JRSR 8 (2021) 126-131

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Predictive Factors of Language Development in Persian-speaking Children Using Cochlear Implants: A Pilot Study

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ARTICLE INFO

Article History:
Received: 08/04/2021
Revised: 16/06/2021
Accepted: 09/08/2021

Keywords:
Cochlear implantation
Prediction
Language development
Outcomes
Persian

Please cite this article as:
Oryadi-Zanjani MM, Mohammadi T, Mohammadi Z, Vahab M. Predictive Factors of Language Development in Persian-speaking Children Using Cochlear Implants: A Pilot Study. JRSR. 2021;8(3):126-131.

ABSTRACT

Background: This study aimed to investigate some child- and environment-dependent factors in a retrospective method to find a prediction model for the spoken language development of children with hearing loss (HL) after cochlear implantation (CI).

Methods: The research reported here was conducted as a cross-sectional pilot study. The sample size was 18 Persian 5-to-7-year-old children with HL using CI (6 girls and 12 boys) who were recruited via consecutive sampling methods from Soroush Rehabilitation Center in Shiraz, Iran. The studied independent variables were categorized into child-related variables and parental variables. At the first step, the participants were divided into two groups, good language ability, and poor language ability, based on the results of Sentence Repetition Test (SRT). The correlation between the independent variables and SRT scores of the groups were compared in two stages.

Results: Regarding the development of spoken language in two groups of Persian-speaking preschool children using the cochlear implants with good and poor language development, IQ, duration of watching TV, duration of playing with the father, education status of the mother, education status of father, and economic status of the family had a significant correlation with language development of these children.

Conclusion: According to this study's findings, the child's IQ, the duration of watching TV during the day, the duration of playing with the father during the day, the level of education of the mother, the level of education of the father, and the economic level of the family may be considered the predictive factors in the language development of cochlear implant children during the preschool years.

Introduction

Indeed, many studies showed that depriving auditory input, at any degree, cannot only impede auditory perception, but also affect the development of the peripheral and central auditory pathways. Therefore, because of an altered auditory input, speech and oral language development can be limited, which will affect oral communication skills and social participation [1]. Besides, cochlear implantation (CI) positively affects children's verbal communication, generally, and receptive and expressive language development, specifically [2-4]. However, language and speech outcomes in children using CI have a wide variation [5, 6].

Although cochlear implantation is effective for profound hearing-impaired children, it may not be effective for all

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children using this device. Some children experience a great deal of environmental stimuli after cochlear implantation; however, some of them would usually not achieve the appropriate language and speech skills [5]. Despite significant individual differences and variations in the battery of speech and language outcome measures [7-9], other various findings were consistently reported in the literature on the cochlear implants in children [10].

Age at cochlear implantation affects all the functional indicators. Hence, in the spectrum of outcome indicators, the children implanted at an early age (under three years old) would function superior abilities than those implanted at an older age (over six years old). Besides, the duration of hearing loss or the duration of deafness is related to outcome and productivity . Furthermore, children who have been deaf for a shorter period before implantation would depict greater performance in the battery of speech and language outcome measures than those who have been deaf for a long period [11]. Therefore, both of these findings indicate the role of the sensitive periods of sensory, perceptual, and language development and emphasize the close relationship between neural and behavioral development, especially auditory, speech, and language development. The effect of sensory experience, primary language, and post-implant language processing activities on individual performance were shown on a range of outcome measures [7, 12].

Early implantation for deaf or hard of hearing children may take advantage of neuronal flexibility in the critical periods of auditory-based learning [13]. Therefore, children implanted after 24 months are much less likely to use oral communication exclusively, especially those with complex medical history or additional conditions associated with language delay [14].

Until recently, therapists and researchers have not been able to find authentic prognosticators of the outcome and success prior to implantation. Evidence strongly suggests that fundamental sensory and perceptual abilities essential for speech and language would emerge after implantation. In usual, the performance of all children using cochlear implants improves over time [10]. However, a number of studies were conducted on predictive factors of spoken language development in children using CI so far such as (I) intelligence quotient (IQ) [15]; (II) programming and auditory monitoring abilities [16]; (III) early intervention [17-19]; (IV) the duration of educational and rehabilitative intervention [3, 6, 15]; (V) family income [20]; (VI) parental socioeconomic status [15]; (VII) parental education [20]; (VIII) parenting style [20]; (IX) family engagement and participation in intervention [21, 22]; and (X) the quantity and quality of parental linguistic input [23].

In conclusion, this study aimed to investigate some predictive factors in a retrospective method to find a prediction model for the spoken language development of children with hearing loss (HL) after CI. Furthermore, in addition to a number of variables which were considered in the earlier studies (IQ, the age of implantation, the duration of CI using, the economic status of the family, the number of children in the family, level of mother's and father's education), some other factors, which have not been studied so far, were included such as birth order, the age of HL detection, the age of hearing aids fitting, rehabilitation program onset age, the time of rehabilitation services pre/post of CI, the number of rehabilitation program days weekly, the duration of watching TV daily, the duration of computer games daily, maternal depression, the duration of reading book for child daily, the duration of mother-child play daily, the duration of father-child play daily, mother's working hour per day, and father's working hour per day. Therefore, this study aimed to investigate the correlation between these factors and language development in Persian-speaking children using cochlear implants.

Methods

This cross-sectional study was conducted as a pilot study. The research protocol was approved by the Ethics Committee of Shiraz University of Medical Sciences, Shiraz, Iran (IR.SUMS.REC.1394.S261), and informed consent was obtained from the parents of each child participating in the study. The sample size was 18 Persian 5-to-7-year-old children with HL using CI (6 girls and 12 boys) who were recruited via consecutive sampling methods from Soroush Rehabilitation Center in Shiraz, Iran. The inclusion criteria were chronological age, bilateral severe-to-profound, congenitally sensory-neural hearing loss, cochlear implantation before 3 years old, using oral language as a communication method pre- and post-implantation, receiving similar education, and rehabilitation services and no other disabilities.

The assessment tool was the Sentence Repetition Test (SRT), which is a highly valid and reliable test for the measurement of grammatical development in Persian-language children. Content Validity Index (CVI), the Interclass Correlation Coefficient, and the standard error measurement for the test were reported 80% and 7.45, respectively. SRT includes 41 sentences with different lengths and complexities [24]. At the first step, the participants were divided into two groups, good language ability and poor language ability, based on the SRT scores providing in the results section (Table 1).

The studied independent variables were categorized into child-related variables and parental variables. Moreover, the variables related to children included birth order, IQ, the age of HL detection, the age of hearing aids fitting, age of implantation, the duration of CI using, rehabilitation program onset age, the time of rehabilitation services pre/post of CI, the number of rehabilitation program days weekly, the duration of watching TV daily, and the duration of computer games daily.

Thus, the independent variables related to the parents included the economic status of the family, the number of children in the family, maternal depression, the duration of reading book for child daily, the duration of mother-child play daily, the duration of father-child play daily, the level of mother's education, the level of father's education, the duration of the mother's employment daily, and the duration of the father's employment daily.

At the second step, except for the variables of IQ and maternal depression, other variables were determined

Table 1: Comparison of the distribution of age, gender, and severity of hearing loss between groups

Groups	N[$]	SRT[#]			Gender			Age			Hearing loss severity			
		Mean	SD^	P*	Girl	Boy	P	Mean	SD	P	Moderately severe	Severe	Profound	P
Children with good language abilities	8	424.50	30.36	<0.05	2	6	$p >$ 0.05	74.87	6.87	>0.05	2	4	2	>0.05
Children with poor language abilities	10	338.70	71.52		4	6		77.40	7.45		5	5	0	

[$] N=number; [#] SRT=sentence repetition test; ^ SD=standard deviation; * P=P-value

Table 2: The mean and the standard deviation of continuous independent variables

Groups	N^	IQ		Age of hearing loss detection		Age of hearing aids fitting		Age of cochlear implantation		Duration of CI using	
		Mean	SD*	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Children with good language abilities	8	93.25	8.94	11.25	3.99	14.25	2.86	41.00	15.41	34.62	13.80
Children with poor language abilities	10	82.00	5.33	10.70	12.80	14.50	11.42	38.90	6.70	38.00	12.84

* SD=standard deviation; ^ N=number

Table 3: The mean and the standard deviation of continuous independent variables

Groups	N^	Depression of mother		Duration of TV watching		Duration of computer game		Book reading for child		Duration of mother's playing with child		Duration of father's playing with child	
		Mean	SD*	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Children with good language abilities	8	17.00	11.72	83.37	70.11	67.50	47.43	33.75	19.22	30.00	22.67	17.14	18.22
Children with poor language abilities	10	15.70	11.19	150.00	42.42	36.00	41.95	18.50	11.06	19.50	18.77	3.00	9.48

* SD=standard deviation; ^ N=number

using the available information in children's records. At the third step, the children's IQ and the mother's depression were assessed by an expert psychologist. To measure the children's IQ, the Persian version of the Wechsler Intelligence Scale for children was used [25]. Persian version of the Beck depression questionnaire was used to determine the presence or absence of depression in mothers [26]. Finally, the correlation between the independent variables and the groups' SRT scores was compared in two stages. In the first stage, all the variables were compared between the two groups by Mann–Whitney U test and the chi-squared test. In the second stage, according to the first stage results, just the significantly different variables were analyzed by the Stepwise method of Linear Regression.

Results

There was a significant difference among the SRT scores of the two groups (Table 1). There was; however, no significant difference between the two groups in the aspect of age, gender distribution, and severity of HL (Table 1).

The mean and the standard deviation of continuous independent variables are shown in Tables 2 and 3. They include IQ, the age of HL detection, the age of hearing aids fitting, the age of implantation, the duration of CI using, rehabilitation program onset age, maternal depression, the duration of watching TV daily, the duration of computer games daily, the duration of reading book for child daily, the duration of mother-child play daily, and the duration of father-child play daily.

The frequency distribution of discrete variables is shown in Tables 4 and 5, and they include birth order, the number of children in the family, rehabilitation program onset age, the number of rehabilitation program days weekly, the economic status of the family, the level of mother's education, the level of father's education, the duration of the mother's employment daily, and the duration of the father's employment daily.

There was no significant difference among the groups in some factors, including the age of HL detection (P>0.05), age of hearing aids fitting (P>0.05), age of cochlear implantation (P>0.05), the duration of CI using (P>0.05), rehabilitation program onset age (P>0.05), the number of rehabilitation program days weekly (P>0.05), birth order (P>0.05), the number of children in the family (P>0.05), depression of mother (P>0.05), duration of mother's playing with a child (P>0.05), duration of a computer game (P>0.05), the duration of the reading book (P>0.05), working status of the mother outside home (P>0.05), and no working time of father outside home (P>0.05).

Whereas, a significant difference was found between the groups in terms of IQ (P<0.05), the duration of watching TV (P<0.05), the duration of father's playing with a child (P<0.05), the level of mother's education (P<0.05), educational status of the father (P<0.05), and

Table 4: The frequency distribution of the discrete variables

Groups	N*	Birth order					Numbers of children					Rehabilitation program onset age					Rehabilitation program onset time		Numbers of rehabilitation program days	
		1st	2nd	3rd	4th	5th	1	2	3	4	5	1st	2nd	3rd	4th	5th	Pre-CI	Post-CI	3 days weekly	6 days weekly
Children with good language abilities	8	5	1	1	0	1	4	2	0	1	0	1	7	0	0	0	7	1	7	1
Children with poor language abilities	10	5	3	1	1	0	3	5	1	1	0	0	3	2	4	1	8	2	8	2

* N=number

Table 5: The frequency distribution of the discrete variables

Groups	N*	Economic status of family			Educational status of mother			Educational status of father			Working status of mother outside home		Working time of father outside home		
		Poor	Moderate	Good	Illiterate	Under diploma	Upper diploma	Illiterate	Under diploma	Upper diploma	No	Yes	4 hours daily	8 hours daily	More than 8 hours daily
Children with good language abilities	8	0	5	3	0	1	7	0	3	4	7	1	0	3	4
Children with poor language abilities	10	4	6	0	1	9	0	0	10	0	10	0	1	3	6

* N=number

the economic status of the family (P<0.05). Moreover, a significant correlation was observed between SRT scores and IQ (B=4.163, SD=1.763, P=0.032). In other words, it can be predicted that by increasing each unit of IQ, the SRT scores of the children using CI will increase 4,163 units.

Discussion

Regarding the development of spoken language in two groups of Persian-speaking preschool children using cochlear implants with good and poor language development, IQ, duration of watching TV, duration of playing with the father, education status of the mother, education status of the father, and economic status of the family had a significant correlation with language development of these children. In other words, the acquisition of speech and language skills may be predicted by addressing the investigated factors in this study. There was no significant difference between the two groups of children using cochlear implants with good and poor language development due to the remaining variables. It can be said that the effect of these variables was controlled in the study. In other words, the two groups studied were similar in terms of these variables.

The result of this study was in accordance with a study conducted by Wijayanti et al., who stated that there was a strong relationship between parenting style, family income, and maternal education with the development of speech and language in children [20]. If these variables were good and in accordance with the needs of children, the development of speech and language would also be good. On the contrary, if the parenting style was not good enough and not according to the needs of children, then the development of speech and language of the children would also be poor. This finding is also consistent with a study carried out by Bingham et al. [27] reporting that parenting contributes directly to the academic skills as well as the language development of the children. Besides, parental language input has an influence on a child's language development. In a systematic review and meta-analysis study, Holzinger et al.'s findings emphasized strong positive correlation between parental linguistic input during the first years after cochlear implantation and later child language outcomes [23]. Therefore, our findings show that parental interventions can be very effective in developing children's speech. The results obtained from this study regarding the IQ, parental education level, and family economic level are consistent with the results of Piccolo et al. and Duncan et al. [28]. The socio-economic status of families directly influences the level of parental time and parenting style investments, as well as the productivity of the investment process and IQ [28]. There are strong relationships between IQ and language outcomes as well as between language skills and speech perception ability [29]. A comprehensive review over seventy-eight studies addressed the importance of father playing with children, and it highlighted that fathers' playtime has unique features that is distinguished from a maternal playtime as well as overlaps [30]. According to previous findings, the more time a child spends playing and interacting with their parents, the better his/her spoken language development will be expected [20, 27]. Therefore,

regarding the duration of watching TV and duration of the father playing with the child during the day, it can be explained that the more time the child spends watching TV, the less time he spends interacting and playing actively.

In general, when we look at these six factors together, we find that these variables operate in an interactive framework with each other. This means that the higher the child's intelligence, the better his interaction with parents and others around him/her. On the other hand, the higher economic and educational level of the parents can guarantee that the parents have more time and patience to interact and play with their child. As a result, a child who spends more time with his or her parents will spend less time watching television.

The ineffectiveness of the other variables studied does not mean that these variables are not important. Rather, it simply means that since the two groups were not significantly different in these variables, the effect of these variables in this study was naturally controlled. The small sample size of the children studied was the only significant limitation in this study. Conducting studies with greater sample sizes and controlling other variables can be effective in obtaining results that are more accurate. Among the issues that should be addressed in future studies is the extent, or burden of the impact of each factor in predicting the rate of development of oral language skills in children with the implant. It is also recommended to perform similar studies on children with hearing aid. Therefore, in future studies, we hope to find a relationship between these variables and oral language development in children using hearing aids and to compare this study's findings.

Conclusion

According to this study's findings, the child's IQ, the duration of watching TV during the day, the duration of playing with the father during the day, the level of education of the mother, the level of education of the father, and the economic level of the family may be considered as predictive factors in the language development of cochlear implant children during the preschool years.

Acknowledgement

The authors would like to thank Z. Zandi for her cooperation in collecting the data, Dr. Z. Bagheri for her careful statistical advice, and Dr. L. Khojasteh for the language editing of the manuscript. Special thanks are expressed to the families and children who participated in the research.

Conflict of Interest: None declared.

References

1. Bergeron F, Berland A, Demers D, Gobeil S. Contemporary Speech and Oral Language Care for Deaf and Hard-of-Hearing Children Using Hearing Devices. J Clin Med. 2020;9(2):378.
2. Eisenberg LS. The Impact of Hearing Loss on Childhood Development and Family Constellation. Volta Review. 2019;119(1):56-114.
3. Oryadi-Zanjani MM, Vahab M, Bazrafkan M, Haghjoo A. Audiovisual spoken word recognition as a clinical criterion for sensory aids efficiency in Persian-language children with hearing loss. Annual review of neuroscience. 2015;79(12):2424-7.
4. Oryadi-Zanjani MM, Vahab M, Rahimi Z, Mayahi A. Audiovisual sentence repetition as a clinical criterion for auditory development in Persian-language children with hearing loss. Int J Pediatr Otorhinolaryngol. 2017;93:167-71.
5. Pisoni DB. Speech perception in deaf children with cochlear implants. In: Pisoni DB, Remez RE, editors. The Handbook of Speech Perception. Malden: Blackwell Publishing; 2009. p. 494-523.
6. Oryadi-Zanjani MM, Hasanzadeh S, Rahgozar M, Shemshadi H, Purdy SC, Bakhtiari BM, et al. Comparing the effect of auditory-only and auditory-visual modes in two groups of Persian children using cochlear implants: a randomized clinical trial. Int J Pediatr Otorhinolaryngol. 2013;77(9):1545-50.
7. Oryadi-Zanjani MM. Production of Infant Scale Evaluation (PRISE) in Persian normal hearing children: A validation study. Int J Pediatr Otorhinolaryngol. 2018;113:76-81.
8. Oryadi-Zanjani MM, Vahab M, Purdy SC. The Persian Version of the Auditory Behavior in Everyday Life Questionnaire Int J School Health. 2018;5(1):e55952.
9. Oryadi-Zanjani MM, Purdy SC, Vahab M, Rasouli J, Vasfinia M, Lotf E. Translation and Adaptation of the Auditory Behavior in Everyday Life. JRSR. 2015;3:63-7.
10. van de Vijver R. Pisoni, D., Remez, R.(eds.), The handbook of speech perception; Oxford, Blackwell, 2005: The handbook of speech perception. 2009.
11. Konishi M. Birdsong: from behavior to neuron. Annu Rev Neurosci. 1985;8(1):125-70.
12. Zanjani MMO, Vahab M. Oral-Language Skills of the Iranian Pupils With Hearing-Impairment. Int J School Health. 2015;2(1).
13. Niparko JK, Tobey EA, Thal DJ, Eisenberg LS, Wang N-Y, Quittner AL, et al. Spoken language development in children following cochlear implantation. Jama. 2010;303(15):1498-506.
14. Hoff S, Ryan M, Thomas D, Tournis E, Kenny H, Hajduk J, et al. Safety and effectiveness of cochlear implantation of young children, including those with complicating conditions. Otol Neurotol. 2019;40(4):454-63.
15. Panda S, Sikka K, Singh V, Agarwal S, Kumar R, Thakar A, et al. Comprehensive analysis of factors leading to poor performance in prelingual cochlear implant recipients. Otol Neurotol. 2019;40(6):754-60.
16. Oryadi-Zanjani MM, Zamani A. Development of Persian Lexical Neighborhood Tests. Int J Pediatr Otorhinolaryngol. 2020;139:110406.
17. Chu C, Dettman S, Choo D. Early intervention intensity and language outcomes for children using cochlear implants. Deafness & Education International. 2020;22(2):156-74.
18. Oryadi-Zanjani MM. Development of the Childhood Nonverbal Communication Scale. J Autism Dev Disord. 2020;50(4):1238-48.
19. Oryadi-Zanjani MM, Vahab M, Rasouli J, Ghasemi S, Yazdizade A. Center-Based Care and Language Development: A Pilot Study on 6-15 Month-Old Persian-Speaking Children. JRSR. 2016;1:1-4.
20. Wijayanti A, Wekadigunawan C, Murti B. The effect of parenting style, bilingual school, social environment, on speech and language development in preschool children in Surakarta, Central Java. Journal of Maternal and Child Health. 2018;3(03):184-96.
21. Mostafavi F, Hazavehei SMM, Oryadi-Zanjani MM, Rad GS, Rezaianzadeh A, Ravanyar L. Phenomenological needs assessment of parents of children with cochlear implants. Electronic Physician. 2017;9(9):5339-48.
22. Mostafavi F, Oryadi-Zanjani MM, Rad GS, Hazavehei SMM, Rezaianzadeh A, Ravanyar L. Family-based training program: The role of mothers' empowerment in the speech development of children with hearing impairments. Pharmacophore. 2017;8(6s):8.
23. Holzinger D, Dall M, Sanduvete-Chaves S, Saldaña D, Chacón-Moscoso S, Fellinger J. The Impact of Family Environment on Language Development of Children With Cochlear Implants: A Systematic Review and Meta-Analysis. Ear Hear. 2020;41(5):1077-91.
24. Hasanati F, Agharasouli Z, Bakhtiyari BM, Kamali M. Sentence repetition test for measurement of grammatical development in Farsi speaking children. Audiol. 2011;20(1):73-81.
25. Rostami R, Sadeghi V, Zarei J, Haddadi P, Mohazzab-Torabi S, Salamati P. Concurrent validity of persian version of wechsler intelligence scale for children - fourth edition and cognitive assessment system in patients with learning disorder. Iran J Pediatr. 2013;23(2):183-8.

26. Dadfar M, Kalibatseva Z. Psychometric Properties of the Persian Version of the Short Beck Depression Inventory with Iranian Psychiatric Outpatients. Scientifica. 2016;2016.
27. Bingham GE, Jeon HJ, Kwon KA, Lim C. Parenting styles and home literacy opportunities: Associations with children's oral language skills. Infant Child Dev. 2017;26(5):e2020.
28. Duncan GJ, Brooks-Gunn J, Klebanov PK. Economic deprivation and early childhood development. Child Development. 1994;65(2):296-318.
29. Sarant JZ, Hughes K, Blamey PJ. The effect of IQ on spoken language and speech perception development in children with impaired hearing. Cochlear Implants Int. 2010;11(sup1):370-4.
30. Amodia-Bidakowska A, Laverty C, Ramchandani PG. Father-child play: A systematic review of its frequency, characteristics and potential impact on children's development. Developmental Review. 2020;57:1009-24.