Original article
Effects of visual impairment on sensory integration and new opportunities for inclusive education
Ekaterina Belyaeva¹, Oxana Kartashova², Nadezhda Sokolaeva³, Zoya Snezhko⁴, Valentina Spichak⁵

Abstract
Objective: Inclusive education aims to offer comprehensive collaborative education to healthy and disabled children. The purpose of the study is to perform a comparative analysis of the learning results in healthy and disabled children from different groups with those who study remotely, and a similar analysis between students of higher education institutions. Methods: The study was conducted in 2018–19 in Moscow, Russia, involving 150 students with disabilities and 397 healthy students. Consideration was given to academic performance, psychophysical development and speech development. Results and Discussion: Among students with healthcare nosologies, students with vision impairments are considered the most promising. The number of underachievers is 4.9 times lower than their peers (p 0.001). The greatest success in e-learning was among students with health nosologies relative to a similar group of children. Conclusions: The number of outstanding students in the group with visual impairments exceeds those in the control group by 1.5 times (p≤0.05). Of the students with health nosologies, the most promising group is visually impaired students. High academic performance of students with visual impairments and disordered motor activity provides them with the opportunity to practice comprehensive education at universities, including inclusive education, which corresponds to current worldwide trends. Keywords: psychophysical development; speech development; visual impairment; health nosologies, academic achievement.

Introduction
The present stage of development of human society implies increased control over the healthy lifestyle of the younger generation, particularly children. A special attention deserve children with disabilities. They include the following categories of children with disorders in: a) mental evolution; b) mental subnormality; c) unimpaired functioning of the visual and auditory sense analyzers; d) emotional and volitional spheres of personality; e) musculoskeletal system.¹

From the medical point of view, in particular preventative treatment, health is an essential condition for the preservation of normal or approximately normal personal qualities. Health, in turn, depends on the way of life. This statement applies equally to

1. Ekaterina Belyaeva, Department of Social Work, Ural Federal University named after the first President of Russia B.N. Yeltsin, Yekaterinburg, Russia
2. Oxana Kartashova, Department of Organizations and Economics of Pharmacy, Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia
3. Nadezhda Sokolaeva, Institute of Linguistics and Intercultural Communication, Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia
4. Zoya Snezhko, Institute of Linguistics and Intercultural Communication, Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia
5. Valentina Spichak, Institute of Linguistics and Intercultural Communication, Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia

Correspondence to: Zoya Snezhko, Institute of Linguistics and Intercultural Communication, Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia. Email: sokolaevanade4@rambler.ru
disabled children. Aside from an active lifestyle, a normal lifestyle also includes the cognitive activity of a child with a disability. To a large extent, a child’s lifestyle is dependent upon that of family members. Among the problems present in children with disabilities, the majority are specified by the peculiarities of their interaction with the surrounding society (100% of children). In particular, it also includes family issues observed in every three out of four children (75%), which can be a cause of emotional conflicts in the majority of children with disabilities (85%). All such children have cognitive and behavioral problems caused by their physical or mental diseases, i.e., biological impairments, which are also seen in 100% of children.

Noci influence may facilitate the formation of mental deviations in early childhood (up to age 5–7), including in children with disabilities. This moment is of crucial importance as it is a time when basic moral and ethical feelings are formed, accompanying the child throughout their future life. Such influences leave children with disabilities particularly vulnerable, not only because of their families, but also because of their peers. In addition to congenital mental illness, these children have increased anxiety due to reduced self-esteem, outbursts of anger, irritability, and constant mood swings. Heightened anxiety and other mental disorders may also be caused by parental alcoholism, which is seen in 25% of parents of families with children with disabilities. An extra burden on the psyche of such children is the awareness of their failure in life, their inferiority compared to “normal” children. It is known that among mothers whose children do not have health problems, the frequency of depression is 9% on average, while among those who have disabled children, this frequency amounts to 19% of cases, which is twice as high. Research over recent years has shown that the more stressed the body is, the weaker its functions are and its mental structure is damaged.

There is a very high prevalence of health-limiting syndrome worldwide. According to the UN, about 450 million people (almost one in fifteen of the over 7 billion population of the Earth) of all the inhabitants of the planet have mental and physical health disorders. The World Health Organization confirms these figures and points out that 13% of the population has mental and physical health problems. Developmental impairments from birth are revealed in 3% of all newborns, and the remaining 10% have other types of mental or physical impairments. As a result, the total number of children with disabilities stands at 200 million. These scales are evident across the globe, in every country in the world. In Russia, in particular, there are 554,000 children under 18 years old. In this context, the means to integrate these children in human society as full participants are still extremely urgent. A set of measures, also known as inclusive education, serves this purpose.

The primary goal of inclusive education is to teach children who, for whatever reason, have a disability together with healthy children. In this type of education, children not only learn together, but also share leisure activities. This also includes other activities designed to build and develop additional skills and education. However, inclusive education has some challenges. According to some experts, only some students or learners with disabilities can receive a comprehensive education. This is primarily because students have a level of speech and general development consistent with or close to the norm at that age. Inclusive education methods may be effective for children with speech disabilities or speech delays if targeted and timely prevention of these disorders is in place. Furthermore, inclusive education can be very successful for some autistic children.

Depending on the nosology of health problems, different outcomes may be obtained. In particular, the key factor in hearing impaired children is the development of speech structure associated with phonetic and intonational components. For these children, the rhythmic movements of the body and vocal organs, especially music and dance classes, are very important for timely prevention. In the case of visual impairment, the normal movement development also contributes to the progress in the ability to accurately perform a set of movements related to play, work, or learning activities. Speech impairment prevention is also very important for later learning by using a combination of different techniques, such as movement, tempo and rhythm, and speech.

Despite the large number of studies focusing on each group of learners (or students) with disabilities, they all tended to be performed within the same group. The People’s Republic of China is the most populated country on the planet. As a result, the number of persons with disabilities is also very high here. In China, issues of inclusive education are highly
relevant, and a great deal of attention is given to this type of education. Mixed classes are being held in secondary schools, whereas also higher education institutional so pay special attention to students with disabilities. The results obtained by the authors of this study may be used as recommendations for other parts of the world where inclusive education is practiced.

This study provides a comparative analysis of student achievement across different age groups in an inclusive online educational environment. As the primary criterion, the authors selected one medical criterion, namely, the nosology of the disease. The authors hypothesize that, according to the nosology of health problems, students will obtain variable performance results, significantly inferior to those of students without health limitations. At the same time, some groups of schoolchildren with disabilities will achieve outcomes that are close to or statistically inseparable from those of non-disabled peers.

The purpose of this study was to compare learning outcomes of children with disabilities from different groups with healthy children in a school with inclusive online education, as well as to conduct a similar analysis among university students. The objectives of the study were to: a) assess the learning outcomes of children with disabilities from different groups; b) compare the learning outcomes of children with and without disabilities in a comprehensive secondary school; c) conduct a comparative analysis among students attending inclusive education courses.

**Material and methods**

**Materials**

The study was conducted in 2018–2019 in Moscow (Russia), involving 150 students with disabilities (out of whom 35 were from China), and 397 healthy students, including 65 students from China.

Data were collected among 150 students. For the control, similar data were collected for 397 students at the university without abnormalities in schools.

Depending on the nature of the health nosology, children were divided into the following groups: a) visual disturbances; b) musculoskeletal system disorders; c) mental retardation. The gender distribution is presented in Table 1. The control group of students, there were 197 boys and 200 girls, also without differences by age.

<table>
<thead>
<tr>
<th>Group</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fifth-year students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual disturbances</td>
<td>53</td>
<td>42</td>
<td>95</td>
</tr>
<tr>
<td>Mental retardation</td>
<td>11</td>
<td>16</td>
<td>27</td>
</tr>
<tr>
<td>Musculoskeletal disorders</td>
<td>13</td>
<td>15</td>
<td>28</td>
</tr>
</tbody>
</table>

No significant differences were observed in the gender distribution among the groups. There were also no age differences between the three groups.

**Research design**

The belonging of each of the students to a particular group with health limitations was confirmed by the corresponding medical documentation based on the conclusion of a specialist. Depending on the results, three achievement criteria were identified: a) underachievement in all subjects; b) underachievement in one subject; c) achievement in all subjects. The following criteria were analyzed for students: a) academic performance (satisfactory, good, and excellent grades); b) employment (or continuation of studies).

**Ethical and Moral Standards**

This study did not violate generally accepted norms of ethics and morality, and the confidentiality of information was respected. A verbal and written agreement was made with each of students from the control group and the group with health problems on non-disclosure and anonymity of information, on observance of individual rights, as well as an observance of ethics and morals in the research.

**Statistical analysis**

The data were statistically processed using Statistica v. 6.0 (StatSoft Inc., USA). The data were entered into Excel database 2013 (Microsoft Inc., USA), mean scores and error of the mean were calculated, and results for each of the parameters (performance in one group or another) were presented as a percentage. The significance of the differences was derived from a two-sample t-test for independent samples. Differences were significant at the minimum level of \( p \leq 0.05 \).

**Ethical clearance:** The authors declare that the work is written with due consideration of ethical standards.
Results

Students demonstrate results with significant differences between controls and those with health nosologies (Figure 1). The level of excellence among control group students was still lower than among visually impaired students (p ≤ 0.05). On the other hand, there were approximately as many excellent students in the normal group as there were among visually impaired students (p ≥ 0.05). The number of visually and motor impaired students who performed well was 9% higher (p ≤ 0.05).

Figure 1. Academic achievement of control students and group with health issues.

Finally, the control group had 0.5 to 2.0 times as many students with poor academic performance as students with visual or motor impairments (p ≤ 0.05). On the other hand, there were more students with poor academic achievement among the mentally disordered group than among the control group (p ≤ 0.05). Students with retarded mental development were usually characterized by satisfactory and good academic results; there were virtually no excellent students among them. No significant differences were established between the group with satisfactory scores and the group with good scores. Among the students with musculoskeletal disorders, the number of good students was 1.8 times higher than the number of low-performing students (p ≤ 0.05) and 3 times higher than the number of outstanding students (p ≤ 0.01). Maximum number of outstanding and good-performing students is among those with visual impairment (1.5 times more good-performing students compared to outstanding ones, p ≤ 0.05, 4.9 times less good-performing students compared to outstanding students, p ≤ 0.001), and their number exceeds even the control group (1.5 times more outstanding students, p ≤ 0.05). As a result, students with visual disabilities are the most promising group in terms of learning among students with health nosologies.

The employment analysis showed that nearly half of students with visual disabilities prefer to continue their studies even after graduation (Figure 2).

Figure 2. Employment rates of control students and the group with health limitations.

The situation in the group with musculoskeletal problems and retarded mental development is similar to that in the control group. In particular, most of the students prefer to get a job and not to continue their education (12-17%) continue, the rest do not, i.e. 6.5–7.0 times fewer students than employed, p ≤ 0.001).

Discussion

In modern medical practice, when analyzing the causes of personality formation in students with disabilities, the dominant view is that the main cause is minimal brain dysfunction - congenital organic lesions of the brain or spinal cord. The consequences include cerebral palsy, mental retardation, and muscular skeletal dysfunction. In less serious lesions, autism, mental developmental disorders, nervous tics and hyperactivity are among the consequences. This concept is medically referred to as the reproductive trauma continuum. Most modern researchers consider it oversimplified compared to the real situation. In addition, some studies suggest that minimally impaired brain function is not the primary cause of neurodevelopmental disorders in students.

The brain has a number of compensatory mechanisms that, for the most part, can mitigate the effects of minor brain damage. The most significant influence on the formation of mental disorders will be a combination of neurologic and mental factors. This is in inverse correlation with the age of the child, i.e., the younger he or she is, the more negative influence neurological symptoms will have on his or her psyche. The mental condition of disabled students therefore depends on external factors. Furthermore, as they grow older, the primary role is reassigned to
Students with motor disabilities, such as cerebral palsy, require several specialists at once – a neurologist, a psychiatrist. In the preschool period of a child’s development, these symptoms occur through mental development delays combined with symptoms of neuropathy. At school age, the primary role is cognitive impairment and, during adolescence, emotional and volitive disorders. Ultimately, this leads to the development of pathologic personality. It is interesting to note that these disorders are twice as frequent among boys as among girls.

The example of students with speech disabilities illustrates the risk factors that cause physical and mental health problems. These include: a) medical and biological factors – all students participating in the study were assigned to the vigilance group; of them, 17% were in the high risk group; b) factor of early childhood – about 25% of students were in the high risk group; c) lifestyle factor – up to 30% of students were in the high risk group. These rates were reliably 2-3 times higher than those of students with normal health and mental development.

Therefore, mental and physical health problems in students with disabilities may be one of the main reasons for their failure to perceive the learning material offered in the general education process.

The monitoring of the online lessons showed that teachers, understanding the difficulty of learning the material through students with health problems, knowingly give them simpler tasks compared to normal students. In particular, at an English lesson, one of the students was given the task to copy the letters of the alphabet in order into a notebook while other students were learning more complicated material. Students with health nosologies often disturb the discipline (68% of the time) even during an online conference, so teachers do homework to entertain them.

Teachers have argued that students with nosologies are much slower and with inherent specificity in answering questions, slowing the progress of others.

An approach clearly illustrated above is certainly not conducive to the normal development of a child with special needs. This indicates that inclusive online education in a comprehensive secondary school should be approached with caution, and only include groups of students who are close to the age norm, such as students with visual impairments. For students who cannot manage with the general curriculum, such as those with mental disabilities or autism, education in special schools or in separate individual classes is desirable. Physical education classes also have their specifics. Here, visually and musculoskeletally impaired students are not able to learn the material normally. Hearing impaired students have trouble with music classes. Students with speech disorders learn poorly relative to their healthy peers in their mother tongue and foreign language.

However, in the context of inclusive online education, these limitations can be removed if all the necessary conditions for the child’s comprehensive education are created. The three categories of students with speech, vision, and mental retardation were characterised by non-acute learning disabilities. Students with visual impairment had a level of 0.1-0.4 vision and could use books with flatprint, in students with speech impairment the latter was characterized by third level of underdevelopment, i.e., this pathology was not clearly pronounced. It is important to note that the group of successful students may also include students with musculoskeletal disorders, hearing disorders and autism. Their academic performance will depend to a large extent on early correction followed by full academic achievement. Yet these students require special attention from teachers. All of these groups, with the exception of mentally retarded students, have no significant cognitive impairment. Therefore, they can learn fully as well with healthy peers in some conditions.

Conclusions

The number of students with a normal level of psychophysical development in the group with visual impairments is 1.3 times higher compared to students with a normal level of speech development. Among the speech impaired group, this difference was 1.7 times (p ≤ 0.05). Among students with health nosology, the most promising were students with a visual impairment. The number of good-performing students are 1.5 times higher compared to outstanding students (p ≤ 0.05), and the number of low-performing students is 4.9 times less compared to good-performing peers (p ≤ 0.001). The number of outstanding students in the group with visual impairments exceeds that number even in the control group by 1.5 times (p ≤ 0.05). Mass inclusion of students with special abilities in schools by implementing inclusive education program does not give unambiguous results. Only a small proportion of such students belonging to the three health nosology
groups are able to learn the curriculum material in the same time and to the same extent as students from the control group. These students are visually impaired, to a lesser extent mentally retarded, and have musculoskeletal disorders. For the remaining groups of students with disabilities, early correction with subsequent creation of special conditions to stimulate their educational needs with the participation of teachers-defectologists is desirable. The high performance of visually and motor impaired students suggests that this group is quite promising for comprehensive education in universities, as well as for inclusive education.

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Data gathering and idea owner of this study: OK and ZS
Study design: NS, ZS, and VS
Data gathering: OK, NS, and VS
Writing and submitting manuscript: OK, NS, ZS, and VS
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