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DEVELOPMENT OF FUNCTIONAL VISION IN CHILDREN WITH PERINATAL BRAIN DAMAGE

RAZVOJ FUNKCIONALNOG VIDA I ZNAČAJ RANE INTERVENCIJE KOD DJECE S PERINATALNIM OŠTEĆENJEM MOZGA

Sadmela Bratanović, Amela Teskeredžić, Hurma Begić*

Faculty of Education and Rehabilitation Sciences, University of Tuzla
Univerzitetska 1 Street, 75000 Tuzla, Bosnia and Herzegovina

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ABSTRACT

The sense of sight plays a very important role in the life of every individual, since we receive most of the information from the environment with the help of sight. Visually impaired children have difficulty receiving information from the world around them. Lack of visual experience can negatively affect their development. Timely examinations and assessments will indicate the occurrence of various neurological disorders in children, if any are present. A very common cause of neurological disorders is perinatal brain damage. Children with perinatal brain damage often have difficulties in visual functioning and it is therefore very important to assess functional vision in these children. If there are any neurodevelopmental disorders in the child, it is important to start vision rehabilitation as soon as possible, in order to effectively influence the improvement of visual functions.

Keywords: functional vision, perinatal brain damage, early vision rehabilitation.

SAŽETAK

Osjet vida ima veoma važnu ulogu u životu svakog pojedinca, budući da najviše informacija iz okoline primamo uz pomoć vida. Kod djece oštećena vida javljaju se poteškoće pri primanju informacija iz svijeta koji ih okružuje. Nedostatak vizuelnog iskustva može uticati negativno na njihov razvoj. Pravovremena ispitivanja i procjena ukazat će na pojavu različitih neuroloških poremećaja kod djece ukoliko postoje. Jako čest uzrok neuroloških poremećaja jeste perinatalno oštećenje mozga. Djeca sa perinatalnim oštećenjem mozga često imaju poteškoće u vizuelnom funkcionisanju te je stoga jako važno procijeniti funkcionalni vid kod ove djece.

* **Corresspondence to:**
Hurma Begić, Faculty of Education and Rehabilitation, University of Tuzla
E-mail: hurmabegicjahic@gmail.com

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Ukoliko su prisutna neka neurorazvojna odstupanja kod djeteta, važno je što prije početi sa rehabilitacijom vida, kako bi se efikasno uticalo na poboljšanje vidnih funkcija.

Ključne riječi: funkcionalni vid, perinatalna oštećenja mozga, rana rehabilitacija vida.

INTRODUCTION

Intervention at an early age is of great importance for the development of a child with visual impairment (Radovanović, 2004). The developmental processes of brain maturation take place most rapidly in the first months of the first year of life. This is especially true for processes that allow reorganization after function damage. This process, the so-called brain plasticity is limited to early childhood (Mejaški-Bošnjak, Đuranović, Gojmerac, & Krakar, 2005). Since early visual impairment can affect a child's development, it is necessary to make an assessment of visual functions and functional vision (Colenbrander, 2010). "Assessment of visual functions serves to describe specific visual behaviors, and assessment of functional vision refers to the assessment of a person's residual vision and describes the way a person uses their visual skills during daily activities" (Alimović, Katušić and Jurić, 2013).
The development of vision can be conditioned by perinatal brain damage (Boonstra, Limbutg, Tijmes, Gendern, Schuil and Nispen, 2012). Children with severe perinatal brain damage have greater problems in visual functioning compared to children with mild brain damage (Alimović, 2013). After the impairment is diagnosed and the assessment of visual functions and functional vision is performed, based on the obtained results, a program of visual stimulations is created and implemented in order to raise awareness of the rest of the child's vision for more efficient use (Alimović, Katušić and Jurić, 2013).

INFLUENCE OF VISION ON CHILD DEVELOPMENT

Visually impaired children are lacking in various areas of development, especially in imitation and movement (Prechtl, Zionini, Einspieler, Bos, & Ferrari, 2001). Visual impairment also has an impact on child development in the context of a limiting impact on the integration and interpretation of data obtained through other senses, on the development of social skills and other cognitive concepts (Sonksen and Dale, 2002). For this reason, visual impairment is one of the main causes of childhood difficulties in children (Fazzi, Signorini, Bova, Ondei, & Bianchi, 2005). Timely detection of visual impairments is important for more efficient implementation of preventive measures for the protection of vision (Alikadić Husović, Alender and Ljaljević, 2006). In visually impaired children, visual perception is reduced, and in blind children, it is absent at all (Šupe, 2009). Depending on the degree of visual impairment, the child receives limited visual impressions from the reality that surrounds it, which is why its observations and performances are incomplete (Teskeredžić and Tulumović, 2013). Konecki (2013) states, that the process of processing an image obtained through the sense of sight involves a series of information processed through the brain. The development of visual function from birth affects learning processes, since young children learn by imitation - due to visual impairment - this process is difficult (Hećimović, Martinec and Runjić, 2014).

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The development of its visual functioning will depend on how the child uses sight when planning and performing activities (Moslavac, Bošnjak-Nađ and Kapitanović, 2019). Dale, Sakkalou, O'Reilly, Springall, De Haan, and Salt (2017) examined the impact of vision on a child's early development. The study included infants aged 8-16 months, with congenital visual impairment, in whom vision and nonverbal cognition were assessed. The results showed that new-borns with congenital visual impairment have the most difficulty with cognitive functions.

FUNCTIONAL VISION AND ASSESSMENT OF FUNCTIONAL VISION

Vision development is a complex process and arises as a result of what is inherited and the experience gained from the environment (Dorn, 2004). According to Politzer (2008), the visual process can be divided into three categories: visual acuity and visual field; motor abilities of the eye; and visual perception. Visual acuity refers to the clarity of vision, while the visual field is the complete central and peripheral range of vision. The motor abilities of the eye include fixation, tracking, saccades, accommodation, convergence, binocularity, and stereovision. For the interpretation of the environment that surrounds us, the answer is visual perception. Taking into account the above, the complete ability of visual perception consists of visual-motor integration (eye-hand, eye-foot and eye-body coordination); visual-auditory integration (connecting what is seen and what is heard); visual memory (ability to remember and recall what is seen); visual closure (filling in missing parts based on seen parts); spatial relations "(knowledge of where I am - in relation to objects and space around us as well as where objects are in relation to each other), and character-background discrimination (distinguishing objects from background)" (Politzer, 2008). Colenbrander (2010) states that the sense of sight is very important for the overall development of a child, and that for this reason it is necessary to determine as soon as possible how children use their sight in everyday life. Rehabilitators under the term functional vision imply the ability of a person to use their rest of vision in planning and performing tasks, while ophthalmologists under functional vision imply the absence of limitations in visual functions (Colenbrander, 2010). Visual functions, in contrast to functional vision, refer to measurable visual behaviours such as object fixation, eye mobility, and the like. (Alimović, 2013). Prerequisite for timely recognition of deviations in the development of vision is knowledge of the physiological development of vision (Knezović, I., et al., 2015).

In children, functional vision is most often assessed through four areas:

1) solving close-up tasks (observing the child's behaviour in tasks such as searching the desktop, spotting objects at short distances and assessing the position of objects),

2) communication (implies noticing visual characteristics in communication),

3) everyday skills (related to information during daily activities, such as feeding),

4) orientation and movement (involves observing objects and assessing the position of objects in relation to the body in space) (Hyvärinen, 2003).

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The ability to use sight in the above situations is most often assessed on a scale of 3 levels: 1 = usage of the techniques of persons with no visual impairments (in solving tasks it relies primarily on visual information); 2 = usage of techniques of visually impaired people (in solving tasks, visual information that is checked through other senses is used) and 3 = usage of techniques of a blind person (in solving tasks the person relies on the remaining senses, does not use sight at all) "(Hyvärinen, 2003). Alimović and Mejaški-Bošnjak (2011) state that when observing functional vision, it is assessed how a person acts in relation to the use of residual vision. During the assessment of visual functioning, it is necessary to take into account the ability to retain visual attention (Carrasco, 2011). Visual attention implies a focus on certain characteristics of the environment, in order to acquire visual information (Bisley, 2011). If visual information is used to perform certain activities, then such vision is considered functional (Alimović, 2012).

In a study of the importance of assessing and promoting functional vision, visual functions and functional vision were assessed in 30 children, from birth to 3 years of age with perinatal brain damage and visual impairment. After the program of visual stimulations, the variables of functional vision and sensitivity to contrast were significantly improved, while visual acuity improved in only 2.7% of children. Based on the results, it was concluded that the assessment of functional vision is necessary in the early monitoring of a child with perinatal brain damage (Alimović, Jurić and Mejaški-Bošnjak, 2014). Alimović (2013), in his research, compares the differences in the development of visual functions and functional vision in relation to the type and degree of perinatal damage. The study included 101 children aged from early birth days to 3 years who were assessed for functional vision. The results showed that children with perinatal brain damage, who started the visual stimulation program within the first year of life, achieved better results in the progress of visual functioning, than children who started the program within the second year of life. Similar results were obtained by Alimović, Katušić and Jurić (2013), in a study of improving functional vision in 100 children with perinatal brain damage after a visual stimulation program. Based on the results in this study, the greatest improvement was noted in the ability to retain visual attention. The results of visual acuity detection in 50 children with severe perinatal brain damage were compared with the developmental norms of visual acuity detection in children of typical development. Most children had intracranial haemorrhage, periventricular leukomalacia, and hypoxic ischemic changes. The results showed that in most children with severe perinatal brain damage, detection visual acuity developed below the expected limit for the chronological age (Alimović, Penava and Sikirić, 2015).

The study of visual functioning of children with intellectual disabilities concluded that the visual functions of most children are developed below the expected results in relation to their age, and that assessment of functional vision must become mandatory for children with intellectual disabilities, in order to identify visual impairments and that the adjustment of teaching aids and methods must be made (Alimović, 2017). Tončić (2018) claims that visually impaired children, after a vision rehabilitation program, achieve better reading results, general and specific visual functionality.

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PERINATAL BRAIN DAMAGE-EARLY INTERVENTION AND VISION REHABILITATION

Today, it is considered that 10-15% of children belong to the group of neuro-risk children, while 50% of these children may experience mild or severe neurodevelopmental disorders (Mustafić and Trnovčević, 2006). Mejaški-Bošnjak (2007) points out that the most common cause of neurodevelopmental disorders in children is brain damage during pregnancy, childbirth and the new-born/infant period. Precisely for this reason, perinatal brain damage has a special place among the causes of neurodevelopmental disorders (Jugović et al., 2007). The most common types of perinatal brain damage are: intracranial haemorrhage, vascular disorders, hypoxic-ischemic damage, infection and bilirubinemic encephalopathy (Mejaški-Bošnjak, 2007). One of the causes of brain damage is the release of glutamate, calcium accumulation and lipid peroxidation (Perlman, 2006).

The most common causes of intracranial haemorrhage are mechanical head injuries when passing through the birth canal and hypoxia, which causes venous congestion of the brain and damages the capillary endothelium (Behrman, Kliegman and Jenson, 2000; according to Ljutić, 2013). If these haemorrhages occur in the first week of life, they worsen the neurodevelopmental diagnosis of the new-born (Goldstein, Cotten, Shankaran, Gantz and Poole, 2013), which leads to various cognitive impairments (Schmid, Reister, Mayer, Hopfner, Fuchs and Hummler, 2013). Gram et al. (2013) state that there is still no known therapy that would help the new-born to prevent the occurrence of neurodevelopmental disorders after intracranial haemorrhage. Another type of perinatal brain damage is hypoxic-ischemic encephalopathy (HIE), which is non-progressive, and which occurs as a result of disorders of the brain's blood and oxygen supply (Presečki, Benjak and Barišić, 2009; according to Alimović, 2013).

In the postnatal period, about 15–25% of affected infants die, while 25% develop severe and permanent neurodevelopmental consequences, including visual impairment (Liu and Mccullough, 2013). In his paper, Kuzmanić-Šamija (2015) states that premature infants are a particularly vulnerable group of new-borns for early brain damage, and the frequency of brain damage is higher if the gestational age is lower, i.e. the immaturity of the preterm new-born and if the birth weight is lower. Since there are no well-established treatments when it comes to HIE, it is important to understand the complete pathophysiology to prevent deterioration (Dixon, Reis, Mann Ho, Thang, and Zhang 2015). The neurodevelopmental outcome of a child after brain damage will largely depend on the interactions/relations: the child and the environment, existing brain damage, and compensatory processes of maturation and brain plasticity (Matijević and Marunica Karšaj, 2015). Being able to understand the causes of perinatal brain damage can help identify new strategies for the prevention and treatment of the child in order to reduce the neurological consequences (Hagberg et al., 2015). Alimović, Katušić and Špionjak (2009) found that there are significant differences in children in neurodevelopmental outcome with regard to the type of perinatal brain damage and the time of inclusion in the early intervention program, and that there is a need for habilitation programs in treatment of these children.

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By analysing the incidence and risk factors for the development of intracranial haemorrhage in 150 preterm infants, the results showed that 60% of them had intracranial haemorrhage, with a significant difference in Apgar score, gestational age, birth weight, age and the prophylactic use of the surfactant. Based on the obtained results, it was concluded that the most important factor for the occurrence of intracranial haemorrhage is the use of corticosteroids (Spasojević, Stojanović, Savić and Doronjski, 2010). The characteristics of intracranial haemorrhage in 42 new-borns younger than one month were examined by Hong and Lee (2018) in Korea. Clinical data, mode of childbirth, Apgar score at 1 and 5 minutes, hypoxic injury, neurological symptoms, bleeding site and extent, and developmental outcomes were reported. A total of 30 infants had a combination of infratentorial and supratentorial bleeding. Subdural haemorrhage was the most common type of intracranial haemorrhage, and 44.4% of children had a poor prognosis, while perinatal asphyxia was the most common significant cause. In a study conducted on a sample of 170 high-neurosis children, the results showed that in 75% of children with severe neuromotor abnormalities, brain ultrasound indicated structural changes in perinatal impairment. 38 children had vision impairment, and blindness was recorded in 3 children. 14 children had an abnormal EEG, while West's syndrome and febrile convulsions were observed in 2 children each. Based on the results, it was concluded that neuro-risk children should be recognized and diagnosed early, their development observed, and in case of neurodevelopmental disorders, included in habilitation programs early (Bošnjak-Nađ, Mejaški-Bošnjak, Popović Miočinović, Gverić Ahmetašević and Đaković, 2011). The results of a study evaluating the role of oxidative stress in 90 neonates with perinatal hypoxic-ischemic encephalopathy showed that oxidative stress could be an important factor contributing to hypoxic-ischemic brain damage, especially in preterm infants (Vasiljević, Maglajlić-Dlajlajjni Stankovic, 2012). A large number of new-borns with asphyxia that developed at birth are exposed to the possibility of hypoxic-ischemic encephalopathy. In this case, care by professional staff is very important, in order to influence the improvement of neonatal outcomes (Simiyu, Mchaile, Katsongeri, Philemon and Msuya, 2017).

Harmony et al. (2016), conducted a study aimed at determining the effectiveness of the "neurorehabilitation" method. Infants younger than 2 months with perinatal risk factors for brain damage were included in the study, divided into two groups. One group was treated by the "neurorehabilitation" method (n = 20), while the other was not treated (n = 13) because treatment was voluntarily discontinued after the initial evaluation. At the first examination, all children showed abnormal clinical characteristics as well as an unfavourable picture after magnetic resonance imaging tests. The results showed that the treated group had a higher percentage (90%) of children with the expected outcome than the untreated group. In the second group, only one in five children born before 34 weeks had the expected outcome.

By presenting the types of perinatal damage and the mentioned research, the importance of early intervention and vision rehabilitation can be noticed. Early intervention of an infant with severe visual impairment caused by brain damage may have a different prognosis (Dutton and Jacobson, 2002). Difficulties that occur in children with perinatal brain damage may remain present for the rest of their lives (Jensen, Garnier, Middelanis, & Berger, 2003).

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For this reason, the inclusion of the child in the early intervention program is of great importance for the development of all its abilities, since the child already in the first interactions with the environment acquires experiences that are the basis for further development. Intervention at an early age is defined as timely assistance to the child and its parents (Radovanović, 2004). Blauw-Hospers and Hadders-Algra (2005) state that "early intervention consists of multidisciplinary procedures that promote a child's health, encourage developmental skills, reduce developmental delays, eliminate existing or prevent possible disorders, prevent functional deterioration, and promote family functioning. Only such procedures can stimulate the processes of plasticity of the brain and accelerate the recovery of impaired function (Mejaški-Bošnjak, 2007). Katušić (2011) states that the term plasticity refers to the brain's ability to learn, remember and forget, but also to its ability to reorganize and recover after damage.

Therefore, vision rehabilitation is carried out as part of early intervention and refers to a series of procedures that are applied with the aim of correcting and improving binocular vision, oculomotor and visual perception. Such rehabilitation involves visual stimulation at the earliest age, and later vision exercises. The goals of vision rehabilitation are determined on the basis of the assessment of functional vision, where the basic goal is the rehabilitation of visual functions and more efficient use of vision in everyday activities (Alimović, Katušić and Jurić, 2013). Visual stimulation will help the child become aware of the rest of its vision and focus on using it more efficiently (Alimović, 2012). During exercise, all procedures are individualized and controlled, and are applied depending on the child's reactions to individual stimuli (Ayers, 2002; according to Bošnjak-Nađ, Kapitanović Vidak, Petrović, Tomašković and Nađ, 2019).

Alimović and Mejaški Bošnjak (2011), determined the visual functioning of children with perinatal brain damage, aged 3 years, during which different types of visual stimulation were performed with children. Through a program of visual stimulation, some children are stimulated with light stimuli, some with different materials under ultraviolet light, and some with high-contrast materials. After a one-year program, there was a significant improvement in functional vision, especially in visual attention and visual communication. The results of the research, which aimed to determine the frequency of inclusion of children with neurodevelopmental risk in the early rehabilitation program, given the level of parental education, indicated insufficient information of parents about the importance of early childhood, but also about the possibilities of including neuro-risk children in early rehabilitation programs (Matijević Mikelić, Košiček, Crnković and Radanović, 2011). Researching the impact of rehabilitation on the functional vision of visually impaired children, it was concluded that it is important for these children to apply early rehabilitation to reduce the negative effects associated with visual impairment and to improve their learning abilities (Ganesh, Sethi, Srivastav, Chaudhary and Arora, 2013). In a study of the critical period for visual stimulation in children with perinatal brain damage, 35 children in the first eight months of life were compared with 35 children between the ages of eight and thirty months, all with perinatal brain damage.

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The results showed that children who started a visual stimulation program in the first eight months of life had more improvements in visual functions (Alimović, Katušić and Mejaški-Bošnjak, 2013), which confirms the fact that timely inclusion of highly neurological children in the early intervention program can prevent or at least reduce their neurodevelopmental deviation (Bošnjak-Nađ et al., 2019).

CONCLUSION

From this overview of the development of functional vision in children with perinatal brain damage, and based on available research, it can be seen that for the neuro-risk group of children and children with low Apgar values it is important to ensure timely diagnosis, to educate their parents, provide early stimulation programs, and provide a stimulating environment that will constantly encourage their development. A review of the available literature showed that there is a lack of research related to the involvement of children in the activities of everyday life as well as to determine the effectiveness of the use of residual vision. Therefore, we can conclude that if the treatment is started on time, then such rehabilitation will have a more effective outcome on the child's development. Future research should include a series of activities that will raise awareness among the population about the importance of early intervention and vision rehabilitation in children with neurodevelopmental disorders.

LITERATURE

1. Alikadić Husović, A., Aleneder, M., Ljaljević, S. (2006). *Kako sačuvati vid*. Sarajevo: Ministarstvo zdravstva Kantona Sarajevo.
2. Alimović, S. (2012). The assessment and rehabilitation of vision in infants. *Paediatria Croatic*, 56(1): 218-226.
3. Alimović, S. (2013). *Razvoj funkcionalnog vida kod djece s perinatalnim oštećenjem mozga* (Doktorska disertacija). Preuzeto sa https://core.ac.uk/download/pdf/18506751.pdf
4. Alimović, S. (2017). Problemi u vizualnom funkcioniranju djece s intelektualnim teškoćama. *Hrvatska revija za rehabilitacijska istraživanja*, 53(n.b.): 98-104.
5. Alimović, S., Jurić, N., Mejaški-Bošnjak, V. (2014). Functional vision in children with perinatal brain damage. *Journal of Maternal-Fetal and Neonatal Medicine*, 27(14): 1491-1494.
6. Alimović, S., Katušić, A., Jurić, N. (2013). Ishod rane habilitacije funkcionalnog vida u djece s perinatalnim ozljedama mozga. *Hrvatska revija za rehabilitacijska istraživanja*, 4(9): 1-9.
7. Alimović, S., Katušić, A., Mejaški-Bošnjak, V. (2013). Visual stimulations' critical period in infants with perinatal brain damage. *NeuroRehabilitation*, 33(2): 251-255.
8. Alimović, S., Katušić, A., Špionjak, J. (2009). Neurorazvojni ishod u djece sa cerebralnom paralizom. *Paediatria Croatica*, 53(3).
9. Alimović, S., Mejaški-Bošnjak, V. (2011). Stimulation of Functional Vision in Children with Perinatal Brain Damage. *Coll. Antropol*, 35(1): 3-9.

Research in Education and Rehabilitation 2021; 4(2): 109-119. DOI 10.51558/2744-1555.2021.4.2.109

10. Alimović, S., Penava, V., Sikirić, D. (2015). Vidna oštrina u djece s teškim perinatalnim oštećenjem mozga. Vuković, M. (ur.), *Specijalna edukacija i rehabilitacija danas: Zbornik radova devetog međunarodnog naučnog skupa* (str. 65-72). Beograd: Univerzitet u Beogradu-Fakultet za specijalnu edukaciju i rehabilitaciju.
12. Bisley, J. W. (2011). The neural basis of visual attention. *J Physiol*, 589(1): 49-57.
13. Blauw-Hospers, C. H., Hadders-Algra, M. A. (2005). Systematic review of the effects of early intervention on motor development. *Dev Med Child Neurol*, 47(6): 421-432.
14. Boonstra, N., Limbutg, H., Tijmes, N., Gendern, M., Schuil, J., Nispen, R. (2012). Changes in causes of low vision between 1988 and 2009 in a Dutch population of children. *Acta Ophthalmologica*, 90(3): 277-286.
15. Bošnjak, V., Đuranović, V., Gomjerac, T., Krakar, G. (2005). Intrakranijska ultrasonografija u dijagnostici perinatalnog oštećenja mozga. *Medicina: glasilo Hrvatskoga liječničkoga zbora*, 42(41): 49-55.
16. Bošnjak-Nađ, K., Kapitanović Vidak, H., Petrović, D., Tomašković, M., Nađ, I. (2019). Rano otkrivanje visokoneurorizične djece i uključivanje u programe rane intervencije. *Paediatr Croat*, 63(1): 107-111.
17. Bošnjak-Nađ, K., Mejaški-Bošnjak, V., Popović Miočinović, Lj., Gverić Ahmetašević, S., Đaković, I. (2011). Rano otkrivanje neurorizične djece i uključivanje u rane habilitacijske programe. *Paediatr Croat*, 55(2): 121-128.
18. Carrasco, M. (2011). Visual attention: The past 25 years Vision Res. *Vision Research*, 51(13): 1484-1525.
19. Colenbrander, A. (2010). Assessment of functional vision and its rehabilitation. *Acta Ophthalmologica*, 88(2): 163-173.
20. Dale, N., Sakkalou, E., O'Reilly, M., Springall, C., De Haan, M., Salt, A. (2017). Functional vision and cognition in infants with congenital disorders of the peripheral visual system. *Dev Med Child Neurol*, 59(7): 725-731.
21. Dixon, B. J., Reis, C., Mann Ho, W., Thang, J., Zhang, J. H. (2015). Neuroprotective Strategies after Neonatal Hypoxic Ischemic Encephalopathy. *International Journal of Molecular* Sciences, 16(9): 22368-22401.
22. Dorn, Lj. (2004). Vid i vidna oštrina u male djece. *Paediatr Croat*, 48(1): 247-254.
23. Dutton, G. N., Jacobson, L. K. (2002). Cerebral visual impairment in children. *Seminars in Neonatology*, 6(6): 477-485.
24. Fazzi, E., Signorini, S. G., Bova, S. M., Ondei, P., Bianchi, P. E. (2005). Early intervention in visually impaired children. *International Congress Series*, 1282(n.b.): 117-121.
25. Ganesh, S., Sethi, S., Srivastav, S., Chaudhary, A., Arora, P. (2013). Impact of low vision rehabilitation on functional vision performance of children with visual impairment. *Oman J Ophthalmol*, 6(3): 170-174.
26. Goldstein, R. F., Cotton, C. M., Shankaran, S., Gantz, M. G., Poole, W. K. (2013). Influence of gestational age on death and neurodevelopmental outcome in premature infants with severe intracranial hemorrhage. *Journal of Perinatology*, 33(1): 25-32.

Research in Education and Rehabilitation 2021; 4(2): 109-119. DOI 10.51558/2744-1555.2021.4.2.109

27. Gram, M., Sveinsdottir, S., Ruscher, K., Hansson, S. R., Cinthio, M., Åkerström, B., Ley, D. (2013). Hemoglobin induces inflammation after preterm intraventricular hemorrhage by methemoglobin formation. *Journal of Neuroinflammation*, 10(1): 1-13.
28. Hagberg, H., Mallard, C., Ferriero, D. M., Vannucci, S. J., Levison, S. W., Vexler, Z. S., Gressens, P. (2015). The role of inflammation in perinatal brain injury. *Nature Reviews Neurology*, 11(4): 192-208.
29. Harmony, T., Barrera-Reséndiz, J., Juárez-Colín, M. E., Carrillo-Prado, C., Pedraza-Aguilar, M. C., Asprón Ramírez, A., …Ricardo-Garcell, J. (2016). Longitudinal study of children with perinatal brain damage in whom early neurohabilitation was applied: Preliminary report. *Neuroscience Letters*, 611: 59-67.
30. Hećimović, I., Martinec, R., Runjić, T. (2014). Utjecaj terapije pokretom i plesom na sliku tijela adolescenata sa slabovidnošću. *Hrvatska revija za rehabilitacijska istraživanja*, 50(1): 14-25.
31. Hong, H. S., Lee, J. Y. (2018). Intracranial hemorrhage in term neonates. *Child's Nervous System*, 34(6): 1135-1143.
32. Hyvärinen, L. (2003). How to classify paediatric low vision. Preuzeto sa http://lea-test.info/en/assessme/paediatric_low_vis.html
33. Jensen, A., Garnier, Y., Middelanis, J., Berger, R. (2003). Perinatal brain damage-from pathophysiology to prevention. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 110(1): 70-79.
34. Jugović, D., Tumbri, J., Medić, M., Kusan Jukić, M., Kurjak, A., Arbeille, P., Salihagić-Kadić, A. (2007). New Doppler index for prediction of perinatal brain damage in growth-restricted and hypoxic fetuses. *Ultrasound in Obstetrics & Gynecology*, 30(3): 303-311.
35. Katušić, A. (2011). Early brain injury and plasticity: Reorganization and functional recovery. *Translational Neuroscience*, 2(1): 33-42.
36. Knezović, I., Belovari, M., Belšak, Z., Cerovski, B., Kacun, I., Knezović, A., ...Vukojević, D. (2015). *Oftalmologija za studij sestrinstva*. Bjelovar: Visoka tehnička škola u Bjelovaru.
37. Konecki, M. (2013). *Sistem za pomoć osobama oštećena vida za potrebe programiranja grafičkih sučelja* (Doktorska disertacija). Preuzeto sa https://repozitorij.foi.unizg.hr/islandora/object/foi:534
38. Kuzmanić-Šamija, R. (2015). Neuropedijatrijsko praćenje neurorizične djece. Preuzeto sA http://poliklinika-gemini.hr/neuropedijatrijsko-pracenje-neurorizicne-djece/
39. Liu, F., Mccullough, L. D. (2013). Inflammatory responses in hypoxic ischemic encephalopathy. *Acta Pharmacologica Sinica*, 34(9): 1121-1130.
40. Ljutić, T. (2013). Najčešći čimbenici perinatalnog oštećenja središnjeg živčanog sistema. *Hrvatska revija za rehabilitacijska istraživanja*, 49(2): 158-171.
41. Matijević, V., Marunica Karšaj, J. (2015). Neurorizično dijete. *Fizikalna i rehabilitacijska medicina*, 27(1,2): 133-142.
42. Matijević Mikelić, V., Košiček, T., Crnković, M., Radanović, B. (2011). Uključenost djece s čimbenicima neurorizičnosti u program rane rehabilitacije s obzirom na razinu obrazovanja roditelja. *Acta clinica Croatica*, 50(4): 457-460.

Research in Education and Rehabilitation 2021; 4(2): 109-119. DOI 10.51558/2744-1555.2021.4.2.109

43. Mejaški-Bošnjak, V. (2007). Dijagnostički pristup ranom otkrivanju neurorazvojnih odstupanja. *Peadiatria Croatica,* 51(1): 105-110.
44. Moslavac, A., Bošnjak-Nađ, K., Kapitanović Vidak, H. (2019). Rana stimulacija vida kod visokoneurorizične djece. *Paediatr Croat*, 63(1): 137-140.
45. Mustafi, N., Trnovčević, J. (2006). Neurorizično dijete. *Pedijatrija danas,* 2(1): 54-60.
46. Perlman, J. M. (2006). Intervention strategies for neonatal hypoxic-ischemic cerebral injury. *Clinical Therapeutics,* 28(9): 1353-1365.
47. Politzer, T. (2008). Vision Is Our Dominant Sense. Preuzeto sa https://www.brainline.org/article/vision-our-dominant-sense
48. Prechtl, H. F., Cionini, G., Einspieler, C., Bos, A. F., Ferrari, F. (2001). Role of vision on early motor development: lesson from the blind. *Developmental Medicine and Child Neurology*, 43(3): 198-201.
49. Radovanović, S. (2004). Intervencije rane životne dobi kod djece s oštećenjima vida i dodatnim poteškoćama u razvoju. Đurek, V. (ur.), *Dobra edukacijsko-rehabilitacijska praksa za 21. stoljeće: Zbornik radova petog međunarodnog seminara* (str. 317-326). Trakošćan: Savez defektologa Hrvatske.
50. Schmid, M. B., Reister, F., Mayer, B., Hopfner, R. J., Fuchs, H., Hummler, H. D. (2013). Prospective Risk Factor Monitoring Reduces Intracranial Hemorrhage Rates in Preterm Infants. *Dtsch Arztebl Int*, 110(29-30): 489-496.
51. Simiyu, I. N., Mchaile, D. N., Katsongeri, K., Philemon, R. N., Msuya, S. E. (2017). Prevalence, severity and early outcomes of hypoxic ischemic encephalopathy among newborns at a tertiary hospital, in northern Tanzania. *BMC Pediatric*, 1(1).
52. Sonksen, P. M., Dale, N. (2002). Visual impairment in infancy: impact on neurodevelopmental and neurobiological processes. *Developmental Medicine & Child Neurology*, 44(11): 782-791.
53. Šupe, T. (2009). Dijete s oštećenjem vida u vrtiću. *Dijete, vrtić, obitelj: Časopis za odgoj i naobrazbu predškolske djece namijenjen stručnjacima i roditeljima*, 15(55): 21-24.
54. Spasojević, S., Stojanović, V., Savić, R., Doronjski, D. (2010). Intrakranijalno krvarenje i transport 'k sebi' prevremeno rođenog novorođenčeta. *Medicinski pregled*, 63(7-8): 454-458.
55. Teskeredžić, A., Tulumović, Š. (2013). *Biotičke osnove i dijagnostika vidnog analizatora*. Tuzla: OFF-SET.
56. Tončić, Z. (2018). *Утицај рехабилитације вида специјалним помагалима на квалитет живота слабовиде дјеце* (Doktorska disertacija). Preuzeto sa https://www.kg.ac.rs/doc/2.3.7_zorica_toncic_izvestaj.pdf
57. Vasiljević, B., Maglajlić-Djukić, S., Gojnić, M., Stanković, S. (2012). The Role of Oxidative Stress in Perinatal Hypoxic-Ischemic Brain Injury. *Srp Arh Celok Lek*, 140(1-2): 35-41.