



Correlation of neuropsychological indicators of child development with speech: empirical research underpinning the National Children's Health Prevention Program

Povezanost neuropsiholoških indikatora razvoja dece i govora: empirijsko istraživanje kao osnova pripreme nacionalnog preventivnog programa dečije zaštite

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Abstract

Background/Aim. Psychophysiological disorders and speech pathology is one of the priority public health problems in the Republic of Serbia. A child's growth and development proceed in a particular sequence and course, depending on individual physiological capacities, quality of neuromuscular structures, and stimuli, which can be significantly affected by the environment. The development of speech from birth to the adult age is a result of the interaction of neurocognitive factors that contribute to the gradual attainment of phonological presentation and motor control abilities. The aim of the study was to examine the connection between manipulative manual dexterity, oral praxis, and lateralization with the development and speech in children and their potential for the development of prevention programs. **Methods.** The sample included 60 children from Belgrade of both sexes, aged between 5.5 and 7 years. Of these, 30 made up the experimental group – children with deviations in speech development (articulation disorders), and 30 made up the control group – typically developing children from the general population. The instruments used were the Manipulative Manual Dexterity Test (Lafayette), Oral Praxis Test, and part of the Test for assessing lateralization (auditory, visual, and functional). **Results.** The hand grip development level was statistically

significantly different between the experimental and the control group ($\chi^2 = 21.40$, $df = 3$, $p < 0.01$). The presence of associated involuntary movements statistically significantly differed between the experimental and the control group examinees ($\chi^2 = 10.58$, $df = 1$, $p < 0.01$). Oral praxis statistically significantly differed between the experimental and the control group ($t = 2.01$, $p < 0.05$). Visual laterality statistically significantly differed ($\chi^2 = 7.56$, $p < 0.05$) between the observed groups. When all predictors were taken into account, significant contribution to the explanation of the existence of speech pathology (articulation disorders) was given by the variables: Visual lateralization [odds ratio (OR) = 0.38; 95% confidence interval (CI) = 0.179–0.832; $p = 0.015$] and the level of hand grip development (OR = 0.23; 95% CI = 0.082–0.699; $p = 0.009$). **Conclusion.** The hand grip development level and visual laterality are worse in children with speech (articulation) impairment and developmental deviations. These indicators of child development should be used as a guide in designing the national programs for developmental assessment and prevention in the child healthcare system.

Key words:

child; growth and development; motor activity; national health program; serbia; speech; speech disorders.

Apstrakt

Uvod/Cilj. Psihofiziološki poremećaji i patologija govora su jedan od prioritarnih problema javnog zdravlja u Republici Srbiji. Rast i razvoj deteta odvijaju se određenim tokom i redosledom, zavisno od individualnih fizioloških kapaciteta, kvaliteta nervno-mišićnih struktura i podsticaja, na koje sredina može značajno da utiče. Razvoj govora od rođenja do odraslog doba rezultat je interakcije

neurokognitivnih faktora pomoću kojih se postepeno stiču sposobnosti fonološke prezentacije i motorne kontrole. Cilj istraživanja bio je da se ispita povezanost manipulativne manuelne spretnosti, oralne praksije i lateralizovanosti sa razvojem i govorom kod dece i njihov potencijal za izradu preventivnih programa. **Metode.** Uzorkom je obuhvaćeno 60 dece iz Beograda, oba pola, uzrasta od 5,5 do 7 godina. Njih 30 činilo je eksperimentalnu grupu – deca sa odstupanjima u razvoju govora (artikulacioni poremećaji) i

30 kontrolnu grupu – deca urednog razvoja, iz opšte populacije. Od „instrumentsa“ ispitivanja korišćeni su: test manipulativne manuelne spretnost (*Lafayette*), test oralne praksije i deo testa za procenu lateralizovanosti (auditivna, vizuelna i upotrebnost). **Rezultati.** Nivo razvijenosti hvata je bio statistički značajno različit kod eksperimentalne i kontrolne grupe ($\chi^2 = 21,40$, $df = 3$, $p < 0,01$). Prisustvo nevoljnih kretnji bilo je statistički značajno različito kod ispitanika eksperimentalne i kontrolne grupe ($\chi^2 = 10,58$, $df = 1$, $p < 0,01$). Oralna praksija je bila statistički značajno različita kod eksperimentalne i kontrolne grupe ($t = 2,01$, $p < 0,05$). Vizuelna lateralizovanost je bila statistički značajno različita ($\chi^2 = 7,56$, $p < 0,05$) među posmatranim grupama. Kada se uzmu u obzir svi prediktori, u višestrukom regresionom

modelu statistički značajan doprinos u objašnjenju postojanja patologije govora (poremećaji artikulacije) dali su vizuelna lateralizovanost [*odd ratio* (OR) = 0,38; 95% *confidence interval* (CI) = 0,179–0,832; $p = 0,015$] i nivo razvijenosti hvata (OR = 0,23; 95% CI = 0,082–0,699; $p = 0,009$). **Zaključak.** Nivo razvijenosti hvata i vizuelna lateralizovanost je lošija kod dece sa oštećenjem govora (artikulacije) i odstupanjima u razvoju. Ove indikatore razvoja deteta trebalo bi iskoristiti u kreiranju nacionalnih programa procene i prevencije razvoja u sistemu zdravstvene zaštite dece.

Ključne reči:

deca; rast i razvoj; aktivnost, fiščka; zdravstveni programi, nacionalni; srbija; govor; govor, poremećaji.

Introduction

Most activities in the first seven years of life are part of one process of organizing nerve impulses in the nervous system. Nerve impulses arise as a result of the direct influence of stimuli. As the child experiences stimuli during its life, learning how to organize them in the brain and discovering what each of them means, it learns how to focus its attention on a particular one, disregarding all the others. Additionally, by organizing the stimuli, the child gains control over its perceptual experiences. Nerve impulses must pass through two or more neurons to shape a sensory experience, a motor response, or an opinion. The more complex the functioning, the more neurons become involved in the message transmission. The nervous system of each human being operates in a particular, distinct manner ¹.

The function of neurons is determined by the localization and a series of other circumstances throughout development. One of the basic postulates of development is that functionally higher parts develop under the influence of lower parts (e.g., development of the thalamus induces further development of the cerebral hemispheres) ². Neurons, by way of their intercellular connections, are organized into dynamic functional systems. During development, there occur morphological changes that form the basis of cognitive functions and various skills gained during individual maturation.

The root causes of behavioral variability and flexibility are morphological and structural changes in neurons, as well as a multitude of established synaptic connections. For neurons to develop interconnections, they must be stimulated. The development of new connections generates new possibilities for neural communication. Each new connection adds another element to the sensory perception and motor ability of a child. The more neural connections, the more capable the child is of learning ¹. Psychomotor activities with exposure to various stimuli (that stir different senses eliciting thus psychomotor response) are the stimulating factors that promote the maturation of the nervous system.

Growth and development are interrelated but not necessarily interdependent. Growth can be defined as a

combination of increases in both the number and size of cells. Development is the increase in the complexity of an organism due to nervous system maturation. A child can develop normally but have a delay in growth and *vice versa*. Growth can be measured precisely but presenting the measurement of development in numbers is much more difficult and almost impossible ³. Development means synchronized motor, intellectual, and emotional maturation. When we assess development, we can reduce this assessment to four major areas: gross motor skills (basic motor movements), fine motor skills (differentiated motor movements), speech and language, and social development.

Speech development cannot be observed solely through biological development as is, for example, the case with walking, because, once the neurological basis becomes mature, a child gradually, by itself, starts walking, which is genetically programmed, while it will never occur with speech however predisposed the child is to that function. The reason is that speech originates exclusively from the biolinguistic conjunction, that is, one of neurobiological potential and verbal social environment. Development of speech from birth to the adult age is the result of the interaction of neurocognitive factors that lead to a gradual acquisition of the abilities of phonological presentation and motor control in the presence of a range of physical and physiological changes in the morphology of the articulation system ⁴. Given the dynamics of growth and development, as well as the plasticity of the nervous system, a preschool-age child is particularly susceptible to the overall influences that are, in that period, the most enduring and efficient.

It stands as an obligation of every serious society to ensure in the best possible way the timely assessment of the psychophysiological development of every child from its birth. Early detection of any, even the minimal, developmental disability should be a signal for a thorough monitoring and timely undertaking of the preventive and therapeutic stimulation of development.

Psychophysiological disorders and speech pathology pose a global problem, particularly in transition countries. Every year a significant rise in the number of children with developmental disabilities is recorded. It is estimated that, worldwide, there are about 11% of children with

psychophysiological disorders of varying types, including speech pathology⁵. Speech disorders occur both in children with developmental disabilities and in the general population⁶. Although no accurate epidemiological studies exist, it is estimated that about 20–30% of the children population in our environment suffers from some form of psychophysiological and speech disorder. If we add to this figure data on the acquired disorders that can evolve in children after the period of speech acquisition, then the proportion of the population with psychophysiological and speech disorders is considerably higher⁷.

The development/review of the National Program for the Prevention and Treatment of Psychophysiological Disorders is in line with the recommendations of the World Health Organization. For this exact reason, the Republic of Serbia has advocated for decades the development of a detailed and precise National Prevention Program to decrease the number of children with psychophysiological and speech disorders. One of the preventive measures is early detection, timely diagnosis, and treatment of children with developmental disabilities. Institutional capacities in the field of public health protection need to be strengthened in order to effectively implement public policies.

Governments should have a role in maintaining and improving capacities for the benefit of populations. In health, this means being ultimately responsible for the careful management of their citizens' wellbeing. The health of the people must always be a national priority: government responsibility for it is continuous and permanent. The tasks and vision of each public policy need to be defined in accordance with public interest and priorities. Consequently, exceptional knowledge and skills – competencies have been required⁸. Representatives of public institutions have a key role in both formulating and implementing government policies. In addition to this, they should devote their entire capacities to the purpose of achieving public interest⁹.

The aim of the study was to examine the connection between manipulative manual dexterity, oral praxis, and lateralization with the development and speech (articulation) in children and their potential for the development of prevention programs.

Methods

The research was organized as a quasi-experiment with two observed groups. It was conducted in Belgrade, at the Institute for Psychophysiological Disorders and Speech Pathology "Cvetko Brajović", and partly at the Children's University Clinic, as well as at the development counseling service of the Medical Center Voždovac, in 2016. The study followed the tenets of the Declaration of Helsinki and was approved by the Ethics Committee of the Medical Center Voždovac. Taking into account that the research participants were children, informed consent was obtained from the parents/guardians.

The sample included 60 children of both sexes, aged between 5.5 and 7 years. The experimental group (E) consisted of 30 children with diagnosed speech (articulation)

and development disorders who were on continuous treatment. The control group (C) of 30 children comprised typically developing children. We used the technique of individual testing for both the E and C groups.

The instruments used in the research were the Manipulative Manual Dexterity Test (Lafayette), Oral Praxis Test, and part of the Test for Assessing Lateralization (Auditory, Visual, and Functional hands use). Manipulative Manual Dexterity was examined using two tests. The aspects monitored during the tests were hand dominance, manner of selecting materials, presence of involuntary movements of extremities, and facial musculature. In the first test, examinees were given a box containing balls of four different colors and a wire on which they needed to slide colored balls in a specific order. On the agreed command, the examinee started sliding the balls and stopped doing so after 2 min on the examiner's signal. The balls slid down the wire were then counted. In the second test, examinees were given a long bolt with corresponding nuts. They were required to place as many nuts as possible on the bolt within 4 min. Both tests monitor which hand is used to pick up the ball/nut and whether the same hand is used all along, then what type of hand grip is used (the pincer, the tripod, or the palmar-for fingers hand grip, or whole hand grip) and the presence of involuntary movements. The Test for Examining Oral Praxis was conducted by way of acting in imitation of the examiner, who asked the child to repeat the same model. The test contains 22 items (motor patterns for the orofacial region). The maximum number of points is 22, and the minimum is 0 (which would mean that the respondent cannot report any movement). The examination begins with the simplest motor patterns and, if the examinee successfully repeats a given model, proceeds toward the next – more difficult ones. By using this test, we accurately identify the condition of the orofacial region and, based on the established condition, the cause of occurrence of articulation-speech disorder. The assessment of lateralization was conducted in respect of eyes, ears, and hand use. The examinees were asked to perform certain actions as instructed using the specific objects. The examiner recorded the responses by monitoring the assessed lateralization of a sense or a hand.

Results obtained from the research were statistically processed by the appropriate selection of statistical methods. Statistical data processing was performed using the software SPSS ver. 20. Of the descriptive statistics measures, we used arithmetic mean with the associated standard deviation, as well as the minimum and the maximum. We also used frequency and percent. The χ^2 test was used to examine the relationship between two categorical variables, then the *t*-test for large independent samples, as well as univariate logistic regression and multivariate regression analysis.

Univariate logistic regression was performed to determine the individual influence of indicators-predictors on the existence/non-existence of development and speech pathology. The predictive value of the following variables was examined: Hand-Use Lateralization, Visual Lateralization, Auditory Lateralization, Assessment of Oral Practice, Dominance of the Hand, the hand grip development level, and

Presence of involuntary movements. Cox & Snell R-Squared was used as a substitute for the coefficient of determination showing the percentage of explained variance.

Results

This research involved children of ages 5.5 to 7 years. There were 60 participants, 36 of which were male and 24 female, divided into two groups. As this was a prospective cross-sectional study, the structure of the sample by gender reflected the numerical representation of the groups in the population as well. In this way, a larger number of participants within the E group were boys (76.7%), while a larger number of girls (56.7%) were within the C group. The average age of sample participants in the E group was 6.07 ± 0.5 years, and in the C group, 6.34 ± 0.46 .

The Manipulative Manual Dexterity Test showed that the hand dominance, the hand grip evolution level, and the presence of involuntary movements were statistically significantly different between the examinees of the E and C groups on both trials. In the hand dominance subtest in both trials, right-handers were dominant in both groups with 60% frequency. However, there were more left-handers (40%) in the C group than in the E group (23.3%).

The hand grip evolution level showed a statistically significant difference between the E and C groups ($\chi^2 = 21.40$, $df = 3$, $p < 0.01$). In the C group, most were those with a group – grip with three fingers (50%) and those with a pincher grip (46.7%), while in the E group, the examinees whose hand grip was with four fingers (36.7%) and three fingers (40%) were dominant. The presence of involuntary

movements was significantly different in the subjects of the E and C groups ($\chi^2 = 10.58$, $df = 1$, $p < 0.01$). In the second trial, there was a statistically significant difference in the hand grip development level ($\chi^2 = 21.40$, $df = 3$, $p < 0.01$). Furthermore, on the presence of involuntary movements subtest, the inverse results were identical to the first trial ($\chi^2 = 10.58$, $df = 1$, $p < 0.01$). The results obtained from the tests were summarized and the analysis was conducted on the differences between the E and the C group on three items. Statistically significant differences were found on all three items: hand dominance ($\chi^2 = 6.31$, $df = 2$, $p < 0.05$), hand grip development level ($\chi^2 = 20.25$, $df = 3$, $p < 0.01$), and presence of involuntary movements ($\chi^2 = 12.00$, $df = 1$, $p < 0.01$) (Figure 1).

The score on the Oral Praxis Test was obtained by adding the movements that were possible, i.e., where they exist. The results of the Oral Praxis Test showed a statistically significant difference between the E and the C group regarding the overall test score ($t = 2.01$, $p < 0.05$). The average number of proper movements of the oral region in the C group (19.6 ± 2.20) was higher than in the E group (18.1 ± 3.64).

With the lateralization assessment, a statistically significant difference between the E and C groups existed on the subtest Visual Lateralization ($\chi^2 = 9.32$, $p < 0.01$). The largest number of subjects in the C group belonged to the group with right lateralization (83.3%), while in the E group (36.7%), subjects belonged to the group with left lateralization, and 13.3% of them to the group of ambidextrous. Figure 2 shows that both groups were predominantly right-lateralized regarding Hand use

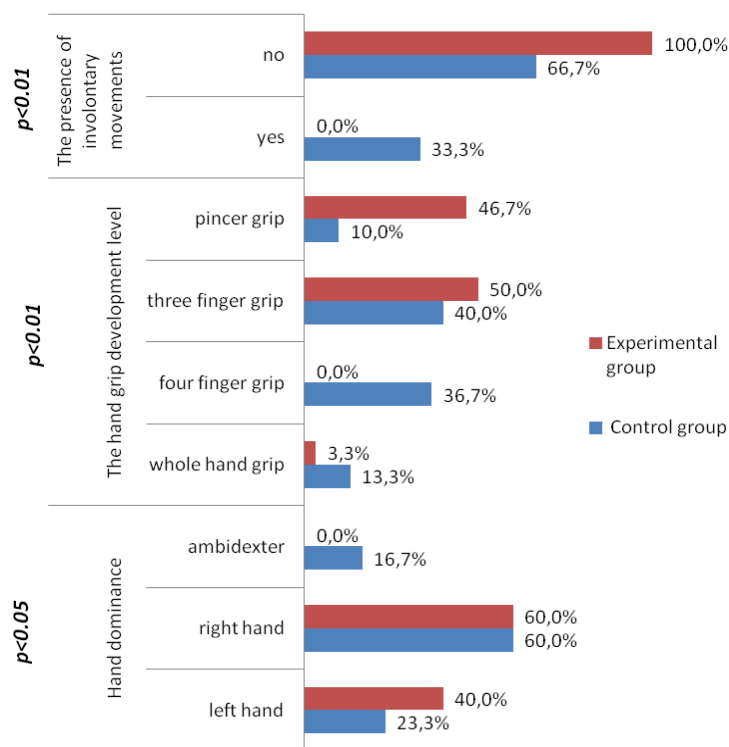


Fig. 1 – The Manipulative Manual Dexterity Test – difference between the experimental and control group.

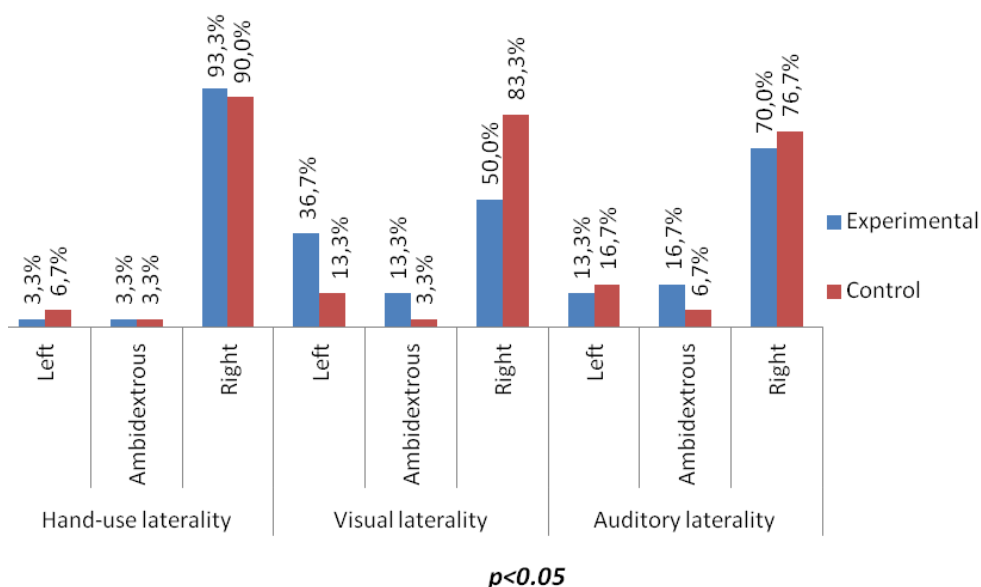


Fig. 2 – The assessment of lateralization – difference between the experimental and control group.

lateralization. By careful analysis, we can observe that the C group had more (6.7%) functionally left-handed compared to the E group (3.3%), with the number of the ambidextrous also being higher in the E group (13.3%) than in the C group (3.3%). On the subtest of Auditory lateralization, both groups are predominantly right-lateralized, but the number of ambidextrous subjects was higher in (16.7%) the E group than in the C group. After obtaining the results of the E and C groups on each subtest, we presented the results of both groups on all three subtests of lateralization (Figure 2).

Univariate logistic regression revealed that the predictors of speech pathology (articulation disorders) were: Visual Lateralization [odds ratio (OR) = 0.43; 95%

confidence interval (CI) = 0.225–0.951; $p = 0.015$], Oral Practice (OR = 0.82; 95% CI = 0.674–1.00; $p = 0.050$), Hand Dominance (OR = 2.82; 95% CI = 1.08–7.36; $p = 0.034$), The hand grip development level (OR = 0.19; 95% CI = 0.079)–0.495; $p = 0.001$) (Table 1). When all predictors were taken into account, in the multiple regression model a statistically significant contribution to the explanation of the existence of speech (articulation) pathology was given by the variables: Visual lateralization (OR = 0.38; 95% CI = 0.179–0.832; $p = 0.015$) and The Hand Grip Development Level (OR = 0.23; 95% CI = 0.082–0.699; $p = 0.009$). These two variables together explain as much as 48% of the variance of the dependent variable (Table 2).

Table 1

Predictive properties of measured parameters on the existence of pathology in development and speech (articulation) – univariate logistic regression

Parameter	p	Exp(B)	95% CI for EXP(B)		Cox & Snell R-Squared	Percentage of well-classified
			lower	upper		
Hands use lateralization	0.583	1.373	0.443	4.249	0.005	51.7
Visual lateralization	0.015	0.438	0.225	0.851	0.106	66.7
Auditory lateralization	0.861	0.940	0.473	1.870	0.001	53.3
Oral Praxis Test	0.050	0.824	0.674	1.008	0.067	60.0
Hand dominance	0.034	2.822	1.081	7.368	0.080	58.3
Hand grip development level	0.001	0.198	0.079	0.495	0.272	73.3
Presence of involuntary movements	0.999	0.000	0.000		0.032	66.7

CI – confidence interval.

Table 2

Predictive properties of measured parameters on the existence of pathology in development and speech (articulation) – multivariate regression analysis

Parameter	p	Exp(B)	95% CI for EXP(B)		Cox & Snell R-Squared	Percentage of well-classified
			lower	upper		
Visual lateralization	0.015	0.386	0.179	0.832	0.480	80.0
Oral Praxis Test	0.578	0.906	0.641	1.282		
Hand dominance	0.214	2.586	0.577	11.584		
Hand grip development level	0.009	0.239	0.082	0.699		

CI – confidence interval.

Discussion

The age of examinees for purposes of this research is selected according to the opinion that, at that age, children reach a certain degree of maturity of motor, speech, and social abilities. The result shows that articulation speech disorders are more common in boys than in girls, as shown by other studies¹⁰⁻¹². Timely and appropriate assessment of these abilities can point to potential deviations and deficits in the child's development. In order for a child to become fully developed, it must reach a certain degree of maturity of the nervous system, which allows it to connect with the external world¹³. Each stage of child development is characterized by certain abilities that constitute the preparatory 'elements' and a base for more complex and mature development. The psychomotor ability of hands is essential to organizing ways to exist in the social field. Its organization indicates the development degree of speech, intelligence, opinion, and feelings. The results of the Manipulative Manual Dexterity Test show that the first test records a statistically significant difference on the item "hand dominance", with the right-handers being dominant in both groups with 60% prevalence in each. However, the C group recorded more left-handers (40%) than the E group (23.3%). The E group recorded 16.7% of ambidextrous children, showing that this group had considerably more children without differentiated lateralization, which indicates slow maturation of the structures and functions that determine movement lateralization. While around 40% of children aged between 4 and 5 are weakly lateralized, this percentage drops to about 30% among those aged between 5 and 7¹⁴. The hand grip development level was another item recording a statistically significant difference between the E and C groups. More dominant in the E group were those with four-finger and three-finger grip, while in the C group, those with three-finger (tripod) grip and pincer grip prevailed. The presence of involuntary movements statistically significantly differed between the E and the C group examinees. These movements were not recorded in the C group; however, they were found in 33.3% of examinees of the E group. In the second test, there was a statistically significant difference in the hand grip development level. The results showed that hand grip was better developed among the C group examinees compared to the E group examinees. In a hierarchical development, a child first acquires simpler manipulative hand movements, such as the palmar grip, that eventually evolve into the pincer grip. In the C group, we had considerably more of those using the pincer grip, which involves the ability of proper grip (appropriate to the examined age group), characterized by thumb opposition and meaningful coordination of movements of hand segments in performing manipulative activities^{15, 16}. Statistical difference was also found in the item "presence of involuntary movements". The lower prevalence of involuntary movements among the examinees of the C group relative to the E group indicates better neuromaturation of CNS within the C group. The obtained results showed that differentiated hand motor patterns are better developed in typically

developing children, that is, the ones in the C group. Given that differentiated hand motor patterns hierarchically develop before oral motor patterns (responsible for oral praxis), some deficits in speech development can be expected and predicted in children without differentiated hand motor movements at a certain age¹⁷. The results of the Oral Praxis Test showed a statistically significant difference between the E and the C group, which shows that children with some developmental speech (articulation) deviations have a less developed oral praxis relative to typically developing children¹⁸. In the development and maturation of orofacial musculature, the first acts to evolve are swallowing, sucking, and chewing. Deficits in these functions at certain stages of development are the first indication of poor oral praxis^{19, 20}.

Lateralization assessment revealed a statistically significant difference between the E and the C group concerning visual laterality. Figure 2 shows a higher number of examinees with non-differentiated laterality in the E group and indicates the existence of disharmonic laterality, which concurrently indicates the slow maturation of certain functions among these examinees²¹. From further processing of research results, we found the following as the predictors of the existence of speech pathology (articulation disorders): hand dominance, hand grip development level, oral praxis, and visual laterality. After conducting a univariate regression analysis, the variables that proved to be statistically significant predictors in the explanation of the speech (articulation) disorders entered the multivariate regression analysis. The results showed that poorer visual lateralization increased the chance that the subject would have speech pathology by 62% and that gripping with the whole hand and with four fingers increased the chance of developing speech (articulation) pathology by 77%. These two variables accurately classify 80% of participants.

These findings show that the inability to learn or immaturity of any of these functions can provide a timely indication of the delays in child development and predict future deficits in the development of speech as a more complex function. It is crucial to timely recognize disharmony and include the child in stimulating treatments to prevent potential disorders to any extent. All obtained results point to the necessity of preventive action, which should be conducted at the level of primary health care to timely prevent the occurrence of developmental disabilities. The psychophysiological growth and development of a child must be appropriate to its age; if not synchronized, whether for objective or subjective reasons, it creates disharmony in the child's development, which can particularly be observed in speech development. With a view of developing the health care system in the Republic of Serbia, special consideration is given to the protection, improvement, and promotion of health of the youngest generation. Determination of causes of disorders as well as early detection and prevention are the main aims of all health systems, including both those of our country and Europe and of the rest of the world. For this exact reason, it is necessary to develop a detailed and precise Program for preventive child protection at the national level, which

would be implemented through the level of primary health care by monitoring the child from birth. The main goals of the Program would be the promotion of and support for the health and healthy development of all children in the first years of life, particularly those with present developmental risks and disabilities. The Programs would be aimed at the primary prevention of developmental disorders by reducing and preventing the influence of risk factors and would assume the engagement of the health system and intersectoral cooperation. Another major precondition for the successful implementation of the Program is a developing partnership with families using the family orientation approach in work.

The aim of developing a National Prevention Program is to decrease the number of children with psychophysiological and speech disorders. One of the preventive measures is early detection, timely diagnosis, and treatment of children with developmental disabilities (Government of the Republic of Serbia, 2004). This National Program is one of the priority programs of the Ministry of Health, the implementation of which requires the involvement of all the defined tiers of health care delivery. The development/review of the National Program for the prevention and treatment of psychophysiological disorders is in line with the recommendations of the World Health Organization. The aims of the Program are early detection of psychophysiological disorders and speech pathology, appropriate diagnostics, and therapy aimed at decreasing the frequency of psychophysiological and speech disorders and improving the quality of life of persons with developmental disabilities and their families. The government's mission is to ensure coherence and consistency across departments and sectors by an overall reform of public administration²².

The health care system and the organization of health services are regulated by the Health Care Act²³. Decree on the National Program of Preventive Health Care of Children with Psychophysiological Disorders and Speech Pathology establishes the National Program for preventive health care of children with psychophysiological disorders and speech pathology and regulates the activities on early detection of children with psychophysiological and speech disorders at all tiers of health care delivery. Following the objectives of the proposed National Program, the strategy has been defined for information, education, communication, and social mobilization, along with the action plan for its implementation, time frames, and entities responsible for the implementation of the set activities in primary health care.

The key limitation of this study is the small sample size. These data can be the basis for future research in order to develop preventive and therapeutic programs.

Conclusion

The research results show that visual lateralization and the level of hand grip are worse in children with impaired speech (articulation) compared to typically developing children. Poorer visual lateralization increased the chance that the subject would have speech pathology by 62%, and that gripping with the whole hand and with four fingers increased the chance of developing speech-articulation pathology by 77%. The ability of fine motor coordination, visuomotor control, and differentiated lateralization are all associated with the development of speech and higher nervous activities, which means that they can help assess the child's developmental level and maturity. This fact should be considered in creating the assessment and prevention programs in the health care system.

R E F E R E N C E S

1. *Ayres J.A.* Sensory Integration and the Child. Zagreb: Naklada slap; 2009. (Serbian)
2. *Filipović B.* Anatomy of the central nervous system. Belgrade: NNK Internacional; 2001. (Serbian)
3. *Rudolf M, Levene M.* Pediatrics and child health. Belgrade: Data status; 2011. (Serbian)
4. *Dobrota N.* Articulatory-phonological disorders. Belgrade: Institute of Psychophysiological Disorders and Speech Pathology, "Dr. Cvetko Brajović" and Faculty of Special Education and Rehabilitation, University of Belgrade; 2017. (Serbian)
5. *UNICEF.* Children and disability in transition in CEE/CIS and Baltic states. Innocenti Research Centre, Available from: <http://www.unicef.org/ceecis/Disabilityeng.pdf>
6. *McGregor KK.* How We Fail Children With Developmental Language Disorder. Language Speech Hear Serv Sch 2020; 51(4): 981–92.
7. *Otašević J, Dobrota Davidović N.* Institutional capacities of Serbia in resolving the problem of Children with Disabilities. Srpska politička misao 2018; 61(3): 157–73. (Serbian)
8. *Vukašinić-Radojčić Zorica.* Development of Administrative Capacities through development of the Competency Framework. Bezbednost 2017; 59(2): 27–42. (Serbian)
9. *Vukašinić-Radojčić Z, Rabrenović A.* Theoretical understandings of the concept of a Public servant: towards a common definition. NBP, Journal of Criminalistics and Law 2020; 25(1): 53–64.
10. *Dmitrić T, Veselinović M, Mitrović SM.* Articulation disorders in Serbian language in children with speech pathology. Med Pregl 2015; 68(5–6): 168–72.
11. *Mihajlović B, Cvjetičanin B, Veselinović M, Škerbić R, Mitrović SM.* Articulation of speech sounds of Serbian language in children aged six to eight. Med Pregl 2015; 68(7–8): 240–4.
12. *Georgievska-Jancheska T.* Lambdacism, Rhotacism and Sigmaticism in Preschool Children: Frequency and Distribution. Open Access Maced J Med Sci 2019; 7(3): 336–40.
13. *Voti P, Conte A, Rocchi L, Bologna M, Khan N, Leodori G, et al.* Cerebellar continuous theta burst stimulation affects motor learning of voluntary arm movements in humans. Eur J Neurosci 2014; 39(1): 124–31.
14. *Heitger MH, Mace MJ, Jastorff J, Swinnen SP, Orban GA.* Cortical regions involved in the observation of bimanual actions. J Neurophysiol 2012; 108(9): 2594–611.
15. *Boschi SR, Frère AF.* Grip and pinch capability assessment system for children. Med Eng Phys 2013; 35(5): 626–35.
16. *Hepping AM, Ploegmakers JJ, Geertzen JH, Bulstra SK, Stevens M.* The Influence of Hand Preference on Grip Strength in

- Children and Adolescents; A Cross-Sectional Study of 2284 Children and Adolescents. *PLoS One* 2015; 10(11): e0143476.
17. Otašević J, Kljajić D, Rajović V, Mašić Z, Bratorović V. The significance of differentiated motor hand movements in development of speech in Children. *Int Sci J Kinesiol* 2018; 11(2): 33–9.
 18. Redle E, Vannest J, Maloney T, Tsevat RK, Eickenberry S, Lewis B, et al. Functional MRI evidence for fine motor praxis dysfunction in children with persistent speech disorders. *Brain Res* 2015; 1597: 47–56.
 19. Newmeyer AJ, Grether S, Grasha C, White J, Akers R, Aylward C, et al. Fine motor function and oral-motor imitation skills in preschool-age children with speech-sound disorders. *Clin Pediatr (Phila)* 2007; 46(7): 604–11.
 20. Morgan AT, Haafsten LV, van Hulst K, Edley C, Mei C, Tan TY, et al. Early speech development in Koolen de Vries syndrome limited by oral praxis and hypotonia. *Eur J Hum Genet* 2018; 26(1): 75–84.
 21. Dobrota Davidović N, Otašević J, Kljajić D. Neuropsychological parameters as possible indicators of speech fluency disorder in children. *Vojnosanit Pregl* 2018; 75(4): 341–6. (Serbian)
 22. Vukašinović-Radojčić Z. Changes in the legal framework in the direction of strengthening the professionalization of the administration. *Pravni život* 2018; 67(10): 245–59. (Serbian)
 23. Decree on the National Program of Preventive Health Care of Children with Psychophysiological Disorders and Speech Pathology. ("Sl. glasnik RS", br. 15/2009). (Serbian)

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