ORIGINAL ARTICLE

The Preliminary Study of the Effects of Cochlear Implantation on Developmental Outcome in Thai Children

Adidsuda Fuengfoo, MD[1,3], Wimoltip Chanjaiwong, MD[1], Naiyana Neesanan, MD[2]

[1] Division of Developmental and Behavioral Pediatric, Department of Pediatrics, Queen Sirikit National Institute of Child Health, Bangkok, Thailand; [2] Division of Social Pediatric, Department of Pediatrics, Queen Sirikit National Institute of Child Health, Bangkok, Thailand; [3] College of Medicine, Rangsit University, Bangkok, Thailand

Background: Children born with severe or profound hearing loss usually have delays in receptive and expressive language development that affect academic achievement and social functioning. Cochlear implantation is the treatment of choice for these children. There were very few studies on developmental outcome of the children with severe sensory neural hearing loss who had gone through cochlear implantation.

Objective: 1) To assess developmental outcome of cochlear implantation in children aged 9 to 66 months. 2) To study attitude and Parenting Styles and Dimensions Questionnaire (PSDQ) of the parents.

Materials and Methods: A cross-sectional descriptive study of 27 children aged 9 to 66 months who received cochlear implantation at Rajavithi Hospital. The data were collected online using the Ages & Stages Questionnaires, Third Edition, Thai-Version (ASQ-3 Thai), Parents' attitudes and PSDQ, Thai version.

Results: The age of cochlear implant was 30.52±12.22 months with 29.6% of the patients getting the cochlear implantation before two years of age. There was 70%, and 37% of children suspected of having delays in language and problem solving. Relationship between language development with age at diagnosis of hearing impairment, age of receive hearing aids, age of auditory-verbal therapy, age of cochlear implantation, and duration of auditory verbal training after cochlear implantation were statistically significant. There was a significant relationship between problem solving and reading with children family type. Most parenting style was authoritative. Parental knowledge and attitudes were very good at 96.3%.

Conclusion: Children with severe sensory neural hearing loss who received early diagnosis and cochlear implantation at the age younger than 2 years old, as well as long consecutive auditory and speech skills training, results in better language developmental outcomes.

Keywords: Cochlear implantation; Development outcome; Language; Sensory neural hearing loss

Received 18 April 2023 | Revised 5 September 2023 | Accepted 15 September 2023

J Med Assoc Thai 2023;106(10):965-71

Website: http://www.jmatonline.com

According to the World Health Organization (WHO)'s report, there were an estimated 466 million people worldwide suffering from hearing impairment, including 34 million children. Hearing loss can be present at birth or develop later in life and directly affect a child's attention, language, speaking, social, and emotional development. Children have difficulties doing well in school, resulting in low academic achievement and an economic effect[1,2]. In England, 370 children are born with severe hearing loss and deafness every year. There is a prevalence of 1 per 1,000 children diagnosed with severe hearing loss and deafness at the age of 3[3].

The Report on Disability Situation in Thailand of the year 2020 showed that there are 12,893 disabled children aged between 0 and 5 years, and 968 children were suffering either from hearing or speech impairments, which accounted for approximately 7.5% of the children with disabilities[4].

The Ministry of Social Development and Human Security act defines deafness as "a person's limitation in doing daily activities or participating in social activities resulting from hearing impairment. If a person is unable to hear sounds at the lowest frequencies of 500, 1,000 and 2,000 hertz, and sounds greater than 90 decibels or higher, which is 81 decibels according to the WHO definition, the hearing loss is profound[5].

A cochlear implant is an electronic device that

Correspondence to:

Fuengfoo A.

Developmental Division, Department of Pediatrics Queen Sirikit National Institute of Child Health, Bangkok 10400, Thailand.

Phone & **Fax**: +66-2-3458439

Email: dr_adidsuda@yahoo.com

How to cite this article:

Fuengfoo A, Chanjaiwong W, Neesanan N. The Preliminary Study of the Effects of Cochlear Implantation on Developmental Outcome in Thai Children. J Med Assoc Thai 2023;106:965-71.

DOI: 10.35755/jmedassocthai.2023.10.13900

helps provide a sense of sound to an individual profoundly deaf or has sensorineural hearing loss (SNHL)[3].

Based on Sahli's study, children diagnosed with hearing loss before the age of six months, received hearing aids between three and six months, and started auditory-verbal training tended to develop skills in their social, communication, fine and gross motor capabilities. Late diagnosis and treatment could cause delay in development domains, which is statistically significant ($p<0.001$)[6]. The study from Moreno-Torres showed the correlation between language development and parental engagement[7]. Sarant's study showed high family engagement increased their children's literacy performance[8].

According to Svirsky et al., cochlear implantation in children before two years of age showed significant development in language and speech perceptions over children implanted between three and four years of age[9]. Iwasaki et al. conducted a speech and language assessment in children with cochlear implantation. The result showed higher average score in children implanted before 24 months of age[10].

A study in Thailand demonstrated that cochlear implantation treatments, as assessed by Categories of Auditory Performance (CAP) scores, were found to be effective in enhancing language development and improving overall quality of life[11]. Apart from age, the presence of conditions like autism spectrum disorder was identified as a significant factor associated with favorable treatment outcomes[12].

Wie et al. studied language development in cochlear implanted children and found that children implanted by the age of 12 to 48 months demonstrated normal developmental score in language cognition at 81% and language expression at 57%[13]. Bakhshaee et al. conducted a 5-year follow-up study of cochlear implanted children and found that 91% were able to respond to sounds at six months, some single words identifiable at the end of year one, and after three years, 84% were able to understand common phrases without lip reading. In terms of linguistic expression, the difference between the level of speaking ability increased significantly each year for three years[14]. After five years of cochlear implantation and rehabilitation, children had intelligible speech to all listeners. According to the criteria prescribed by the Ministry of Social Development and Human Security, a deaf person is one of the types of persons with disabilities who has "learning impairment or inability to communicate by hearing or speaking", considered by its severity. After hearing Impairment test obtaining the means of the thresholds at 500, 1,000, 2,000 Hz for each ear, then selected the better-ear for each participant. A person with hearing loss above 90 dB or 81 dB HL according to WHO definition, is considered deaf with the highest rating in mode and median speech intelligibility, which is classified Category 5[4].

Delayed postural development and motor development is a common sensorimotor impairment in profoundly deaf children. This is because postural and motor control is a complex process that requires coordination of multiple systems including the sensory system, the central nervous system, motor system, and the vestibular system[14]. Gheysen et al. compared deaf children with and without cochlear implants and hearing children. They found that children with normal hearing scored higher in motor development assessment than those who were deaf. Children with cochlear implants had a statistically significant difference in balance compared to children with normal hearing[15].

According to knowledge-attitude-behavior model, parents' knowledge and positive attitude could support their child to follow doctor's and speech pathologist's advice[16]. Parenting style could also impact their child's intellectual, physical, social, and emotional development[17].

There are very few studies on developmental outcomes of the children with severe SNHL who had a cochlear implant. Since child development is influenced by biological factors and parenting style, the present research was the first in Thailand to monitor childhood development after cochlear implant by parenting style.

Objective

1. To study the developmental outcomes in children after cochlear implantation.
2. To study the factors of family environment, attitudes, and parenting style.

Materials and Methods

Cross-sectional descriptive study was used in the present research. The participants were asked to join the study by administrative officer without conflict of interest in treatment and follow-up process. The data of implanted children between the age of 9 to 66 months at Rajavithi Hospital between September and December 2021 were collected. The study had obtained approval according to document No. REC.079/2564 on June 8, 2021 from the Human Research Ethics Committee, Queen Sirikit National

Institute of Child Health.

Population

Inclusion criteria: Parents of children aged between 9 to 66 months who received a cochlear implant at Rajavithi Hospital.

Parents of children who receive cochlear implant rehabilitation after surgery and attended doctor's follow-up consecutively for three months.

Exclusion criteria: Children with a history of neurological disease such as epilepsy or traumatic brain injury.

Children with other disabilities such as autism, vision and down syndrome, premature and low birth weight babies of less than 2,500 g.

Children with cochlear implant or device failures.

Withdrawal criteria: Change of a device or treatment at another hospital.

Methodology and data collection

There were 34 implanted children aged 9 to 66 months at Rajavithi Hospital and 27 children were selected. The participants were asked to complete consent forms and questionnaires through an interview, VDO call or postage mail. The questionnaires included demographic information of children, family history, home environment, and assessments that included parents attitude assessment, Parenting Styles and Dimensions Questionnaire (PSDQ), and Ages & Stages Questionnaires, Third Edition (ASQ-3), which took 20 to 35 minutes. Parents who completed the questionnaires via postage mail would be called to recheck information again via VDO call.

Research tools

Section 1: Questionnaire

Set 1: Demographic information of children, family history, and training environment.

Set 2: Parents attitudes and knowledge assessment of cochlear implanted children. The questionnaire consisted of ten questions including two on treatment knowledge, five on parent attitudes, and three on family potential with each question worth 0 to 4 points. As a part of collecting evidence for content validation of the instrument, the objective of congruence (IOC) analysis was used in the present study. Most of the items scored an IOC value of 1, except item 6, which had the IOC value of 0.66. The Cronbach's alpha value of 10 parents of implanted children was 0.85

Set 3: PSDQ-short version: Thai version by Professor Dr. Weerasak Chonchaiya, Faculty of Medicine, Chulalongkorn University, included 32 items based on three parenting styles, authoritative, authoritarian, and permissive. The highest mean scores in each category indicate dominant parenting styles. The internal consistency of authoritative parenting style was 0.8, authoritarian was 0.75, and permissive was 0.62[18].

Section 2: Assessment tools

The Early Childhood ASQ-3 is a set of questionnaires for children from 2 to 66 months of age and is the most widely used in the United States. It has been used as a development screening tool that covers five developmental domains, communication, gross motor, fine motor, problem solving, and personal-social. There were six items in each domain and has a sensitivity of 72% and a specificity of 86%.

ASQ-3 Thai had been translated and modified by Assistant Professor Dr. Prasong Saihong, Faculty of Education, Mahasarakham University, Thailand.

The questionnaire used in a research study was to evaluate and verify results in the Northeastern children aged 24, 30, and 36 months. The result showed internal reliability (Cronbach's coefficient alphas 0.58 to 0.89) and test-retest reliability greater than 90%[19]. A score below the age cutoff less than 2SD is considered abnormal. Content validity was defined and compared to Bayley-III[20].

Data analysis

Descriptive statistics for categorical SPSS reported in percentages and continuous variables. The normal distribution was defined by mean and standard deviation. The non-normal distribution was reported in median, minimum value, and maximum value. To analyze correlations between variables, inferential statistics were used, chi-square test, Fishers' exact test, or binary logistic regression analysis with a statistically significant test result of p-value less than 0.05.

Results

The sample of 27 children consisted of 17 males (63%) and 10 females (37%). The average age was 48 (43, 59) months, and average age of diagnosis was at 17.22±11.48 months. Twenty-five children (92.6%) suffered from hearing loss before one year old. The average age of children wearing hearing aid and receiving cochlear implantation was 21.96±11.01 months and 30.52±12.22 months, respectively. Nineteen children (70.4%) received

Table 1. General information of children with cochlear implant

Variables	n=27
Sex; n (%)	
Male	17 (63.0)
Female	10 (37.0)
Age (16 to 62 months); median (min, max)	48 (43, 59)
Age of diagnosis (1 to 41 months); mean±SD	17.22±11.48
Loss of hearing; n (%)	
Before 1 year old	25 (92.6)
After 1 year old	2 (7.4)
Age of wearing a hearing aid (3 to 48 months); mean±SD	21.96±11.01
Age to start hearing and speech training (3 to 48 months); mean±SD	23±11.31
Age of implantation (9 to 55 months); n (%)	
Before 2 years old	8 (29.6)
After 2 years old	19 (70.4)
Mean±SD	30.52±12.22
Period of hearing and speech training after cochlear implantation (4 to 36 months); median (min, max)	14 (11, 26)

SD=standard deviation

hearing implantation after two years of age. The average age of receiving hearing and speech training after cochlear implantation was 14 (11, 26) months. General information of children with cochlear implant is shown in Table 1.

Table 2 shows the family history and home environment of the respondents. Twenty-two children (81.5%) were taken care of by their father and mother. The mean age of their father was 31.81±6.99 years and their mother's mean age was 29.78±6.33 years. In terms of education, 55.6% of their mothers completed a bachelor's degree or higher, which was more than their fathers at 33.33%. Most families (63%) had only one child with family income ranging from less than 10,000 Baht to more than 50,000 Baht. More than 70.4% had interpretive medicine practitioners visiting their home every day for 60 (60, 60) minutes and 77.8% read with their children approximately 60 (10, 150) minutes per week. Concerns about their children's attendance at school was high with 66.7% that had concerns but 88.9% planned to send their children to regular school, while the rest planned send their children to special education centers and home school.

The overall knowledge and attitudes of parents were at a very good level at 96.3%. Most of them had an authoritative parenting score of 4.05±0.54 points, followed by permissive parenting score of 2.83±0.68 points, and authoritarian parenting score of 2.17±0.63 points. Authoritative parenting style was mostly used among parents at 96.3%, followed by permissive parenting style at 3.7%, as shown in Table 3.

Table 2. Family history and home environment

Variables	n=27
Caregivers; n (%)	
Father/mother	22 (81.5)
Grandparents	5 (18.5)
Average age of parents; mean±SD	
Father (lowest-highest 18 to 47 years)	31.81±6.99
Mother (lowest-highest 19 to 45 years)	29.78±6.33
Education; n (%)	
Father: Bachelor's degree or above	9 (33.3)
Mother: Bachelor's degree or above	15 (55.6)
Family type; n (%)	
Nuclear family	12 (44.4)
Extended family	15 (55.6)
Number of children; n (%)	
One	17 (63.0)
More than two	10 (37.0)
Monthly income; n (%)	
Less than 20,000 Thai Baht	11 (40.7)
20,001 Baht or above	16 (59.3)
Duration of speech training practices at home; n (%)	
Every day	19 (70.4)
1 to 6 days per week	7 (25.9)
None	1 (3.7)
Speech practice at home (minutes/day) (lowest-highest 20 to 240 minutes); median (min, max)	60 (60, 60)
Reading with children; n (%)	
No	6 (22.2)
Yes	21 (77.8)
Reading duration (0 to 300 minutes/week); median (min, max)	60 (10, 150)

SD=standard deviation

Table 3. Knowledge, attitudes, characteristics and dimensions of parenting

Variables	n=27
Knowledge and attitudes; n (%)	
Very good	26 (96.3)
Moderate	1 (3.7)
Parenting styles; n (%)	
Authoritative	26 (96.3)
Authoritarian	0 (0.0)
Permissive	1 (3.7)
Authoritative parenting score; mean±SD	4.05±0.54
Authoritarian parenting score; mean±SD	2.17±0.63
Permissive parenting score; mean±SD	2.83±0.68

SD=standard deviation

The development outcomes of children receiving cochlear implantation were based on normal

Table 4. Correlation factors between language development, problem-solving skills, and other variables

Variables	OR (95% CI)	p-value
Language development		
Age of diagnosis of hearing loss, ≤12 and >12 months	26.25 (2.45 to 280.20)	0.007
Age of wearing hearing aids, ≤18 and >18 months	59.5 (4.61 to 767.17)	0.002
Age to start hearing and speech training, ≤18 and >18 months	126 (6.89 to 2,303.83)	0.001
Age at cochlear implantation, ≤24 and >24 months	25.50 (2.91 to 223.27)	0.003
Age to receive hearing and speech training after cochlear implant, ≤12 and >12 months	12 (1.21 to 118.88)	0.034
Problem-solving skills		
Family type: Nuclear and extended family	16.5 (1.66 to 163.42)	0.017
Reading with children (yes, no)	16 (1.49 to 171.20)	0.022

OR=odds ratio; CI=confidence interval

Binary logistic regression analysis statistically significant test result of $p<0.05$

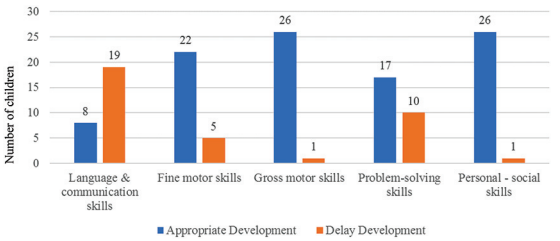

Figure 1. Developmental outcomes of children after cochlear implantation using ASQ-3 Thai.

developmental milestones and were measured to determine if the progress met appropriate milestones. Figure 1 illustrates the ASQ-3 results of the five developmental domains of 27 children that underwent cochlear implantation and received consecutive language training for at least three months. The greatest improvement was fine motor skills at 96.3% and personal-social skills at 96.3%, followed by fine motor skills at 81.5%, problem-solving skills at 63%, and language and communication skills at 70.4%.

Development of language and communication skills

Children diagnosed with hearing impairment at less than 12 months of age were 26.25 times more likely to have normal language development than children over 12 months of age with a statistical significance (p=0.007, 95% CI 2.45 to 280.20). Children who wore hearing aids before 18 months of age were 59.5 times more likely to have normal language development than those who wore hearing aids after 18 months with a statistical significance (p=0.002, 95% CI 4.61 to 767.17). Children who received hearing and speech training before 18 months of age were 126 times more likely to have normal language development, with statistical significance (p=0.001, 95% CI 6.89 to 2,303.83). Children less than 24 months old who received Cochlear implant were 25.50 times more likely to have normal language development with statistical significance (p=0.003, 95% CI 2.91 to 223.27) and children receiving hearing and speech skills training after cochlear implant for more than 12 months were 12 times more likely to have normal language development with statistical significance (p=0.034, 95% CI 1.21 to 118.88) as in Table 4.

Development of problem-solving skills

Nuclear family tended to develop problem-solving skills 16.5 times more than extended families with statistical significance (p=0.017, 95% CI 1.66 to 163.42) and parents who read with their children were 16 times more likely to improve problem-solving skills than parents who did not (p=0.022, 95% CI 1.495 to 171.20), as shown in Table 4.

Discussion

From the present study, 40.7% of the children were diagnosed with hearing loss younger than 12 months, and 33.3% received hearing aids and 29.6% auditory-verbal training before the age of 18 months. Seventy-point-four percent of the participants in the study had cochlear implantation after 2 years of age, which led to speech and language delay.

Children with hearing impairment who wear hearing aids within the first year of age experienced better speech and language development compared to children with untreated hearing loss. According to Sahli's study, children with hearing loss who receive appropriate treatment and training within the first six months of life are more likely to have normal development in every dimension, which is better than children aged 6 to 12 months and 12 to 18 months[6]. From the present study, the optimal age for cochlear

implantation was before two years old. In the study of Svirsky et al, children who receive cochlear implant have better development than children aged three and four years[9]. According to Iwasaki et al.[10], universal early screening is currently highly beneficial in detecting hearing loss in children, making them receive early treatment and developing language and communication skills as normal children.

In the study of Pulsifer et al.[21], children who receive 1-year auditory-verbal training after cochlear implant surgery improved in hearing and speaking skills. It is necessary that parents are encouraged to continuously practice hearing and speaking skills with their child after surgery. However, no previous study has examined holistic developmental assessment by ASQ-3 Thai in children with cochlear implants.

The second most developmental delay was problem solving skills at 37%, which is based on knowledge acquisition and language proficiency. Children with hearing impairment usually have difficulties in language and problem-solving skills.

In the present study, nuclear family is associated to the development of problem-solving skills, but not number of children nor practitioners. A study of Zahra and Kamal showed the differences in problem-solving skills. The small families had higher average score in problem-solving than larger families, less family problems, and clear environment support for children's learning[22].

Reading together with their child improves problem-solving skills, but not language development. Unlike the Sarant et al. study, reducing 30 minutes of screen time and replacing it with 30 minutes of reading with the child, thus adding 150 minutes of reading per week, resulted in an increase of language development score at 15.66.

The present study found no relationship between parenting style, language development and parents who bring their children to receive treatment and follow-up training. Authoritative has no relationship with gross muscles development because the tools do not measure the development in gross motor and physical balance, which is a detailed assessment of muscle development.

After analyzing the five variables include age receiving hearing impairment diagnosis, age wearing hearing aids, age receiving hearing and speech training, age receiving cochlear implantation, duration of hearing and speech training, and value of language and communication developmental scores using multiple logistic regression, the result showed that there is no correlation between the variables and language and communication skills, but the five variables are dependent upon one another. Highly correlated variables with multicollinearity are removed using variable inflation factor (VIF). Dependent variables consisting of age receiving hearing impairment diagnosis (VIF 5.7), age wearing hearing aids (30.6), age receiving hearing and speech training (33.3), and age receiving cochlear implantation (11.1). Age of diagnosis had the lowest VIF and likely to be an important indicator because age at diagnosis always comes before the age receiving intervention. Then, multiple logistic regression analysis was conducted again, with only duration of hearing and speech training with the lowest VIF (1.8) and age receiving hearing impairment diagnosis (VIF 5.7). Hearing diagnosis has a significant correlation value of 0.0396 and the correlation value of duration of hearing and speech training was almost significant (p=0.053). Both factors have no multicollinearity (VIF 1.3), which indicate that age receiving diagnosis of hearing impairment and duration of hearing and speech skills training after cochlear implantation affect the outcome of language development when a child receives early diagnosis (odds ratio 0.80, 95% CI 0.60 to 0.94) or longer duration of hearing and speech training (odds ratio 1.16, 95% CI 1.01 to 1.40), is related to the success of language development.

Limitation

A larger sample size is recommended for future research. The developmental assessment tool has been modified as a screening tool after the outbreak of COVID-19. It should be able to categorize language development into language perception and language expression.

Conclusion

Children with severe sensory neural hearing loss who received early diagnosis and cochlear implantation at the age younger than two years old, as well as long consecutive auditory and speech skills training, results in better language developmental outcomes.

What is already known in this topic?

In developed countries, cochlear implantation for SNHL is usually performed in adults and children with severe hearing loss. Associate factors that affect child development include age at diagnosis of hearing impairment, speech and auditory training, parents' education level, parenting style, and parental involvement.

What does this study add?

This study showed the results of child development in Thailand after receiving cochlear implantation and the factors of family conditions, attitudes, and parental style to improve appropriate child development care according to Thai context.

Acknowledgement

The authors would like to thank the present research project advisors: Rattothai Plubrukarn, Sija Leelathanaporn, and Wimakanee Boonchouy. Besides the advisors, the authors would like to express their appreciation to Veerasak Cholchaiya, Prasong Saihong, Somjin Chindavijak, Davin Yavapolkul, Supranee Boonmee and Jiratchaya Wannathong staff members of Rajavithi Hospital.

Conflicts of interest

The authors declare no conflict of interest.

References

1. World Health Organization. Deafness and hearing loss [Internet]. 2020 [cited 2020 Mar 1]. Available from: Deafness and hearing loss (who.int).
2. The American Speech-Language-Hearing Association (ASHA). Effects of hearing loss on development. Audiology information series. Rockville, MD: ASHA; 2015.
3. National Institute for Health and Care Excellence (NICE). Cochlear implants for children and adults with severe to profound deafness. Technology appraisal guidance. London: NICE; 2019.
4. Department of Empowerment of Persons with Disabilities, Ministry of Social Development and Human Security, Thailand. Situation report on persons with disabilities in Thailand. Bangkok: Ministry of Social Development and Human Security; 2020.
5. Piyasil V, Ningsanond V. Children with disabilities. Bangkok: The Royal College of Pediatricians of Thailand; 2015.
6. Sahli AS. Developments of children with hearing loss according to the age of diagnosis, amplification, and training in the early childhood period. Eur Arch Otorhinolaryngol 2019;276:2457-63.
7. Moreno-Torres I, Madrid-Cánovas S, Blanco-Montañez G. Sensitive periods and language in cochlear implant users. J Child Lang 2016;43:479-504.
8. Sarant J, Harris D, Bennet L, Bant S. Bilateral versus unilateral cochlear implants in children: a study of spoken language outcomes. Ear Hear 2014;35:396-409.
9. Svirsky MA, Teoh SW, Neuburger H. Development of language and speech perception in congenitally, profoundly deaf children as a function of age at cochlear implantation. Audiol Neurootol 2004;9:224-33.
10. Iwasaki S, Nishio S, Moteki H, Takumi Y, Fukushima K, Kasai N, et al. Language development in Japanese children who receive cochlear implant and/or hearing aid. Int J Pediatr Otorhinolaryngol 2012;76:433-8.
11. Piromchai P, Tanamai N, Kiatthanabumrung S, Kaewsiri S, Thongyai K, Atchariyasathian V, et al. Multicentre cohort study of cochlear implantation outcomes in Thailand. BMJ Open 2021;11:e054041.
12. Chindavijak S, Sannikorn P, Boonmee S, Detyong A, Wanthong J, Tanamai N. The cochlear implant outcome and factors associated of pre-operative among prelingual deafness patients under 3 years and 6 months old in Rajavithi Hospital: A single center experience. J Med Assoc Thai 2023;106:229-34.
13. Wie OB. Language development in children after receiving bilateral cochlear implants between 5 and 18 months. Int J Pediatr Otorhinolaryngol 2010;74:1258-66.
14. Bakhshaee M, Shariian SMR, Ghasemi MM, Naimi M, Moghiman T. Speech development and auditory performance in children after cochlear implantation. Med J Islam Repub Iran 2007;20:184-91.
15. Rajendran V, Roy FG. An overview of motor skill performance and balance in hearing impaired children. Ital J Pediatr 2011;37:33-7.
16. Gheysen F, Loots G, Van Waelvelde H. Motor development of deaf children with and without cochlear implants. J Deaf Stud Deaf Educ 2008;13:215-24.
17. Punyapas S, Techapoonpon K, Tarugsa J, Seree P. Knowledge and attitude of parents of children with learning disabilities. J Psychiatr Assoc Thai 2015;60:157-69.
18. Robinson CC, Mandleco B, Olsen SF, Hart CH. The parenting styles and dimensions questionnaire (PSDQ). In: Perlmutter BF, Touliatos J, Holden GW, editors. Handbook of family measurement techniques. Vol.3. Instruments & index. Thousand Oaks: Sage Publication; 2001. p. 319-21.
19. Saihong P. Use of screening instrument in Northeast Thai early childcare settings. Procedia Soc Behav Sci 2010;7:97-105.
20. Fuengfoo A, Sakulnoom K, Owjinda S, Piromkit A. The feasibility of the ages & stages questionnaires, third edition (ASQ-3, Thai version) for the Assessment of Child Development in Thailand. J Med Assoc Thai 2020;103:1247-54
21. Pulsifer MB, Salorio CF, Niparko JK. Developmental, audiological, and speech perception functioning in children after cochlear implant surgery. Arch Pediatr Adolesc Med 2003;157:552-8.
22. Zahra ST, Kamal A. Family structure and children's problem-solving ability. J Soc Sci, Summer 2013;7:67-72.