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Relationship between nutritional status, psychosocial stimulation, and cognitive development in preschool children in Indonesia

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Abstract

The purposes of the study were to analyze nutritional status, psychosocial stimulation, and factors affecting the cognitive development of preschool-age children. This study was conducted in the Village of Babakan, Sub-District of Dramaga, Bogor Regency, West Java. This cross-sectionally designed study was conducted with mothers who had preschool children aged 3-5 years as respondents. Fifty-eight children were included. The distribution of mother's educational level was quite diverse, and the largest percentage (44.8%) had senior high school education. Approximately 78% of the family income per capita was classified into the non-poor category and 22.4% into the poor category. The average mother's nutritional knowledge score was 76.7 ± 2.5 (moderate category). Most of the preschool children (84.4%) had psychosocial stimulation scores in the moderate category (30-45). The nutritional status of children showed that 15.5% were underweight, 5.2% were wasted, 3.4% were severely wasted, and 19% of the children were in the short and very short categories (stunted). The stepwise regression results showed that psychosocial stimulation ($P < 0.001$), participation in early childhood education ($P = 0.002$) and nutritional status based on the height index for age ($P = 0.028$) had a positive and significant effect on cognitive development of the preschool children (adjusted R^2, 0.434; $P = 0.028$).

Key Words: Children's nutritional status, psychosocial stimulation, cognitive development

Introduction

Based on the UNICEF (1990) conceptual framework, the three aspects that must be considered to improve quality of life in children are food consumption (nutrition), health, and psychosocial stimulation [1]. Furthermore, parenting plays an important role in optimal child development and leads to a normal and independent life. One of parenting aspects that play an important role in child development is the pattern of eating and psychosocial stimulation [2].

The rapid growth and development of children occurs at < 5 years of age, and the rapid growth phase (growth spurt) of the brain occurs until the age of 18 months [3]. Malnutrition during the period from 1-5 years of age results in a delay in physical growth, motor development, and cognitive developmental disorders. This effect can cause an IQ reduction of 15 points. In addition, a lack of nutrition has an effect on changes in social behavior, decreased attention and learning ability, and poor learning outcomes. The negative impact on cognitive ability occurs not only in malnourished children (severe underweight) but also in short children (stunted) due to chronic malnutrition at an early age [4]. Studies in several countries have revealed that malnutrition at an early age affects children's physical growth and brain development [5-7]. The number of children suffering from underweight and severe underweight has reached 18.4% in Indonesia, and stunted children account for > 36.8% of children < 5 years of age [8]. A lost generation will result if the nutritional problem is not resolved.

Children are assets and the future generation. Therefore, they are expected to grow and develop optimally and become adults who are physically, mentally, socially, and emotionally healthy. Children with various potentials can develop optimally and under these conditions. One indicator of high quality human resources is cognitive intelligence (such as IQ). It is a basic factor and key for an individual to succeed in the future.

Cognition is defined as all events and thinking processes of a person that are formed through organization and adaptation [9]. Cognitive development refers to the intellectual ways that individuals adapt to their environment [10]. Cognitive ability develops gradually with physical development and development of the central nervous system, and both innate and environmental factors affect cognitive development [11]. The innate factors refer to the genetic factors existing since conception, whereas environmental factors are those that aid in the cognitive development of children such as nutritional status and psychosocial stimulation [4,12].

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Stimulation includes play activity that is sustained to stimulate the left and right brain through all senses and to stimulate the ability to think, communicate, emote, and enjoy music as well as a variety of other infant capabilities. Psychosocial stimulation includes educational stimulation to develop cognitive, physical, and motor and social-emotional abilities of children [13]. The earlier the psychosocial stimulation is provided, the better the results. Despite no conclusive indication as to whether the effect of stimulation on growth and brain development is additive or interactive, children who receive a combination of nutritional intervention and psychosocial stimulation perform better than those who only receive either one. The quality of the brain is not only determined by nutrient intake but is also affected by the quality of environmental stimulation. The more frequent and varied the stimulation received by babies in the womb (gestational age of 6 months) until the age of 2-3 years, the better and stronger will be the relationships between the synapses in the right and left brain [12].

Various studies have indicated that the most rapid period of intellectual development occurs during the first 4-5 years of life [14]. Thus, preschool age is the best time to provide environmental enrichment programs to maximize intellectual development. This study was conducted to identify the socioeconomic characteristics of families, to analyze the nutritional status and cognitive development of preschoolers, to identify psychosocial stimulation levels among preschoolers, and to analyze the factors that influence cognitive development of children at preschool ages.

Subjects and Methods

Location

This study was conducted in the Village of Babakan, Sub-District of Dramaga, Bogor Regency, West Java. Babakan was the research site because the number of children < 5 years old in the area was quite high, and the percentage of underweight and severe underweight children was above the cut off point set by the Indonesia Health Department, i.e., > 10% of children experienced underweight and > 0.5% suffered from severe underweight.

Subjects

This study was cross-sectionally designed and included mothers with preschool children as the respondents. The research subjects were preschoolers aged 3-5 years, selected through random sampling and the following inclusion criteria: (1) preschool children who still had mothers, (2) lived with their mother, and (3) lived in the sub-district of Babakan. Sample size was calculated using the Slovin formula with a error value of 0.1 + 10%. Fifty-eight children were included.

Data collection

The data included the socio-economic aspects of the households (mother's educational level, nutritional knowledgem and family income per capita), participation of children in PAUD (*Pendidikan Anak Usia Dini* = early childhood education [ECE]), nutritional status, cognitive development of children at preschool age, and current psychosocial stimulation. The family socioeconomic conditions and child involvement in early childhood education was obtained by questionnaire. The nutritional status of the children was measured anthropometrically. Cognitive development and psychosocial stimulation data were collected using questionnaires and direct observation.

The mother's education was divided into four categories of elementary school, junior high school, senior high school, and university or college. The nutritional knowledge instrument consisted of 17 questions and covered food nutritional content, nutrients that affect child intelligence, and child development. Every correct answer was scored 1 and wrong answers were scored 0. The total score was converted into a percentage for the low (< 60%), moderate (60-79%), and high (> 80%). categories.

Children's nutritional status data i.e., Z score of weight for age (WAZ), Z score of height for age (HAZ), and Z score of weight for height (WHZ) were obtained through direct anthropometric measurements of body weight and height and processed using WHO Anthro 2005 software. Child cognitive development was assessed using a child development instrument developed by the Indonesia Department of National Education. The cognitive development measurements were divided into age groups of 3.5-4.4 years and 4.5-5.4 years. Thirteen items represented aspects of using symbols, understanding identity, understanding causality, the ability to classify, and understanding numbers. All of these aspects illustrate the development tasks during Piaget's preoperational cognitive development period [11]. Psychosocial stimulation was measured using the Home Observation for Measurement of the Environment Inventory for children ages 3-6 years and developed by Caldwel and Bradley [2]. This instrument consists of 55 items related to eight aspects: 1) toys and learning materials (learning stimulation), 2) language stimulation, 3) academic stimulation, 4) pride and affection, 5) acceptance (positive punishment), 6) modeling, 7) variety of stimulation, and 8) physical environment. The toys and learning materials (learning stimulation) aspects includes providing children with learning facilities such as puzzles, color cards and drawing books. Language stimulation, academic stimulation, pride and affection and acceptance aspects emphasize the active role of caregivers for providing stimulation for cognitive development. Modeling includes how good the caregiver is as a role model for their children. The variety of stimulation is a combination of facilities and active caregiver roles to enhance children's cognitive development. The physical environment includes aspects of the home such as ventilation, lightening, hygiene, and home density. Each item consisted of a positive

statement and was scored 1 if the answer was "yes" and 0 if the answer was "no". Measurements were carried out through interview and observations. Observations were conducted at the time when the researchers interviewed respondents. As many as four respondents were observed each day.

Statistical analysis

The scores for the question items for each variable were summed and categorized into intervals. The nutritional status data were analyzed using the WAZ, HAZ, and WHZ indices. The standard used to determine the nutritional status of children < 5 years of age was that of the National Center for Health Statistics/ World Health Organization (WHO).

The psychosocial stimulation data were processed by adding the scores for each dimension, and the total score was categorized into low (0-29), medium (30-45), and high (46-55) [2]. A higher composite score for each dimension and total score indicated better psychosocial stimulation given by the respondents. The children's cognitive development data were processed by adding up the scores for each item, which were converted to percentages into low (< 60%), moderate (60-79%) and high (> 80%) categories A higher composite score indicated better cognitive development. The highest cognitive development score in children was 100%.

The data were processed through descriptive and inferential analyses and are presented in tables. The descriptive analysis was used to describe the variables examined, whereas the inferential analysis was used to determine the relationships and influence of the variables on child cognitive development. A correlation analysis was used to determine the relationship between two variables consisting of interval and ordinal data, whereas the chi-square analysis was used to determine the relationship between two variables consisting of nominal and ordinal data. The stepwise linear regression test was used to determine which variables significantly affected child cognitive development.

Results

Socioeconomic characteristics of the respondents

Mother's education

The distribution of the mother's educational level was quite diverse and the largest percentage (44.8%) occurred in the senior high school category (Table 1). Twelve percentage of mothers had successfully completed education to the university level. A total of 8.6% mothers did not complete elementary school, and the remaining 22.4% only completed elementary level education. Although the mother's education level was relatively low, all of the mothers could read and write.

Table 1. Categories and distribution of the respondents and children (n = 58)

Variable categories	N	%
Mother education		
Elementary school (not graduated)	5	8.6
Elementary school	13	22.4
Junior High school	8	13.8
Senior High school	25	43.1
University	7	12.1
Household income per capita, per month		
Poor (< IDR[1)] 183,067)	13	22.4
Not poor (> IDR 183,067)	45	77.6
Mother's nutritional knowledge		
Low (< 60)	10	17.2
Medium (60-79)	19	32.8
High (≥ 80)	29	50
Participation in early childhood education		
Non participant	26	44.8
Participant	32	55.2
Psychosocial Stimulation		
Low (0-29)	3	5.2
Medium (30-45)	49	84.4
High (46-55)	6	10.4
Nutritional status		
HAZ (Z score of height for age)		
Severe stunted (> -3 SD)	3	5.2
Stunted (< -2 SD)	8	13.8
Normal (-2 SD to 2 SD)	47	81
WAZ (Z score of weight for age)		
Underweight (< -2 SD)	9	15.5
Normal (-2 SD to 2 SD)	45	77.6
Overweight (> 2 SD)	4	6.9
WHZ (Z score of weight for height)		
Severe wasted (> -3 SD)	2	3.4
Wasted (< -3SD to < -2 SD)	3	5.2
Normal (-2 SD to 2 SD)	48	82.8
Over (> 2 SD)	5	8.6
Child cognitive development		
Low (< 60%)	12	20.6
Medium (60-79%)	28	48.2
High (> = 80%)	18	31.2

[1)] IDR, Indonesia Rupiah; 10,000 IDR ≒ 1,140 KRW ≒ 1 USD

Income per capita

The Central Bureau of Statistics has set a standard that a family in Bogor Regency is classified as poor if its monthly income per capita does not reach 183,067 Indonesian Rupiah [15]. Based on this standard, 77.6% of the families were classified as prosperous families and 22.4% as poor families.

Mother's nutritional knowledge

Knowledge of nutrition is an important prerequisite for changing attitudes and behaviors towards nutrition. The mother's nutritional knowledge scores ranged from 7 to 17 or 41% to 100% of the maximum score of 100%. Nearly half of the mothers

had relatively good nutritional knowledge (50%), whereas the remaining were moderate (32.8%) or poor (17.2%). The average mother's nutritional knowledge score was 76.7 ± 2.5 (moderate category).

Based on the distribution of mother's nutritional knowledge about food nutritional content, most mothers (86.4%) answered correctly regarding the benefits of DHA and omega 3 fatty acids in milk. However, many mothers did not know the function of proteins as nutrients. In terms of the distribution of mother's nutritional knowledge on child development, 84.7% knew that a minimum weight must be achieved when the child was 2 years old. However, mothers still did not know about the information contained in the KMS (*Kartu Menuju Sehat* = card towards health). Only 66.1% of mothers answered correctly when asked about the function of colored lines on the KMS to monitor body weight in children < 5 years.

Child participation in early childhood education (ECE)

The percentage of preschool children not participating in ECE was 55.2%. Of the 44.8% preschool children who had attended ECE, approximately half participated for > 6 months.

Nutritional status of the children

The prevalence of thin (wasted) children in terms of the WHZ was 5.2% and very thin (severely wasted) was 3.4%. The prevalence of children in the short and very short categories for HAZ was 19%, and none were in the tall category. Prevalence in the low category based on the WHO stunted category criteria was < 20%) [16]. The nutritional status of children measured by WAZ showed that 77.6% of preschool children had good nutritional status, 15.5% were underweight, and the remaining were overweight.

Psychosocial stimulation

Most of the preschool children (84.4%) had moderate (30-45) psychosocial stimulation scores. More than half of the sample had moderate scores for learning stimulation, pride and affection, academic stimulation, modeling, and the variety of stimulation. The language stimulation and acceptance scores generally fell into the high category, whereas almost half of the sample was in the low physical environment category.

Cognitive development of children

The largest percentage (48.2%) of children was in the moderate cognitive development category (60-79%), and as many as 31.2% of children were in the high category (> 80%) with the remainder in the low category (< 60%).

Correlations of various variables with cognitive development

The variables tested for their relationships with child cognitive development included mother's education, income per capita, mother's nutritional knowledge, the participation of children in PAUD (ECE), psychosocial stimulation, and nutritional status. Tables 2 and 3 present a map of various scores/levels of the children's cognitive development related to these categories.

Table 2. Cognitive development scores and correlation with various variables

Variables	N	Cognitive development score of children (%)	Correlation test between cognitive development
Income per capita, per month			r = 0.304 *P* = 0.019
Poor (< IDR[1] 183,067)	13	65	
Non poor (> IDR 183,067)	45	72	
Average ± sd	401,044 ± 326,347 (IDR)		
Mother's nutritional knowledge			r = 0.327 *P* = 0.011
Low (< 60)	10	64.5	
Medium (60-79)	19	65.3	
High (≥ 80)	29	76.9	
Average ± sd	76.7 ± 2.5 (Score)		
Psychosocial stimulation			r = 0.513 *P* < 0.001
Low (0-29)	3	51.9	
Medium (30-45)	49	70.3	
High (46-55)	6	84.8	
Average ± sd	38.4 ± 5.7 (score)		
Nutritional status			
HAZ (Z score of height for age)			r = 0.368 *P* = 0.004
Severe stunted (> -3 SD)	3	58.3	
Stunted (< -2 SD)	8	63.5	
Normal (-2 SD to 2 SD)	47	73.2	
Average ± sd	-1.2 ± 1.2 (Z-score)		
WAZ (Z score of weight for age)			r = 0.373 *P* = 0.004
Underweight (< -2 SD)	9	60	
Normal (-2 SD to 2 SD)	45	71.3	
Overweight (> 2 SD)	4	88.6	
Average ± sd	-0.9 ± 1.2 (Z-score)		
WHZ (Z score of weight for height)			r = 0.187 *P* = 0.155
Severe wasted (> -3 SD)	2	73.8	
Wasted (< -3SD to < -2 SD)	3	73.9	
Normal (-2 SD to 2 SD)	48	68.7	
Over (> 2 SD)	5	87.9	
Average ± sd	-0.3 ± 1.6 (Z-score)		

[1] IDR, Indonesia Rupiah; 10,000 IDR ≒ 1,140 KRW ≒ 1 USD

Table 3. Chi-square test of cognitive development score and various variables

Variables	Score of cognitive development	
	Low (< 60%)	High (> 60%)
	N (%)	
Mother's education[1]		
Low (Junior high school or less)	9 (75.0)	17 (37.0)
High (Senior high school/university)	3 (25.0)	29 (63)
Participation in early childhood education[2]		
Yes	2 (16.7)	24 (52.2)
No	10 (83.3)	22 (47.8)

[1] Significance determined by the X^2 test, F value = 5.569, *P*-value = 0.018
[2] Significance determined by the X^2 test, F value = 4.852, *P*-value = 0.028

Mother's education and children's cognitive development

The result of the chi-square test ($P = 0.018$) showed a significant positive relationship between the mother's educational level and children's cognitive development (Table 3). The children's cognitive development level increased with increasing education level of the mother.

Income per capita and children's cognitive development

Children in prosperous families had much higher cognitive development scores (72%) than those in poor families (65.1%). A positive and significant relationship was observed between family income per capita and child cognitive development scores (Table 2). Higher per capita family income tended to increase children's cognitive development scores. Economically stable families have the opportunity to provide relatively better parenting than those who are not economically independent.

Mother's nutritional knowledge and children's cognitive development

A large difference in the child's cognitive development scores was observed between mothers with a low/moderate level of nutritional knowledge and those with a high level of nutritional knowledge (Table 2). A positive correlation ($P = 0.011$) was observed, indicating that the better the mother's nutritional knowledge, the better cognitive development of the child.

Participation in ECE and child cognitive development.

The chi-square test (Table 3) showed an association between participation in ECE and child cognitive development ($P = 0.028$). Children who were participating in ECE tended to have higher cognitive development than those without such education.

psychosocial Stimulation and Children's Cognitive Development

Table 2 shows that the lowest cognitive development was found in children who received poor psychosocial stimulation, whereas children with high psychosocial stimulation scored the highest on cognitive development ($P < 0.001$). Psychosocial stimulation correlated significantly with child cognitive development (Table 2). Furthermore, the psychosocial stimulation dimensions that were positively correlated with cognitive development based on Pearson's correlation test were learning stimulation ($r = 0.616$, $P = 0.001$), academic stimulation ($r = 0.420$, $P = 0.001$), modeling ($r = 0.395$, $P = 0.002$), language stimulation ($r = 0.378$, $P = 0.003$), and stimulus variation ($r = 0.286$, $P = 0.028$) (data not shown).

Nutritional status and child cognitive development

Based on the HAZ index, severely stunted children had the lowest cognitive development score (58.3%), which increased with increasing nutritional status category. Similarly, the WAZ index showed an increased cognitive development score in line with increased child nutritional status. This result can be seen from the difference in the cognitive development scores between malnourished children and those with good nutrition. Underweight children had a cognitive development score of 60%, which was much lower than those with normal nutritional status, who had a cognitive development score of 71.3% (Table 2). No significant relationship was observed between nutritional status (WHZ) and cognitive development (Table 2).

Factors affecting cognitive development

The results of stepwise regression tests showed that psychosocial stimulation ($P < 0.001$), participation in early childhood education ($P = 0.002$), and nutritional status based on the index of height for age ($P = 0.028$) had a positive and significant effect on cognitive development of preschool children (adjusted R^2, 0.434, $P = 0.028$; Table 4). This result indicated that 43.4% of a child's cognitive development can be explained by these three variables. Thus, increasingly better psychosocial stimulation, participation in ECE, and nutritional status will further enhance and improve cognitive development of preschool children.

Discussion

Our results show that a mother's education played an important role in child cognitive development, as increased mother's educational level had an impact on increasing the average cognitive development score in the children. Education initiates the learning experience of an individual, allowing them to better understand various objects, either positive or negative [17]. These results are consistent with a study showing that mother's education is an influential factor in the cognitive development of the children [18]. Highly educated mothers are more open to new things because it is easier for them get useful information from the media, so they have a better understanding of child development. This is not the case with poorly educated mothers who have a lack of understanding and tend to dominate their children [10].

Income per capita is the total revenue or income in a family

Table 4. Stepwise regression analysis with child cognitive development as the dependent variable

Model	Unstandardized Coefficients		Standardized Coefficients	T	*P* value
	B	Std. Error	β		
Psychosocial stimulation	0.012	0.003	0.407	4.008	< 0.001
Participation in early childhood education	0.113	0.034	0.343	3.294	0.002
HAZ (Z score of height for age)	0.03	0.013	0.231	2.257	0.028
Adjusted $R^2 = 0.434$					0.028

divided by the total number of family members. The higher the family income level, the better the quality of food selected. In our study, higher income per capita tended to lead to better child cognitive development. This result agrees with the view that economically stable families have an opportunity to provide relatively better care than those who are not economically independent [10]. Children from low-income families anywhere in the world are generally those with relatively poor educational stimulation due to their parent's limited resources.

Good education of mothers and sufficient income does not provide optimal support for the cognitive development of children without good nutritional knowledge. Our results showed a tendency for mothers with good nutrition knowledge to have children with higher cognitive development scores than those with a moderate or poor level of nutritional knowledge. Mothers who have good nutritional knowledge tend to provide a healthy diet for their children to meet their nutritional needs. This, in turn, positively impacts a child's cognitive development.

The prevalence of underweight children was 15.5%. Criteria established by the Health Department of the Republic of Indonesia in 2002 stated that public health problems exist if the prevalence of underweight children is > 10% and the percentage of wasted children is > 5%. Thus, our research site had a public health problem indicated by the prevalence of underweight, as wasting cases exceeded the specified cut-off. The results of stepwise regression tests showed that psychosocial stimulation, participation in ECE, and nutritional status of children based on the HAZ index had a significant and positive effect on cognitive development of preschool children. Participation of children in ECE and good psychosocial stimulation improved cognitive development in children.

The intelligence level of a child at the early age determines life direction in adulthood. Therefore, the higher the knowledge and capacity of parents to educate and to care for their children at an early age, the higher is the possibility that parents would be able to provide various constructive stimulations that will accelerate the development of their children's intelligence [4]. The development of a child's intelligence would be more optimal if they were involved in ECE. Children participating in ECE programs had a much higher cognitive development score than those without such ECE. ECE prepares preschool-aged children for higher education. A study by Balitbang (Center for Research and Development) of the Department of National Education in 1999 showed a positive effect of ECE on school readiness of children. Primary school pupils in the first grade who participate in ECE show significant differences in cognitive development, including readiness to read, write and count, development of self-expression, socio-emotional development, and an ability to help themselves.

Unlike stimulation provided outside the home during ECE, the psychosocial stimulation provided by mothers is within the home environment. The highest percentage of samples in our study was in the moderate psychosocial stimulation category. Psychosocial stimulation is an educational effort to develop cognitive, physical, and motor skills, as well as the social-emotional abilities of children. Piaget's cognitive development theory states that preschool children are in the category of preoperational thought that begins with the recognition of symbolic function, i.e., the ability to use something as a symbol to represent something else [11]. Therefore, such stimulation is very important because children are taught the concepts of colors, shapes, and sizes. Furthermore, children are taught about the concept of space and dimensions as well as number recognition. Thus, the greater the stimulation provided, the better the child's ability would be to recognize symbols.

Children require some knowledge to analyze the speech they hear; thus, some language knowledge must be introduced at an early age [19]. Most of our sample (83.1%) had a high degree of language stimulation from their mothers. This was characterized by a high proportion of mothers who began to teach their children object names. The children were also taught about apology, thanks, and greeting expressions.

Almost half of the children (45.8%) were in the low physical environment category. This was due to the condition that most families lived together with another family in a single house, resulting in limited mobility. Children need a safe and comfortable environment for growth and development to occur optimally. A study in the slums of Jakarta and Bogor found that inadequate physical environment such as a small house and unclean environment resulted in a greater risk for impaired cognitive, social, and emotional maturation [2].

Learning stimulation is also used to arouse the cognitive development of children. For example, solving puzzles encourages children to think symbolically and connect one event to another [9]. Thus, when a puzzle can be solved by a child, it indicates that they have experienced a cognitive process signaling organization and adaptation. This view was supported by the correlation between learning stimulation and child cognitive development, which demonstrates that learning stimulation had the closest relationship compared to that of the other dimensions.

Good nutritional status improves cognitive development. Underweight children had a much lower cognitive development score than that of normal children (Table 2). The results of our study support those of a previous study that found a significant relationship between nutritional status based on weight for age and height for age with mental development in children < 2 years old [20]. Studies conducted in several countries have revealed that malnutrition suffered by children at an early age has an effect on physical growth and brain development [5-7]. Furthermore, a review reported that children with nutritional problems at an early age have an IQ deficit of up to 15 points [21]. Research conducted in Bogor on school-aged children during the post recovery of malnutrition at the Nutrition Clinic of the Center for Nutrition Research and Development of Bogor when they were < 3 years old found an IQ deficit of about 11 points compared to that of normal children.

Malnutrition during early childhood affects growth and develop-

ment of brain cells so that the number of brain cells decreases. Brain development is greatly affected by nutritional deficiency during pregnancy until the age of 5 years. Children suffering from undernourishment from an early age generally have difficulties facing the future and will potentially have low physical and intellectual ability and low productivity [22,23].

Our results showed that severely stunted preschool age children had the lowest average cognitive development score, i.e., 58.3%. This is an important finding because a stunted condition describes chronic malnutrition. A previous study demonstrated that nutritional status (stunted) has a negative effect on fine and gross motor skills development as well as language skills [24]. Children who are stunted in the first 2 years of life continue to have lower cognitive development compared with normal children after the age of 8-11 years.

Although good nutrition improves a child's cognitive development, psychosocial stimulation and the involvement of children in early childhood education also play an important role as an intermediary factor in cognitive development. We conclude that nutritional status and psychosocial stimulation as well as the participation of children in ECE play an important role in the cognitive development of preschool children. Good nutrition can help children prepare themselves to receive optimal psychosocial stimulation. However, optimal cognitive development cannot be achieved if it is only supported with good nutrition without efforts to provide good stimulation as well. The presence of nutritional intervention and psychosocial stimulation is expected to contribute to optimal child cognitive development.

References

1. The United Nations Children's Fund. The State of The World's Children. New York: Oxford University Press; 1998.
2. Hastuti D. Parenting: Theory, Principles and Application in Indonesia. Bogor: Faculty of Human Ecology, Bogor Agricultural University; 2008.
3. Khomsan A. Food and Nutrition for Life Quality. Jakarta: Grasindo; 2004.
4. Djalal F. Effect of nutrition and stimulation on child's brain growth and development and intelligence. PAUD Bull 2009;8: 3-15.
5. Nwuga VC. Effect of severe kwashiorkor on intellectual development among Nigerian children. Am J Clin Nutr 1977;30:1423-30.
6. Martorell R. Long term consequences of undernutrition on physical and cognitive development. Ann Nestle Eng 1999;57: 96-106.
7. Grantham-McGregor SM, Fernald LC, Sethuraman K. Effects of health and nutrition on cognitive and behavioural development in children in the first three years of life. Food Nutr Bull 1999; 20:53-75.
8. Ministry of Health, Republic of Indonesia. National Report of Research Result on Basic Health 2007. Jakarta: Board of Health Research and Development, Ministry of Health, Republic of Indonesia; 2008.
9. Santrock JW. Child Development, 11th edition. Jakarta: Erlangga; 2007.
10. Sardjunani N, Saliyo MB. Theories of growth and development of children at early ages. In: Syarif H, Komala LR, Sardjunani N, editors. A Study of Policies on Holistic and Integrated Development of Children at Early Age. Jakarta: Ministry of National Development Planning; 2006. p.9-49.
11. Papalia DE, Olds SW, Fieldman RD. Human Development. Jakarta: Salemba Humanika; 2008.
12. Mayza A. Psychological stimulation on cognitive development of children at early age. PAUD Bull 2008;7(3):26-57.
13. Ministry of National Education, Republic of Indonesia. Reference for Learning in Early Childhood Education: Generic Learning Menu. Jakarta: Ministry of National Education, Republic of Indonesia; 2002.
14. Padmonodewo S. Early intervention program as a means of improving child development [dissertation]. Depok: University of Indonesia; 1993.
15. Indonesian Central Bureau of Statistics. Bogor Regency in Figures 2007. Bogor: Indonesian Central Bureau of Statistics; 2007.
16. World Health Organization Expert Committee. Physical Status: The Used and Interpretation of Anthropometry. Geneva: World Health Organization; 1995.
17. Khomsan A, Anwar F, Sukandar D, Riyadi H, Mudjajanto ES. Nutrition Education to Improve Mother and Cadre Nutritional Knowledge and Children Nutritional Status in Indonesia. Bogor: Department of Community Nutrition, Bogor Agricultural University and Nestlé Foundation; 2009.
18. Wigg NR, Tong S, McMichael AJ, Baghurst PA, Vimpani G, Roberts R. Does breastfeeding at six months predict cognitive development? Aust N Z J Public Health 1998;22:232-6.
19. Turner JS, Helms DB. Lifespan Development, 4th edition. Philadelphia: Rinehart and Winston Inc.; 1991.
20. Anwar F. Model of parenting for children under two years to improve the nutritional status and psycho-social development [dissertation]. Bogor: Bogor Agricultural University; 2002.
21. Martorell R. Under-nutrition during pregnancies and early childhood: consequences for cognitive and behavioral development. In: Young ME, editor. Early Childhood Development: Investing in Our Children's Future. Amsterdam: Elsevier Science; 1997.
22. Nagata S. Brain Nutrition. 2nd Asian Congress of Pediatric Nutrition. Tokyo: Department of Pediatrics Juntendo University School of Medicine; 2004.
23. Malla MA. Nutrition for the intelligence development of children at early age. PAUD Bull 2002;2:19-27.
24. Hizni A, Julia M, Gamayanti IL. Stunted status and its relationship with the development children aged under five in the north coastal region of Lemahwungkuk District, Cirebon. Indones J Clin Nutr 2009;6:131-7.