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Original Article

Stimulation and cognitive function in short-stature preschoolers

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Abstract

Background Normal-height children generally have better cognitive function than growth-stunted, short-stature children. Children's cognitive function reportedly improves with stimulation. However, a correlation between stimulation and cognitive function in children with a history of short stature remains unclear.

Objective To assess correlation between stimulation and cognitive function in normal-height vs. short-stature preschool children.

Methods A cross-sectional study with consecutive sampling was performed in four sub-district areas in Jakarta. Preschool-aged children and their primary caregivers from previous studies on short stature were eligible for inclusion. An Indonesian version of a questionnaire was used to assess stimulation. A psychologist assessed verbal IQ (VIQ), performance IQ (PIQ), and full-scale IQ (FSIQ) with the Indonesian version of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). Data were analyzed using Pearson's correlation and Chi-square tests, and P values <0.05 were considered to be significant.

Results Of 62 subjects, 64.5% had normal height and 35.5% had short stature. Both normal-height and short-stature children had similar IQ outcome and history of stimulation. The stimulation was significantly correlated with FSIQ in normal-height children (r= 0.316; P=0.047), but not short-stature children (r=0.049; P=0.828). However, the percentage differences in VIQ, PIQ, and FSIQ between normal-height and short-stature children were not significant (P=0.409, 0.119 and 0.877, respectively).

Conclusion There is a significant correlation between stimulation and IQ in normal-height children. Short-stature preschoolers are not worse in terms of IQ than normal-height preschoolers. Parents and caregivers should be encouraged to provide regular and adequate stimulation to their young children. **[Paediatr Indones. 2021;61:74-81 ; DOI: 10.14238/pi61.2.2021.74-81**].

Keywords: *stimulation; cognitive function; short stature; preschool age*

Pediatric growth and intellectual development are influenced by various factors, including genetics, nutrition, and stimulation from their environment.[1] Stimulation is a basic need that can improve child development, especially cognitive function.[2] Cognitive function includes a variety of mental processes, such as perception, attention, memory, decision-making, and language comprehension.[3] Cognitive function is influenced by several factors, including birth weight,[4] breastfeeding,[5] nutritional status,[6] sex,[7] birth order,[8] stimulation,[9] parental support,[10] parental education and household income.[11] Stimulation intervention in early childhood has a significantly greater effect on cognitive function than nutritional interventions alone. Stimulation is done to educate children, and should be performed as early as possible, even in the womb. Stimulation

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can be carried out at all stages of development and involves all family members, as well as health workers when they care for children.[12] Many studies in preschool children showed that stimulation was important to achieve optimal cognitive development. A randomized controlled trial on healthy children in Jakarta showed that a combination of cognitive stimulation and nutritional supplementation in early childhood was an effective intervention to improve global cognitive function.[13]

Short stature is a linear growth failure that often occurs in early childhood. Stunted growth is short stature mainly due to a lack of nutritional intake and/or recurrent infections, rather than genetic factors.[14] Short stature in childhood gives rise to short- and long-term health problems, including increased susceptibility to infection and brain development disorders,[15] and increased risk of child mortality. Short stature negatively affects cognitive and motor development, as well as school performance, increases the risk of obesity, and decreases productivity in adulthood.[16] Two previous studies on short stature were done in the same cohort of subjects in 2014 and 2019. The first study found 85 of 238 children age 8 to 10 months old to have short stature,[17] and the second study found 31 of 70 children still have short stature, with a diagnosis of constitutional growth delay in 26 children, familial short stature in three children, and stunted growth in two children.[18] These children were currently preschool age. Therefore, we assessed stimulation, cognitive function, and a possible correlation in these children. We also compared cognitive function in the normal-height and short-stature preschoolers.

Methods

This study was a continuation of two previous studies on short stature,[17,18] had a cross-sectional design, and was conducted from March to May 2019 in four sub-districts in Jakarta: Kampung Melayu, Paseban, Cempaka Putih, and Kramat. Preschool children aged 5 years 1 month to 5 years 11 months and their primary caregivers who participated in the two previous studies were eligible for inclusion. Children who moved out of the study area, could not be reached, did not complete the stimulation questionnaire form, or were unable to perform the task given during the cognitive function assessment were excluded.

We performed repeated body height measurements using a portable stadiometer (*Seca 213*, Germany) with an accuracy of 1 mm. Body height was measured with the subject in a standing position without footwear and with head, buttocks, and heels touching the stadiometer. Body height was plotted on the *World Health Organization* (WHO) growth reference curve to determine the height-for-age (HFA). The interpretation of HFA is as follows: (1) normal, if HFA *z*-scores were between -2 SD and +3 SD and (2) short stature if HFA *z*-scores were below -2 SD.[19] The diagnosis of short stature was based on physical examination, growth velocity, and bone age from a previous study. In growth-stunted children, the presence of malnutrition and/or chronic inflammation was evidenced by laboratory test results for alpha-1 antitrypsin or calprotectin.[18]

Information on stimulation activities was obtained from direct interviews with the primary caregivers using an Indonesian version of a stimulation questionnaire for children aged 4-6 years. It was a non-test, research instrument, and considered appropriate for measuring these activities.[20] The questionnaire consisted of 35 statements that were compiled from the book, "*Stimulation, Detection and Early Development Intervention*" (SDIDTK).[21] Answers provided used a Likert scale from one to four. The questionnaire score ranges from 1 to 140, with three categories of scores: low (1-89), medium (90-107), and high (108-140). The stimulation questionnaire was validated before use (Cronbach's alpha=0.91).

Cognitive function was examined by a certified psychologist using the Indonesian version of the *Wechsler Preschool and Primary Scale of Intelligence* (WPPSI).[22] The manual for the Indonesian version of the WPPSI was issued by the Faculty of Psychology at Universitas Indonesia. The WPPSI test consists of two scales, namely, verbal and performance. The verbal scale consists of five subtests (information, vocabulary, arithmetic, similarities, and comprehension) without sentences (supplementary); the performance scale consists of five subtests (animal house, picture completion, mazes, geometric design, and block design). The test was limited to only four children per day; the examination time was 60 to 90 minutes per child. The final results are in the form of verbal

IQ (VIQ), performance IQ (PIQ), and full-scale IQ (FSIQ) scores. All three IQ scores can be classified descriptively into seven categories: extremely low (65 and below), borderline (66-79), below average (80-90), average (91-110), above average (111-119), superior (120-127), and very superior (128 and over).[22] Cognitive function was classified as normal for average or above average results, or if each of the verbal and performance scale subtest scores were eight or above.[23]

Classification of parent's educational level divided into: (1) basic, if educational level was not finished the elementary school, (2) middle, if educational level was finished the elementary school to junior high school, and (3) higher, if educational level was finished the senior high school to college. Household income was assessed based on the provincial minimum wage value Jakarta in 2019 was set at 3,940,973 rupiah. The classification of household income was as follows: (1) below the provincial minimum wage, and (2) equal or above the provincial minimum wage.

This study was approved by the Health Research Ethics Committee, Universitas Indonesia Medical School/Dr. Cipto Mangunkusumo Hospital, Jakarta. Informed consent was obtained from primary caregivers. Categorical variables were described as percentages. The analyses of stimulation with cognitive function and the difference in cognitive function between normal and short stature were examined by Pearson's correlation and Chi-square tests. All data analyses were done with the *Statistical Package for the Social Sciences (SPSS) version 23.0*, and P values <0.05 were considered to be statistically significant.

Results

Sixty-three children participated in this study and underwent cognitive function tests. Their primary caregivers completed the stimulation questionnaires. One child with familial short stature was excluded because he could not finish the VIQ test. Hence, a total of 62 children were analyzed. Of these, 40 were diagnosed with normal stature and 22 were diagnosed with short stature. In the short-stature children, 20 were diagnosed as normal variants (19 with constitutional growth delay and one with familial short stature), and two were diagnosed with stunted growth.[18]

Subjects' characteristic data including sex, birth order, parental education, household income, stimulation, and cognitive function are presented in **Table 1**. Most short-stature subjects were male (13/22), second and third births (8/22), received medium levels of stimulation (12/22), had average VIQ (13/22), below-average PIQ (10/22), and average FSIQ (11/22). Their parents' educational levels were mostly middle for fathers (14/22) and basic for mothers (13/22). Most normal height children were female (23/40), third births (1740), received medium levels of stimulation (21/40), and had average VIQ (19/40), average PIQ (23/40), and average FSIQ (19/40). Their parents' educational levels were mostly middle for both parents (22/40 fathers and 20/40 mothers). Household income in families with short-stature and normal-height children was mostly below provincial minimum wage value (19/40 and 34/40, respectively).

Figure 1 shows the scatter plot pairs of stimulation and cognitive function (VIQ, PIQ, and FSIQ), which had more pronounced slopes in normal-height children than in short-stature children. The correlation between stimulation and cognitive function in VIQ and PIQ were not significant (r=0.288; P=0.071 and r=0.278; P=0.083, respectively), whereas in FSIQ was significant in normal-height children (r=0.316; P=0.047). However, in short-stature children the correlation between stimulation and cognitive function (VIQ, PIQ, and FSIQ) was not significant (r= -0.164; P=0.466, r=0.237; P=0.288, and r=0.049; P=0.828, respectively).

The majority of the normal height and short stature groups had normal VIQ (57.5% and 68.2%, respectively), PIQ (70.0% and 50.0%, respectively), and FSIQ (52.5% and 54.5%, respectively). Differences in abnormal and normal cognitive function categories were not significant between normal-height and short-stature children, as presented in **Table 2**.

Discussion

Most short-stature subjects were male, with the majority diagnosed as normal variants, while stunted-growth was found only in two children, male and

Table 1. Characteristics of children with normal height and short stature

Characteristics	Short stature (n=22)	Normal height (n=40)
Sex, n		
Male	13	17
Female	9	23
Birth order, n (%)		
1	6	9
2	8	14
≥3	8	17
Education, n (%)		
Paternal		
Basic	7	15
Middle	14	22
Higher	1	3
Maternal		
Basic	13	18
Middle	8	20
Higher	1	2
Household income in IDR, n		
Below the provincial minimum wage	19	34
Equal or above the provincial minimum wage	3	6
Stimulation, n (%)		
Low	5	10
Medium	12	21
High	5	9
Verbal IQ, n		
Borderline	0	4
Below average	7	13
Average	13	19
Above average	2	4
Performance IQ, n		
Borderline	1	1
Below average	10	11
Average	8	23
Above average	3	3
Superior	0	1
Very superior	0	1
Full-scale IQ, n		
Borderline	1	2
Below the average	9	17
Average	11	19
Above the average	1	0
Superior	0	2

female. In contrast, a Jamaican study found that most short-stature children were girls and were diagnosed with stunted growth.[24] This difference was because our subjects were the same as from our previous studies,[17,18] and most of our short-stature children had been previously diagnosed as normal variants.

Both the normal height and short stature groups generally received medium levels of stimulation. However, more than 20% of both groups received low levels of stimulation. This finding was likely related to parental education, especially maternal education. Mothers with higher education levels are more likely provide adequate and appropriate stimulation for their children. Unfortunately, in our study, more than half of mothers of short-stature children and nearly half of mothers of normal-height children had basic education levels. Such parents often do not seek information about stimulating their child's development. The stimulation level found in our study was consistent with that of a previous study

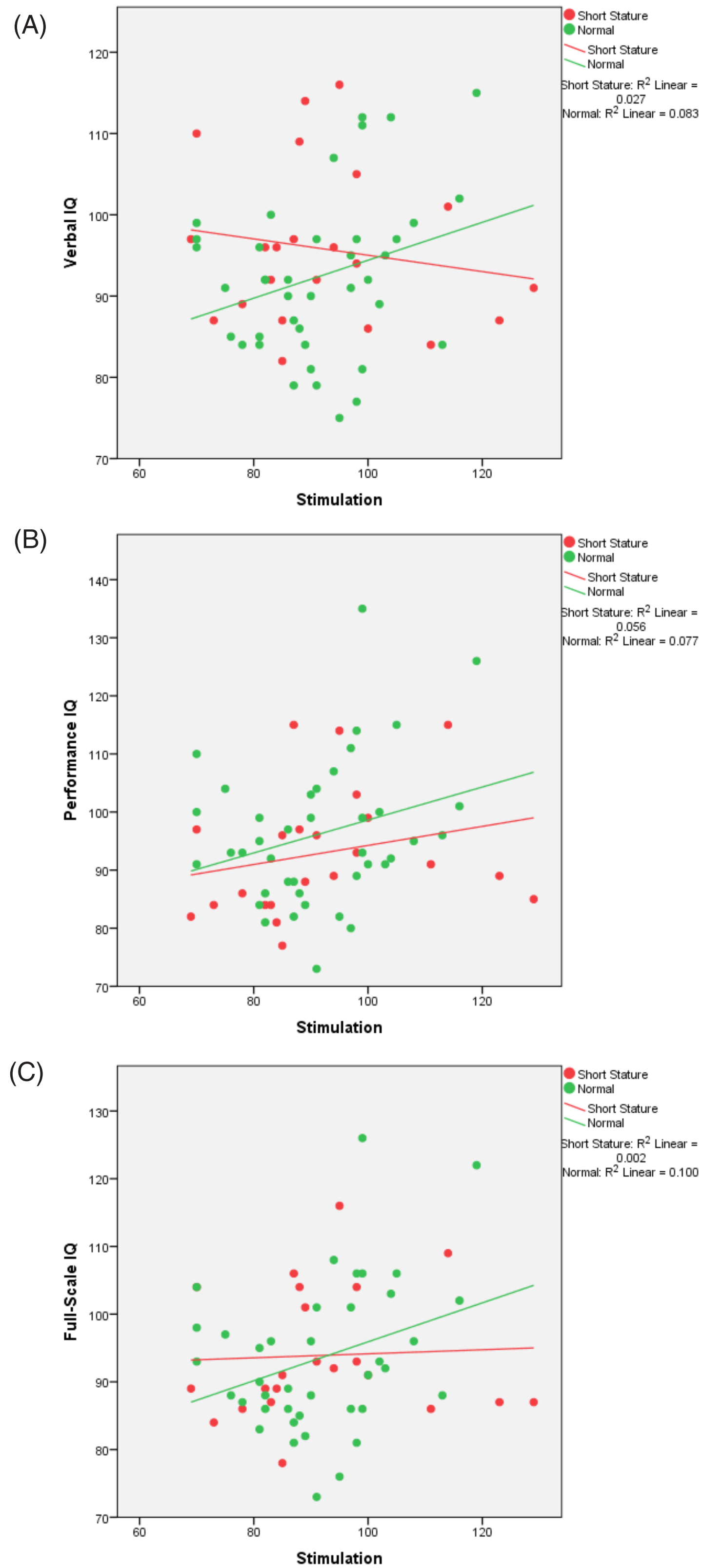

Figure 1. Correlation between stimulation and cognitive function in normal-height and short-stature children. (A) Correlation between stimulation and verbal IQ. (B) Correlation between stimulation and performance IQ. (C) Correlation between stimulation and full-scale

Table 2. Percentage differences in cognitive function between short-stature and normal-height children

Variables	Short stature (n=22)	Normal height (n=40)	P value
Verbal IQ,n			
Abnormal	7	17	0.409
Normal	15	23	
Performance IQ, n			
Abnormal	11	12	0.119
Normal	11	28	
Full-scale IQ, n			
Abnormal	10	19	0.877
Normal	12	21	

in which most preschoolers received medium-level stimulation.[25] In particular, most normal-variant children received a medium level of stimulation, while growth-stunted children received medium and high levels of stimulation. To our knowledge, few studies have been done on stimulation and cognitive function in short-stature children.

More than 30% of normal-height and short-stature subjects had a below average VIQ, because they were unable to describe an object in clear detail for the vocabulary subtest. When children were asked, "What is a hat?", they were able to answer only that a hat was something worn on the head. The expected answer had more details including that a hat has a round shape, may be red, or is worn on the head. Such responses receive a higher score on this question. Another reason for the below-average VIQ was that some words that were tested had never been heard or seen by the child. Children's ability to recognize, understand, and describe words depends on their environment. Children who often have the opportunity to learn by listening to their parents describe an object and their experiences every day tend to have a larger vocabulary. However, in our study, many parents did not describe objects or their experiences to their children daily, because they did not know it could be beneficial to their child.

Below-average PIQ score was more common in short-stature children than in normal-height children; however, in both groups, 30% or more had below-average PIQ scores. Subjects had difficulty with picture completion and block design subtests because most had rarely or never seen or played these games. Another possible reason for the below-average PIQ was that most parents had low socioeconomic level with salaries below the provincial minimum earnings; therefore, they were unable to afford educational games. The VIQ and PIQ scores influence the FSIQ scores. More than 40% of both groups had below-average FSIQ scores, since more than 30% of the VIQ and PIQ scores were below average.

Most normal-variant short-stature subjects had average VIQ, below-average PIQ, and average FSIQ. The two growth-stunted children had similar VIQ and FSIQ scores (that is, below average and average, respectively), while their PIQ scores were average and above average. In contrast, a previous study showed that 16.7% of short-stature children diagnosed with stunted growth had poor cognitive status.[26] This difference was probably because most of our short-stature subjects were diagnosed as normal variants, leaving a small sample size of growth-stunted children (2 subjects).

There was no significant correlation between stimulation and cognitive function in the short-stature group. However, stimulation was clinically related to cognitive function, as seen in the two growth-stunted children. One growth-stunted child received medium levels of stimulation and had an average VIQ, above-average PIQ, and average FSIQ. The other growth-stunted child received high levels of stimulation and had below-average VIQ and FSIQ, and average PIQ. A previous study described that stunted growth was one of the main risk factors, in addition to inadequate stimulation, causing children to fail to achieve optimal development and have poor cognitive abilities.[27] Both growth-stunted children had a quite good cognitive function. Eventhough, one growth-stunted child had below-average VIQ and FSIQ, with a history of high levels of stimulation from the environment, the child's cognitive function was not as poor as children in other study.[26]

We found a positive correlation between stimulation and general cognitive function in normal-height children. Although the correlation was weak and the effect was small, it shows that stimulation can influence cognitive function. This finding is consistent with previous studies showing a positive correlation between stimulation and children's cognitive function.[13,20,25,28]

The percentage difference in cognitive function between the normal-height and short-stature groups was not significant. This finding was likely because stunting was not the cause of most short stature in our subjects. Another potential factor was that both groups had a history of short stature and anemia during the first two years of life,[17] when the brain develops rapidly. A limitation of our study was that we only assessed stimulation and cognitive function, not other factors. Further study is needed to combine our findings with those of the two previous studies to obtain complete results.

In conclusion, there is a significant correlation between stimulation and cognitive function in normal-height, but not in short-stature children. This finding could be used to educate parents or caregivers to provide their children with adequate levels of stimulation to achieve optimal cognitive development. Parents may provide stimulation using anything available in their home and by doing so daily. However, there is no significant percentage difference in cognitive function between normal-height and short-stature children.

Conflicts of interest

None declared.

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