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Original Article

Risk factors for delayed speech in children aged 1-2 years

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Abstract

Background Speech delay is one of the most common developmental delays in children. To minimize the negative outcomes of speech delay, risk factors should be explored to help in early patient diagnosis.

Objectives To assess for associations between delayed speech in children aged 1 to 2 years and possible risk factors including gender, gestational age, birth weight, asphyxia during birth, head circumference, anterior fontanelle closure, gross motor development, duration of breastfeeding, caregiver identity, number of siblings, exposure to gadgets and television, and social interaction.

Methods Parents of children aged 1 to 2 years who were treated at Dr. Cipto Mangunkusumo Hospital, and Klinik Anakku, Pondok Pinang in Jakarta from January 2018 to March 2018 were interviewed. Data were processed with SPSS Statistics for Mac and analyzed by Chi-square test and logistic regression method.

Results Of 126 subjects, 63 children had speech delay and 63 children had normal speech development. Multivariate analysis revealed that the significant risk factors for delayed speech were delayed gross motor development (OR 9.607; 95%CI 3.403 to 27.122; P<0.001), exclusive breastfeeding for less than 6 months (OR 3.278; 95%CI 1.244 to 8.637; P=0.016), and exposure to gadgets and television for more than 2 hours daily (OR 8.286; 95%CI 2.555 to 26.871; P<0.001).

Conclusion Delayed gross motor development, exclusive breastfeeding for less than 6 months, media exposure for more than 2 hours daily, and poor social interaction are risk factors for delayed speech development in children. **[Paediatr Indones. 2019;59:55-62; doi: http://dx.doi.org/10.14238/pi59.2.2019.55-62]**.

Keywords: *breastfeeding; gadget; risk factors; speech delay*

Speech delay is one of the most common developmental delays in children, with a reported prevalence of 5-8% amongst children aged 2 to 4.5 years in 2006.[1] This percentage was lower compared to two decades before, when it was 3-10%.[2] In Indonesia, Dr. Kariadi Hospital in Semarang in 2007 encountered 100 children with speech delay out of the 436 children tested.[3] Data obtained by Dr. Cipto Mangunkusumo Hospital showed that 10.13% from 1125 children visits in 2006 were tested positive for speech delay.[3] More studies should be carried out to obtain a timely prevalence in both Indonesia and worldwide.

Normal speech progresses through stages, starting with cooing at the age of 3 months, continuing with babbling, imitation of sounds, jargon, and single words, word combinations, and finally sentence formation.[4] Some children may progress at a slower pace compared

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to other children, hence the term, speech delay.[5] In such cases, parents or caregivers should pay close attention to speech development of their children, as there are red flags that suggest the need for immediate intervention by physicians. If not managed properly, speech delay may impact a person's life personally, socially, academically, and vocationally for years to come.[5]

Early detection of speech delay is crucial, in order to intervene as early as possible.[6] Early intervention can help these children have a longer time window to catch up in their development.[7] As such, we determined to identify risk factors of speech delay in children. The factors assessed were gender, gestational age, birth weight, asphyxia during birth, head circumference, closure of anterior fontanelle, gross motor development, duration of breastfeeding, caregiver identity, number of siblings, exposure to gadgets and television, and subject's social interaction. Subjects with ages ranging from 1 to 2 years were chosen because this is the period in which brain growth is most rapid during the first 1,000 days of life. The lower age limit of 1 year was chosen because this is normally the age when a child starts to say 1 to 2 meaningful words.[4] The upper age limit of 2 years old was chosen so that detection can be done to allow for at least one year of intervention, in order to give the children a chance to meet normal speech development by the end of the first 1,000 days.

Methods

This study was conducted from August 2017 to April 2018 in Dr. Cipto Mangunkusumo Hospital and Klinik Anakku, Pondok Pinang in Jakarta, Indonesia. Our matched, case-control study included 126 children aged 1 to 2 years. Subjects were classified into two groups: the control and case group, based on fulfillment of the control/case inclusion criteria. Subjects with normal speech development, as indicated by their ability to fulfill the milestones of normal expressive speech and language development milestones (**Table 1**), were placed in the control group. Subjects in the case group had delayed speech development. Children with apparent syndromes or abnormalities in or around the mouth were excluded from this study. This study was approved by the Ethics Committee of the Universitas Indonesia Medical School.

Data collection was done with a purposive sampling method. Subjects' parents or guardians were interviewed using a questionnaire to obtain information about the subjects' gender, gestational age, birth weight, asphyxia during birth, head circumference, closure of anterior fontanelle, gross motor development, duration of breastfeeding, caregiver identity, number of siblings, exposure to gadgets and television, and social interaction of subject. The questions regarding these variables were available in the questionnaire. Head circumference, closure of anterior fontanelle, and subject's social interaction were measured directly on the subjects.

Data were processed by *SPSS Statistics for Mac* and analyzed by Chi-square test and logistic regression method. The significance level in both tests was $P < 0.05$.

In this study, speech delay was defined as a slower progression of speech compared to other children of the same age. Subjects born at under 35 weeks were considered to be premature, and those with birth weight <2,500 grams were considered to have low birth weight. Subjects who did not cry right after delivery were considered to have experienced asphyxia during birth. Subjects who scored below -2 SD (2%) in the Nellhaus head circumference chart were considered to have microcephaly.[8] Subjects' anterior fontanelle sizes were measured and compared to mean anterior fontanelle size in **Table 2** to assess closure.

Table 1. Milestones for expressive speech and language in children[7]

Age (months)	Expressive skills
0-2	Cries
3	Coos Laughs
6	Babbles
9	Imitates sound
12	1-2 meaningful words
18	At least 6 meaningful words
24	Forms 2-3-word sentences

Table 2. Mean of anterior fontanelle size[16]

Age, months	Mean size (SD), cm
9-12	1.15 (1.2)
12-18	0.05 (0.22)
18-24	0 (0)

Subjects who did not fulfill the following milestones were considered to have delayed gross motor development: 12 months - walks with 1 hand held, 15 months - walks alone, 16 months - runs, 18 months - walks upstairs with assistance, and 24 months - jumps. Short duration of breastfeeding was defined as < 6 months of exclusive breastfeeding. Caregiver identity was defined as mother or babysitter/others. Children were considered to have minimal attachment to the mother if they were nurtured by a babysitter or a family member other than the mother. A subject was considered to have a sibling if he was not the only child in the family (either related or unrelated by blood). Subjects who spent more than 2 hours/day exposed to media (gadgets and/or television) were considered to have excessive media exposure. Direct examination was done to measure head circumference, closure of anterior fontanelle (and size of anterior fontanelle if not closed), and the subject's social interaction. Subjects who responded poorly or did not respond at all during social interaction were considered to have poor social interaction.

Results

Of 126 subjects, 75 (59.53%) were male; 63 subjects had speech delay and the other 63 had normal speech development. All subjects were aged 1 to 2 years. Subjects' characteristics are shown in **Table 3**.

Of 126 subjects in our study, 34 children (27.0%) were aged 12 to 15 months, 28 children (22.2%) aged 16 to 18 months, 30 children (23.8%) aged 19 to 21 months, and 34 children (27.0%) aged 22 to 24 months. Most subjects with speech delay were in the 22-24 month age group, with 14 children, accounting for 22.2% of the population with speech delay.

Bivariate analysis (**Table 3**) showed that out of the 12 variables analyzed, 5 were significantly related to speech delay: asphyxia during birth (OR 3.625; 95%CI 1.229 to 10.695; P=0.028), gross motor development not according to milestones (OR 9.750; 95%CI 4.086 to 23.267; P<0.001), duration of exclusive breastfeeding for <6 months (OR 3.558; 95%CI 1.694 to 7.471; P=0.001), exposure to gadgets and television for >2 hours daily (OR 7.125; 95%CI 2.679 to 18.948; P<0.001), and poor social interaction (OR 0.432; 95%CI 0.349 to 0.535; P<0.001). The remaining seven variables had P values >0.05, thus were not significant.

The full multivariate logistic regression model (**Table 4**) included the nine variables with P values < 0.25 in bivariate analysis. In the final model (**Table 5**), three variables were found to be significant, namely, gross motor development (OR 9.607; 95%CI 3.403 to 27.122; P<0.001), duration of exclusive breastfeeding (OR 3.278; 95%CI 1.244 to 8.637; P=0.016), and exposure to gadgets and television (OR 8.286; 95%CI 2.555 to 26.871; P < 0.001).

Discussion

There was a participation of 126 children in this study, in which 50% of the population had a delayed speech development. Mondal *et al.*[10] in 2016 assessed 200 children aged 0 to 36 months and found a prevalence of children aged 13 to 24 months with speech delay was 14.5%, which was lower than the results of this study (50%).

Gender was not significantly associated with speech delay (OR 2.083; 95%CI 1.009 to 4.300; P=0.07), despite more males (68.3%) than females (31.7%) found to have delayed speech development. In contrast, Keegstra et al. in 2006 and Mondal et al. in 2016 found that significantly more males than females had speech delay.[10, 11]

Mondal *et al.* also noted that gestational age and birth weight were not significantly associated with speech delay [(OR 0.4; 95%CI 0.52 to 3.74; P=0.67) and (OR 1.3; 95%CI 0.56 to 2.91; P=0.296), respectively].[10] Similarly, we also found no significant associations between speech delay and gestation age (OR 2.286; 95%CI 0.854 to 6.121; P=0.151), or birth weight (OR 1.700; 95%CI 0.739 to 3.911; P=0.296). The only perinatal factor assessed in our study was perinatal asphyxia, and this factor was found to be significant with regards to speech delay (OR 3.625; 95%CI 1.229 to 10.695; P=0.028). In addition, Nguefack *et al.* in 2013 stated that perinatal asphyxia was the most frequent perinatal factor to cause developmental delay (44%; P=0.05).[12]

Perinatal hypoxia-ischemia is responsible for primary and secondary cerebral energy failure, a phenomena in which the blood flow to the brain is decreased, thus reducing oxygen transport. These

Table 3. Characteristics of subjects (N=126)

Characteristics	Normal (n=63)	Speech delay (n=63)	OR (95%CI)	P value
Gender, n(%)				
Female	31 (49.2)	20 (31.7)	2.083	0.070
Male	32 (50.8)	43 (68.3)	(1.009 to 4.300)	
Gestational age, n (%)				
≥ 35 weeks	56 (88.9)	49 (77.8)	2.286	0.151
< 35 weeks	7 (11.1)	14 (22.2)	(0.854 to 6.121)	
Birth weight, n (%)				
≥ 2,500 grams	51 (81.0)	45 (71.4)	1.700	0.296
< 2,500 grams	12 (19.0)	18 (28.6)	(0.739 to 3.911)	
Asphyxia during birth, n (%)				
No	58 (92.1)	48 (76.2)	3.625	0.028*
Yes	5 (7.9)	15 (23.8)	(1.229 to 10.695)	
Head circumference, n (%)				
Normal	51 (81.0)	44 (69.8)	1.835	0.215
Microcephaly	12 (19.0)	19 (30.2)	(0.802 to 4.199)	
Closure of anterior fontanelle, n (%)				
Yes	44 (69.8)	48 (76.2)	0.724	0.547
No	19 (30.2)	15 (23.8)	(0.328 to 1.596)	
Gross motor development, n (%)				
According to milestones	54 (85.7)	24 (38.1)	9.750	< 0.001*
Not according to milestones	9 (14.3)	39 (61.9)	(4.086 to 23.267)	
Duration of exclusive breastfeeding, n (%)				
> 6 months	45 (71.4)	26 (41.3)	3.558	0.001*
< 6 months	18 (28.6)	37 (58.7)	(1.694 to 7.471)	
Caregiver, n (%)				
Mother	51 (81.0)	43 (68.3)	1.977	0.152
Babysitter (or not mother)	12 (19.0)	20 (31.7)	(0.868 to 4.500)	
Number of siblings, n (%)				
≥ 1	13 (20.6)	17 (27.0)	1.421	0.530
0	50 (79.4)	46 (73.0)	0.622 to 3.246	
Exposure to gadgets and television, n (%)				
≤ 2 hours/day	57 (90.5)	36 (57.1)	7.125	< 0.001*
> 2 hours/day	6 (9.5)	27 (42.9)	(2.679 to 18.948)	
Social interaction, n (%)				
Good	63 (100.0)	48 (76.2)	0.432	< 0.001*
Poor	0 (0.0)	15 (23.8)	(0.349 to 0.535)	

*significant P value < 0.05

Table 4. Results of multivariate logistic regression analysis (full model)

Variables	B	OR (95%CI)	P value
Male gender	0.329	1.390 (0.505 to 3.827)	0.524
Gestational age (< 35 weeks)	0.898	2.454 (0.633 to 9.512)	0.194
Asphyxia during birth (yes)	0.751	2.119 (0.409 to 9.164)	0.751
Head circumference (microcephaly)	-0.354	0.702 (0.184 to 2.673)	0.604
Gross motor development (not according to milestones)	2.371	10.705 (3.124 to 36.687)	< 0.001*
Duration of exclusive breastfeeding (< 6 months)	1.122	3.071 (1.121 to 8.417)	0.029*
Caregiver (babysitter/or not mother)	0.436	1.546 (0.407 to 5.090)	0.473
Exposure to gadgets and television (> 2 hours/day)	2.123	8.354 (2.486 to 28.071)	0.001*
Social interaction (poor)	19.991	48,076.39 (< 0.001)	0.998
Constant	-2.515	0.081	< 0.001

*significant P value < 0.05

Table 5. Results of multivariate logistic regression analysis (final model)

Variables	B	OR (95%CI)	P value
Gross motor development (not according to milestones)	2.262	9.607 (3.403 to 27.122)	< 0.001*
Duration of exclusive breastfeeding (< 6 months)	1.187	3.278 (1.244 to 8.637)	0.016*
Exposure to gadgets and television (> 2 hours/day)	2.115	8.286 (2.555 to 26.871)	< 0.001*
Social interaction (poor)	20.218	60,305.42(< 0.001)	0.998
Constant	-2.046	0.129	< 0.001

*significant P value < 0.05

phenomena are also responsible for decreased high-energy phosphorylated compounds. The decrease in blood flow, oxygen transport, and high-energy phosphorylated compounds may lead to brain injury, resulting in immediate neuronal death (in primary cerebral energy failure), and delayed neuronal death (in secondary cerebral energy failure). Both neuronal deaths have adverse effects on neurodevelopment, including delayed speech development.[13]

Neither head circumference nor closure of anterior fontanelle was significantly associated with speech delay in our study [(OR 1.835; 95%CI 0.802 to 4.199; P=0.215) and (OR 0.724; 95%CI 0.328 to 1.596; P=0.547), respectively]. However, Davidovitch *et al.* found a significant relationship between head circumference and speech delay (P=0.03).[14] To our knowledge, no previous study has investigated the relationship between delayed closure of anterior fontanelle and speech delay. According to Esmaeili et al., delayed closure of the anterior fontanelle results from stunted brain growth, often manifesting as motor and speech delay, as well as cognitive impairment.[9]

Gross motor development was another developmental delay significantly associated with speech delay. Children with delayed gross motor development were more likely to experience delayed speech development (OR 9.750; 95%CI 4.086 to 23.267; P<0.001). In our study, of 63 children with speech delay, 61.9% had delayed gross motor development. A previous study compared infants who were dependent walkers (infants in baby-walker) with independent walkers, in terms of their vocalizations and social interaction. The latter group of walkers scored better in both variables tested.[15] Another previous study found that in children who accomplished milestones of standing with assistance by 2.1 months later scored 21.9 points less than children with normal gross motor milestones in the *Batelle Developmental Inventory*, 2nd edition (BCI-2) (95%CI -41.5 to -2.2).[16] These studies suggest that gross motor development is an important basis for speech development. Motor development may enhance language development in children by providing more opportunities to experience the world.[17] Iverson argued that infants' rib cages are restricted before they are able to sit on their own. When infants are able to sit without assistance, their rib cage is freed, thus, they can breathe more efficiently and maintain subglottal pressure, which is essential in speech production.[17] Iverson added that as soon as infants start walking, they are able to bring objects of interest to adults around them. By focusing on the object in their hands, infants are more likely to learn words related to that object. One of the many ways to increase an infant's interest in the objects around them is to entertain them by engaging their interest.[17] In other words, motor development such as a change in posture and locomotion, supported by object-manipulation, is highly stimulating to an infant's speech development later in life.[17]

The beneficial relationship of breastfeeding to both growth and development of children has been studied for years. We, too, noted that children with a breastfeeding duration of less than the recommended 6 months were at risk of developing speech delay (OR 3.5568; 95%CI 1.694 to 7.471; P=0.001). This result was comparable to that of a longitudinal study by Vestergaard *et al.*, which stated that children with increased duration of exclusive breastfeeding would display early speech and language skills that are indicated by polysyllable babble at the age of 8 months old.[18] The presence of polysaturated fatty acid such as omega-3 [docosahexaenoic acid (DHA)] and omega-6 [arachidonic acid (AA)] in breast milk has been suggested as the mechanism underlying this relationship. Both of these fatty acids are responsible for promoting neural growth and the development of white and gray matter, hence, exclusive breastfeeding for 6 months is highly correlated with higher language and cognitive scores.[19,20]

Similar to a study by Suparmiati *et al.* in 2013, no significant relationship was observed between caregiver (mother vs. babysitter or other) and speech delay (OR 1.977; 95%CI 0.868 to 4.500; P=0.152). However, care given by a babysitter may increase the risk or worsen delayed speech development in children, as shown in a previous study.[21]

There was also no significant relationship between the number of siblings and speech delay (OR 1.421; 95%CI 0.622 to 3.246; P=0.530) in our study. In comparison, Keegstra *et al.* found that an only child in the family had a higher chance of developing speech delay than a child with brothers and sisters (P=0.023).[11]

Exposure to gadgets and television for >2 hours daily was significantly associated with speech delay (OR 7.125; 95%CI 2.679 to 18.948; P<0.001). Out of the 63 children with speech delay, 42.9% were exposed to media for >2 hours daily. Only 9.5% of children without speech delay had media exposure of >2 hours daily. This result was consistent with a study by Duch *et al.* who found that exposure to gadgets and television of >2 hours daily was significantly associated with lower communication scores.[22] Hypotheses on the mechanism of how media may affect speech development have been proposed. Evidence suggests that young children are not proficient in learning words from media. Thus, exposing them to gadgets and television worsens their language acquisition by decreasing the quantity and quality time of the parent-child relationship and children's play activities.[22]

The last variable assessed in our study was social interaction, which was significantly related to speech development in children (OR 0.432; 95%CI 0.349 to 0.535; P<0.001). All children with normal speech development had good social interaction. In comparison, of the 63 children with delayed speech, 48 displayed good social interaction (76.2%) while the remaining 15 children (23.8%) displayed poor social interaction. To our knowledge, no previous study has hypothesized the relationship between the two variables, but Rice *et al.* found that children with delayed speech development have worse social interaction than children with normal speech and language development, which supported the finding in this study.[23]

Delayed gross motor development, <6 months of exclusive breastfeeding, and >2 hours of media exposure daily were significantly related to speech delay in the final multivariate logistic regression model [(OR 9.607; 95%CI 3.403 to 27.122; P<0.001), (OR 3.278; 95%CI 1.244 to 8.637; P=0.016), and (OR 8.286; 95%CI 2.555 to 26.871; P< 0.001), respectively]. A study by Chonchaiya *et al.* also showed a significant association between excessive media exposure and speech delay, with an odds ratio of 5.70 (95%CI 1.85 to 17.61).[24] In addition, Yanuarti et al. in Bandung, Indonesia, showed a relationship between non-exclusive breastfeeding and speech delay (PR 174.756; 95%CI 10.407 to 2,935.516; P<0.001).[25] Furthermore, the relationship between delayed gross motor development and delayed speech were significant in our study, but not in the study by Ghassabian *et al*.[16]

Social interaction was not significant in the final model for multivariate logistic regression (P=0.998). Further investigations are needed to confirm the relationship between social interaction and speech delay.

The limitation of this study was that parents may have provided inaccurate and incomplete information, especially on their child's gross motor development. For subsequent studies, it is recommended for researchers to conduct direct observation of gross motor development for all subjects. This study shall benefit clinicians, especially pediatricians, in educating parents of children with suspected speech delay. Verbal counselling is one of the preferred ways to educate parents on the practical changes to be made in their home environment to reduce the risk of speech delay, such as limiting their children's screen time.

In conclusion, delayed gross motor development, duration of exclusive breastfeeding of less than 6 months, and media exposure for more than 2 hours daily, are the significant risk factors of delayed speech development in children.

Conflict of Interest

None declared.

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