generally compliant with hygienic standards [15]. However, the children's actual diet is unbalanced and non-compliant with hygienic standards: In both schools, children aged 7–11 years had adequate energy intake and protein intake, while fat consumption was excessive and carbohydrate consumption was insufficient (by 14–16%). The energy value of the diet of adolescents at the boarding school was normal, while in the control school the energy value of the diet was insufficient — by 6.8% lower compared to the standard [15]. In the control school, the adolescents' consumption of proteins and carbohydrates was 12.8 and 23.1% lower, respectively, and that of fat was 25.4% higher. Furthermore, an imbalance in the consumption of proteins, fats, and carbohydrates (hereinafter, PFC) was reported for both groups: children from the boarding school — 1 : 1.2 : 3.8; children from the control school — 1 : 1.4 : 3.8; adolescents from the boarding school — 1 : 1.3 : 4.0; adolescents from the control school — 1 : 1.5 : 3.8.

The clustering results are shown in the Figure and in the Table. As can be seen from the Figure and Table, as a result of cluster analysis, the cohort of children was divided into two clusters that differed significantly in all 11 classification characteristics.

Cluster 1, "dysfunctional", is characterized by an unsatisfactory state of body adaptation based on all indicators (MOC, AP according to Baevsky, stress level according to Sheikh-Zade), overweight (based on BMI), lower flexibility indicators, excess caloric intake due to high fat consumption (129% of normal) (Fig., Table). This cluster consists of 64 children, among them 64.1% are schoolchildren from the boarding school, 35.9% are children from the control group.

More than half of the children in this cluster are children with HG V, there are 7.8% of children with HG III and 7.8% with HG I F3, 25.0% of children with HG II. As for MG for PE, more than a half of children belonging to the preparatory MG (56.3%), about a third of children belong to the main MG, and a 12.4% belong to the special group (two schoolchildren

from the control school out of two). As for age, these children are older — half of them are high school students (Table).

As stated above, 35.9% of the cluster (23 children) are children from the control school (healthy). A total of 60.9% of these children are overweight (up to morbid obesity), 34.8% have tension of adaptation mechanisms, and 4.3% have stress. GTO badges were received by 100% of these children (among them 39.1% received a "golden" badge). A total of 21.7% of children from the control groups included in this cluster had HG I, 69.6% had HG II, and 8.7% had HG III. Most children (87.0%) belonged to the main MG, 4.3% to the preparatory one, and 8.7% to the special MG (all were children with HG III). Exceeding the actual daily caloric intake was reported for 78.3% of these schoolchildren. PFC ratio: 1 : 1.5 : 3.9 (Table).

Cluster 2, "functional", is characterized by good adaptation, low stress, normal body weight, good flexibility indicators, combined with a low calorie diet due to low protein and carbohydrate intake (70–77% of normal). This cluster includes 74 children, among them 62.2% were schoolchildren from the control school and 37.8% were children from the boarding school (Fig., Table).

In this cluster, 48.7% of children had HG I and II, and 22.9% of children had HG III. However, 28.4% of this cluster are children with HG V. As for MG for PE classes, a half of children belong to the preparatory MG (50.0%), about a half (47.3%) of children belong to the main group, but there are children belonging to the special group (two children, among them one from the boarding school). One child from the control school was exempted from PE classes (Table).

As stated above, 37.8% (28 children) of this cluster are children from the boarding school (disabled and with SHN). The majority (92.9%) of them have normal body weight (with the exception of one child with underweight and one child with grade 2 obesity). A total of 96.4% of these children have satisfactory adaptation, 78.6% have no stress and have different MOC values (low to high). More than half of these children (57.1%) specified in the questionnaire that they were not engaged in sports, but 89.3% of children received

Table. Comparative characteristics of clusters, mean values

Indicators	Cluster 1	Cluster 2	<i>p</i>
Number of children per cluster, abs.	64	74	
Fraction of schoolchildren studying at the boarding school, %	64.1	37.8	0.002
Fraction of schoolchildren of the control group, %	35.9	62.2	0.002
Health group (HG), %			
– HG I	7.8	17.6	0.088
– HG II	25.0	31.1	0.428
– HG III	7.8	22.9	0.016
– HG IV	0.0	0.0	1.000
– HG V	59.4	28.4	0.000
Medical group for physical education (MG), %			
– main	31.3	47.3	0.056
– preparatory	56.3	50.0	0.460
– special	12.4	2.7	0.028
Indicators of health and adaptation, mean values			
BMI, kg/m ²	23.03	18.35	0.000
MOC, mL/min/kg	56.9	69.7	0.000
AP according to Baevsky (AU)	02.08	1.89	0.000
Stress level according to Sheikh-Zade (AU)	1.11	0.90	0.000
Jumping, % of normal	105	110	0.183
Flexibility, % of normal	102	160	0.002
Running, % of normal	85	91	0.263
Caloric content, % of normal	107	80	0.000
Proteins, % of normal	102	77	0.000
Fat, % of normal	129	99	0.000
Carbohydrates, % of normal	97	70	0.000

GTO badges (of which 50.0% received the “golden” badge). However, the majority of them (75.0% of the total number of children with disabilities and SHN included in the cluster) have HG V, while the rest (25.0%) have HG III. The overwhelming majority (89.3%) of children with disabilities and SHN included in this cluster belong to the preparatory MG for PE classes, among them the majority are primary school students (64.3%). These children have nervous system disorders (G93.8), bilateral sensorineural hearing loss (H90.3), mental disorders (F), eye diseases (myopia, astigmatism) in their medical history. The actual daily caloric intake of these children is insufficient — on average, it is 90.8% of normal. PFC ratio: 1 : 1.3 : 3.6 (Table).

DISCUSSION

The study showed that children and adolescents in boarding schools for children with disabilities have various psycho-functional states that change during their stay in the educational institution, which requires regular assessment of indicators for the objective preparation of individual rehabilitation and habilitation programs, supplemented by recommendations on nutrition and physical education of children, to determine the HG, the MG, as well as to create appropriate conditions for the realization of these programs and the implementation of recommendations.

Among children with disabilities, a fairly large category of those included in the “functional” cluster 2 was identified (28 people out of 69 or 37.8%), whose functional characteristics were close to those of their healthy peers. At the same time,

quite a lot of conditionally healthy children from the control group (23 out of 69 or 35.9%), in terms of their functional indicators, approached those of disabled children with multiple diagnoses and limitations in life activities. This fact can be associated with excess body weight, which is consistent with the data of other authors [17, 18]. In addition, it was noted that the health indicators of children with disabilities studying at the boarding school deteriorated with age, which is consistent with the data provided by other authors [19].

In our previous papers [8], we noted a number of problems and inconsistencies that, in our opinion, exist in the comprehensive assessment of the health of children with disabilities.

Firstly, in no case were students in either the boarding school or the control school diagnosed with HG IV, which is generally assigned extremely rarely in the Tyumen Region [20–22]. Secondly, certain inconsistencies have been noted which, in our opinion, are present in the results of the comprehensive assessment of children's health, specifically: the “functional” cluster included 37.8% of children with HG III and even V, while the “dysfunctional” one included 35.9% of children with HG I and II. The “functional” cluster included 2.7% of children belonging to the special MG for PE classes, while, the “dysfunctional” one included 31.3% of children belonging to the main MG. Furthermore, children with HG V lead a completely normal life for children of this age — they attend school and sports sections, get from home to school and back on their own, and participate in sports competitions for people with disabilities. In our opinion, such distribution of children based on MG for PE classes creates the risk of decreased

effectiveness of physical education for healthier children, and, on the contrary, the risk of developing severe clinical situations during PE classes for sicker children.

Considering the results of the study, it is also clear that some children with disabilities do not have such severe limitations in their life activities that they can be classified as HG V according to the requirements of the regulatory document [23]. And if they are still assigned to group V (in cluster 1 there are 26.1% of such children (Table)), then why are not all of them assigned to the special MG for PE classes (there are only 2.7% of such children (Table))?

In our opinion, in this case, the boarding school doctor experiences methodological difficulties in determining the HG severity: if the doctor can distinguish between HG III and V, then he/she cannot distinguish between HG IV and V, and therefore assigns a more severe group. There are difficulties in distinguishing between "limitations on the opportunity to study or work" (formulation of the HG IV) and "significant limitations on the opportunity to study or work" (formulation of HG V) [7, Appendix 2]. Furthermore, in the formulations of the MG for physical education classes, there is no concept of "limitations of opportunities", but only "limitation of physical activity" [7, Appendix 3], which is not the same thing.

Thus, there is a need for methodological clarifications regarding the comprehensive health assessment. Perhaps, children who lead a normal life for children of their age (those studying at school, even a specialized one, independently attending school, sports sections) should be assigned HG I through IV, and HG V should be assigned to children with severe disorders who need to be educated at home, with significant limitations in learning opportunities and disruptions of the life style that normal for children. That is, the key point in this case should be the child's lifestyle or social and environmental rehabilitation, as specified in the International Classification of Functioning, Disability and Health (ICF) [24]. To resolve these issues, it is obvious that there is a need to harmonize the conceptual apparatus of the Ministry of Health

of the Russian Federation [7] with that of the Medical and Social Expertise Service [7], as was mentioned earlier [8], and to apply quantitative methods for assessing the body's functional state and physical development (as one of the criteria for the comprehensive assessment of health, [7]), as well as indicators of children's physical fitness of as the resulting criteria of human health.

CONCLUSIONS

The child's functional well-being is determined not so much by diagnoses, disability status, or health group (HG), but by his/her actual adaptive reserves, body weight, and physical fitness level.

Among children with disabilities, there is a group of children ($n = 28$, 37.8%) whose functional indicators are close to those of their healthy peers, and among conditionally healthy children, a hidden group at risk was identified ($n = 23$), whose psychofunctional indicators and physical fitness were close to those of children with disabilities. Children in this hidden group at risk are overweight.

In both groups, there were no children with HG IV, as well as contradictions between the definition of the HG and the medical group for PE classes, which, in our opinion, indicates the need to harmonize methodological approaches to defining these groups, including with respect to the use of concepts of limitations in learning or work opportunities.

It is recommended to supplement a comprehensive assessment of the health of children with disabilities and those with special health needs with indicators of body mass index and functional state (assessment of adaptive potential according to R.M. Baevsky, stress level according to Yu.R. Shejkh-Zade, maximum oxygen consumption according to the method by S.A. Dushanin), physical fitness (standing long jump, flexibility, 30/60 m run). Furthermore, it is recommended to consider the child's lifestyle, typical for children of his/her age (facts of attending the educational institution, sports sections, etc.).

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