

ЗНАЧЕНИЕ ОРТОПЕДИЧЕСКОЙ ОБУВИ С ЦВЕТНЫМИ МАРКЕРАМИ В КОРРЕКЦИИ ХОДЬБЫ У ДЕТЕЙ С ДЕТСКИМ ЦЕРЕБРАЛЬНЫМ ПАРАЛИЧОМ

Рашидова Мадина Шавкат кизи

Ташкентский институт текстильной и лёгкой промышленности.,

E-mail: rashidovamadina92@gmail.com

Пазилова Дильноза Зиявутдиновна

Ташкентский институт текстильной и лёгкой промышленности.,

E-mail: dilnoza7474@list.ru

Аннотация. В данной статье исследовано функциональное и психофизиологическое значение ортопедической обуви с цветными маркерами при коррекции ходьбы у детей, страдающих детским церебральным параличом (ДЦП). В исследовании приняли участие 156 детей в возрасте от 5 до 12 лет. В ходе эксперимента с использованием «теста цветной дорожки» были оценены показатели устойчивости шага, равновесия, внимания и моторной активности. Результаты показали, что применение ортопедической обуви с цветными визуальными маркерами способствует улучшению координации движений, ритма шага и пространственной ориентации у детей. Особенно контрастные цветовые элементы положительно повлияли на концентрацию внимания, контроль движений и точность шагов. Статистический анализ показал, что результаты экспериментальной группы были достоверно выше по сравнению с контрольной группой ($p < 0,05$). Полученные результаты имеют практическое значение для разработки функционально-коррекционных конструкций ортопедической обуви и применения их в реабилитации детей. Использование цветных маркеров повышает эффективность сенсомоторной коррекции и расширяет возможности самостоятельного передвижения детей. Рекомендации исследования могут служить для создания современных адаптивных моделей ортопедической обуви.

Ключевые слова: обувь, детский церебральный паралич, цветовая коррекция, движение, ходьба, физиологический, психологический, реабилитация, контрастные цветовые элементы, сенсомоторная коррекция, координация ходьбы, ритм шага, цветовые визуальные маркеры.

At present, the rehabilitation of children with cerebral palsy (CP) and the improvement of their independent motor activity are considered among the most pressing issues in the fields of medicine, pedagogy, psychology, and orthopedic product design. CP is manifested in children through impaired motor coordination, balance maintenance, spatial orientation, and gait functions. This negatively affects children's social adaptation, psycho-emotional condition, and overall quality of life[1].

In the modern rehabilitation system, orthopedic footwear is regarded not only as a mechanical support tool for the musculoskeletal system, but also as a functional means of providing sensorimotor correction and visual adaptation. In particular, studies investigating the influence of colors on human psychology and motor activity have shown that contrast and visual markers improve concentration, movement control, and spatial orientation [2,3].

At the same time, the psychophysiological and functional effects of using colored visual markers in orthopedic footwear designed for children with CP have not yet been sufficiently studied. Most existing studies focus mainly on medical rehabilitation or the mechanical properties of orthopedic constructions, while limited attention has been paid to the influence of visual-navigation elements on gait coordination and motor activity [4].

In this regard, the present study investigates the possibilities of using colored visual elements in the design of orthopedic footwear for children with cerebral palsy, as well as their effects on step stability, balance, attention, and movement activity. The findings of this research are considered to have practical significance for improving functional and adaptive orthopedic footwear designs for children with CP[5].

Research Objective. The purpose of this study is to investigate the psychophysiological and functional effects of using colored visual markers in orthopedic footwear designed for children with cerebral palsy (CP), as well as to evaluate their influence on step stability, balance, spatial orientation, and motor activity [4].

Research Tasks. The study aims to analyze disorders of motor coordination and gait activity in children with cerebral palsy; to examine the psychophysiological effects of colors and their significance in the rehabilitation process; and to identify

the functional characteristics of colored visual markers used in orthopedic footwear constructions. Furthermore, the study evaluates the influence of colored markers on motor activity in spastic, diplegic, and hemiparetic forms of CP. Using the “Colored Path Test,” the research analyzes children’s step stability, balance, and level of concentration, and develops proposals for the design of functional-corrective orthopedic footwear based on colored navigational elements for children with CP[5].

Scientific Novelty of the Research. For the first time, the functional effectiveness of using colored visual markers as a means of sensorimotor correction in orthopedic footwear constructions for children with cerebral palsy (CP) was experimentally substantiated. The study focused on investigating the psychophysiological effects of colored visual elements in children with CP and the possibilities of applying them in orthopedic footwear design. The research was conducted on the basis of a comprehensive approach, utilizing pedagogical observation, sociological surveys, comparative analysis, and statistical processing methods.

Children with different clinical forms of cerebral palsy participated in the study. It was observed that the proportion of children with the spastic form was the highest, which is consistent with data reported in the scientific literature. In particular, children with motor impairments associated with spastic, diplegic, and hemiparetic forms of CP were analyzed.

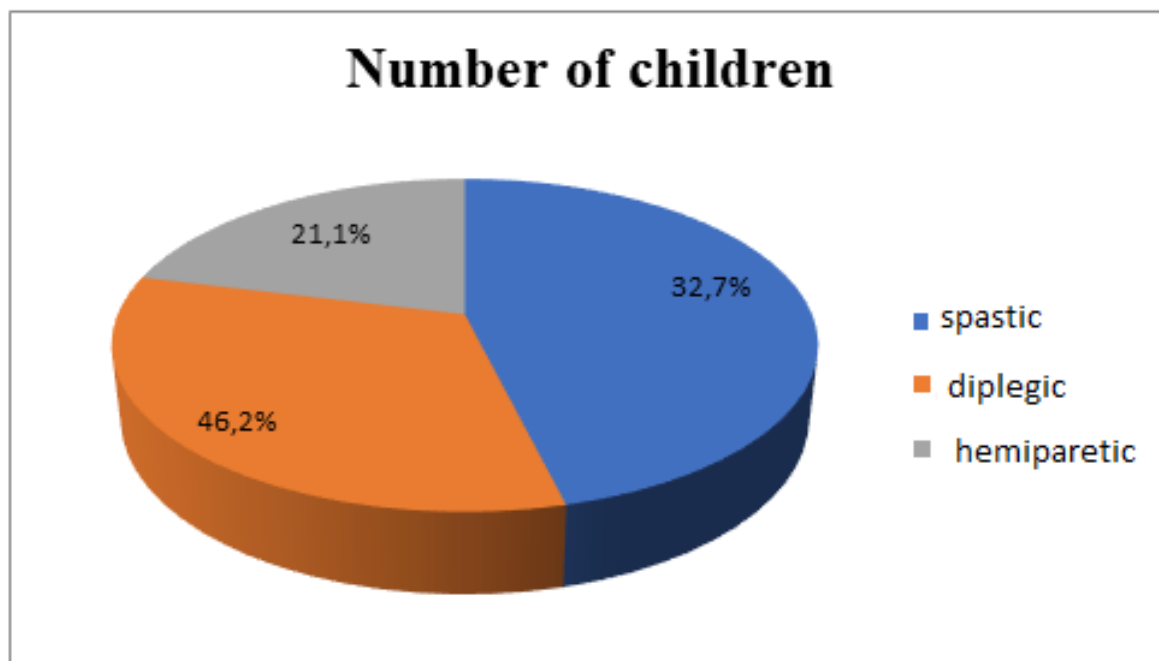


Figure 1. Percentage Distribution of Participants According to the Clinical Forms of CP.

The figure above presents the percentage distribution of participants according to the clinical forms of cerebral palsy (CP). The spastic form is considered the most common type of CP and is characterized by increased muscle tone and restricted movements. In such children, disturbances in step stability and balance during walking are frequently observed. Therefore, the use of visual markers and contrasting colors in orthopedic footwear may facilitate movement control.

In the diplegic form, the muscles of the lower limbs are primarily affected. Children experience difficulties in walking, impaired coordination between the legs, and reduced ability to maintain balance. Colored directional signs and step markers may serve as supportive tools in developing gait rhythm.

In the hemiparetic form, one side of the body is affected. As a result, motor activity in either the left or right leg decreases, and asymmetry in stepping movements is observed [5].

Table 1.

Distribution of Participants According to the Clinical Forms of CP

Clinical Form of CP	Number of Children (n)
Spastic	72
Diplegic	51
Hemiparetic	33
Total	156

Accordingly, the research was conducted at the Republican Children's Neuropsychiatric Hospital named after U.Q. Qurbonov, located in the Mirzo Ulugbek district of Tashkent city. A total of 200 respondents participated in the study. Of these, 156 were children diagnosed with cerebral palsy, who were divided into experimental and control groups. In the experimental group, orthopedic footwear samples equipped with colored visual markers were used, whereas the control group used conventional orthopedic footwear. The remaining respondents consisted of parents, rehabilitation specialists, and users of orthopedic footwear [6].

The children participating in the study were between 5 and 12 years of age and demonstrated impairments in motor coordination, balance, and gait activity. Among them, 87 children were aged 5–7 years, while 69 children were aged 8–12 years [6].



The experimental tests were carried out over a period of 14 days during rehabilitation sessions. In the research process, a “colored pathway test” measuring 5 meters in length and 60 cm in width was used. Colored step markers were placed along the pathway at intervals of 30–40 cm. During the test, green, red, blue, and yellow visual markers were applied. Throughout the study, the effects of colored visual markers on step stability, balance, and motor activity were observed [7].

Children’s step stability, balance, motor coordination, and spatial orientation were evaluated using a 5-point assessment system. The obtained results were analyzed through comparative and statistical methods. In addition, a test entitled “Step Stability” was conducted. In this test, the uniformity of the distance between steps, gait coordination, and the stability of motor control were examined. During the assessment of step stability, observations were made regarding the child’s stepping accuracy while moving along the colored pathway, the consistency of step intervals, the ability to maintain walking direction, and cases of balance disturbance [8].

During the research, it was observed that the use of orthopedic footwear with colored visual markers contributed to the formation of more accurate and stable stepping patterns in children. In particular, contrast-colored markers improved visual orientation and assisted in controlling gait rhythm.

After the application of orthopedic footwear with colored markers in the experimental group, significant improvements in step stability indicators were recorded.

Table 2.

Results of Step Stability Assessment Based on the Colored Pathway Test

Indicators	Very Low	Low (2 points)	Medium (3 points)	Good (4 points)	Very Good (5 points)	Total
Step accuracy	18	34	41	39	24	156
Stability of step rhythm	22	37	46	33	18	156
Maintaining direction	15	29	44	42	26	156

Maintaining balance	24	38	40	35	19	156
Understanding colored markers	11	26	39	47	33	156
Walking according to visual patterns	14	31	42	45	24	156

According to the results of the Colored Pathway Test, it was observed that in the majority of children, the indicators of stepping accuracy and movement based on visual markers were at medium and good levels. During the study, the use of colored visual markers increased children's interest in movement and had a positive effect on improving spatial orientation during walking [9].

Table 3.

Average Values of Functional Indicators

Indicator	M±m
Step stability	3.24±0.08
Balance	3.11±0.07
Attention	3.42±0.09
Motor activity	3.58±0.08

The results presented in the table showed that, according to the Colored Pathway Test, the average step stability score among 156 children was 3.24±0.08 points. Statistical analysis revealed that the indicators of the experimental group were significantly higher than those of the control group ($p<0.05$) [10].

The findings of this study demonstrated that the use of colored visual markers in orthopedic footwear designed for children with cerebral palsy produced effective results in the process of sensorimotor correction. During the research, contrast-colored elements positively influenced improvements in step stability, motor coordination, balance, and spatial orientation indicators [10].

According to the results of the “Colored Pathway Test,” colored markers helped children control gait rhythm, maintain step accuracy, and increase motor activity. Statistical analysis showed that the indicators of the experimental group were significantly higher than those of the control group ($p<0.05$) [11].

The obtained results confirm the feasibility of using orthopedic footwear constructions equipped with colored visual navigation elements in the rehabilitation of children with cerebral palsy.



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