Effect of Low Linear Growth and Caregiving with Poor Psychosocial Aspects on Cognitive Development of Toddlers

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Summary The purpose of this study was to analyze effect of linear growth and psychosocial aspects of caregiving on cognitive development of toddlers. Methods: Longitudinal studies were carried out from pregnancy to three years old children in Bogor. The collected data included body height, nutritional status based on height by age index, morbidity, aspects of caregiving, and cognitive development of three years old children. Linear growth data is obtained from anthropometric measurements of height at birth, age six months, and twelve months measured using a length measuring instrument body with a precision level of 0.10 cm. Caregiving of psychosocial aspect divided by some characteristics, such as learning stimulation, language stimulation, academic stimulation, modelling, warmth and acceptance, caregiving variation, punishment & acceptance and physical environment. Cognitive development measurement was divided into two categories, namely delay and appropriate to age. Multiple logistic regression was applied to analyze the effects. Toddlers who were born stunted and continued to be stunted until they were three years old had lower cognitive development than stunted newborns that were able to achieve normal height at three years old. In addition, children who experience caregiving with poor psychosocial aspects had lower cognitive development than those with good caregiving. This study highlighted the importance efforts to improve nutritional status of children as well as providing good care for them.

Key Words cognitive development, stunting, indonesian children, psychosocial aspect of caregiving

Low linear growth or height below the standard is a nutritional problem commonly found in developing countries. Indonesia is included among countries with the highest prevalence of stunting in the South-East Asia Regional region (SEAR). The prevalence of stunting in Indonesia has dropped, from 37.2 percent in the 2013 to 30.8 percent in the 2018 based on Basic Health Research Ministry of Health 2018.

In many populations in low- and middle-income countries, faltering in linear growth begins before birth and continues until at least 2 y of age (1). Brain development occurs rapidly during this same period, from conception to age 2 y, laying the foundation for the development of cognitive, motor, and socioemotional skills throughout childhood and adulthood (2).

Linear growth may affect the cognitive development of children. Study from Leroy and Frongillo showed that linear growth retardation is associated with delayed development in adulthood, and chronic diseases (3). Meanwhile, stunted children have a higher risk of delays in language development (4–5).

Malnutrition in infants affects the cognitive development of children, a study by Crookston et. al. in Ethiopia, India, Peru and Vietnam, showed children’s cognitive abilities when entering school are affected by stunting at the age of 6–18 mo. Children with short height but become normal at 8 y of age have better cognitive abilities than children who remain short at 8 y old (6–7). Moura et al. proved that maternal education level, low birth weight, premature birth, history of illness and history of developmental delays at first year are risk factors for developmental delays when the child is 2 y old (8).

Psychosocial aspects of caregiving are important factor in cognitive development. Psychosocial caregiving is an overview of the interaction, response and emotional mother to children, giving praise or gifts for good behavior or children or punishment for mistakes made by children, provision of physical environment, play and learning tools as well as involvement of mother in delivering parenting support children to learn (9) Research by Khomsan et al. proved that low cognitive development was found in children under five years old with low psychosocial parenting (10). Study from Ashari et al. showed that there was a significant relationship between caregiving of parents and children’s cognitive development.
development among children aged 3–4 y in early education center in South Magelang District (11).

The results of study above, indicate that cognitive development of toddlers were influenced by many factors, such as heredity, environment, linear growth and caregiving. This study aimed to analyze the relationship between linear growth and psychosocial aspects of caregiving on cognitive development of toddlers.

MATERIALS AND METHODS

Design, place and time. Data were obtained from longitudinal research on the nutritional status of pregnant women and their born children by the Applied Technology Center for Clinical Health and Epidemiology (PT2TEK) in five sub-districts in Bogor Regency started in 2011. This study was conducted in three stages, namely the first stage was started in 2011 and included mothers with gestational age 12–14 wk and followed through until delivery, and the second stage was started in 2012 included infants aged 0–12 mo born to pregnant women from the first stage (12). The third stage was conducted in 2015 to determine the pattern of growth and psychosocial caregiving and its impact on cognitive development of children aged 3 y.

Subject. The total subjects in the first phase of the study were 323 pregnant women, but at the second and third stage of the study, the number of subjects decreased to 190 children. Of these, there were 150 children who have complete data on length at birth, at six months, at one year, and at three year of age. A total of 39 babies had LA-Z score $< -1$ SD (short birth length) and 111 babies had LA-Z score $\geq -1$ SD (normal) at birth.

Data collection methods. Length of the babies was obtained from anthropometric measurements at birth, age six months, and twelve months measured using measurement board with a precision level of 0.10 cm. The height of children at three-year-old was measured using microtoise with a precision level of 0.10 cm. Morbidity, psychosocial aspect of caregiving, and cognitive development was assessed at three years old child. A questionnaire was used to assess morbidity. The psychosocial aspect of caregiving was measured using the Home Observation for Measurement of the Environment Inventory for children aged 3–6 y (9). Cognitive development was assessed using Bayley Scale Infant Development III (13).

Data processing and statistical analysis. Linear growth was determined based on the length/height for age Z-score (L/HAZ). Children were defined as short if their L/HAZs were $< -1$ SD and normal if more than $-1$ SD. Psychosocial aspect of caregiving was grouped into learning stimulation, language stimulation, academic stimulation, modelling, warmth and acceptance, caregiving variation, punishment & acceptance and physical environment.

Cognitive development measurement was divided into two categories, namely delayed and appropriate to age.

Univariate analysis was used to analyze subjects’ characteristics; changes in linear growth at birth, age 1 y and 3 y; morbidity rate; psychosocial of caregiving and cognitive development. Bivariate analysis was performed to analysis effect of linear growth and psychosocial aspects of caregiving on cognitive development of toddlers. Multivariate analysis (multiple logistic regression) was used to determine the risk factor that contributes most in growth pattern of 3-y-old toddlers.

RESULTS

Of the children, 115 (76.7%) had delayed cognitive development. Explain about the basic characteristics of the children based on cognitive development (for example age, sex, whether she/he has siblings or not). Family Characteristics

Mother and family characteristics can be seen by mother’s age during pregnancy, frequency of pregnancy, education and employment of mothers, and the number of family members did not show significant differences between groups of children with delayed cognitive impairment and appropriate to age (Table 1). Nutritional status of children at birth to 3 y old

Judging from the nutritional status based on length/height-age index, current linear growth faltering has more influence on cognitive development than past linear growth faltering. Children with linear growth faltering at 3 y of age have 3 times greater risk of experiencing cognitive development delays (95% CI=1.334–6.747; $p=0.009$). However, past events of linear growth faltering was significantly associated with cognitive delay at age 3 y old as shown in Table 3.

Psychosocial caregiving of 3 y old child

The relationship of psychosocial caregiving with cognitive development of 3-y-olds showed that 3 of the 8 subscales, namely learning stimulation, language stimulation and academic stimulation showed a meaningful relationship. Learning stimulation was the ability of parents to provide play and learning tools for children. Language stimulation is the ability of parents to teach children to recognize letters. say words. and give children the opportunity to speak. Academic stimulation is the ability of parents to teach children about colors. dimensions. numbers and teach singing.

Psychosocial caregiving in the family as a whole has an effect on cognitive development of 3-y-olds with OR = 3.541 (95% CI = 1.432–8.758; $p=0.003$).

DISCUSSION

Maternal age during pregnancy, frequency of pregnancy, education and employment of mothers, and the number of family members did not show significant differences between groups of children with delayed cognitive development and appropriate to age.

Some studies showed that cognitive development was influenced by some factors. There are some factors that can affects the cognitive development such as child factors. caregiver factors (Characteristics of parental engagement as well as quality and quantity of input provided by parents. caregivers. and interventionists). and environmental factors situations. stresses. and sup-
ports present in the child’s environment). Cognitive skills are developing in the context of other skills and abilities. Then, the experiences of the child and the input received from adults and peers can also influence cognitive development.

The employment status of pregnant women, most of them are housewives who do not work out of the house, and most pregnant women have a low level of education (the highest is graduating from junior high school). This reflects that mothers have a lot of time to care for pregnancy and children born. but this does not guarantee that sufficient time is used properly for nutritional and health purposes (14–16). Study from Bernal (2008) about maternal employment showed that having a mother that works full-time and uses child care during one year is associated with a reduction in ability test scores of approximately 1.8% (0.13 standard deviations) the effect of maternal employment could actually be positive in the case of very low ability children, but it is significantly negative in the case of high ability children (17).

Children with linear growth disorders at 3 y of age have a 3 times greater risk of experiencing cognitive development delays (95% CI = 1.334–6.747; p = 0.009).

Table 1. Mother and family characteristics.

| Characteristics                        | Cognitive development |          | Appropriate to age (n=35) |          | p-value |
|----------------------------------------|-----------------------|----------|---------------------------|----------|---------|
|                                        | n                     | %        | n                         | %        |         |
| Mother’s age during pregnancy          |                       |          |                           |          |         |
| <20 or >35 y old                       | 24                    | 20.9     | 6                         | 17.1     | 0.809   |
| 20–35 y old                            | 91                    | 79.1     | 29                        | 82.9     |         |
| Frequency of pregnancy                 |                       |          |                           |          |         |
| >2 times                               | 46                    | 40.0     | 8                         | 22.9     | 0.099   |
| <2 times                               | 69                    | 60.0     | 27                        | 77.1     |         |
| Mother’s Education                     |                       |          |                           |          |         |
| Less than junior high School (SMP)     | 99                    | 86.1     | 25                        | 71.4     | 0.080   |
| More than senior high school (SMA)     | 16                    | 13.9     | 10                        | 28.6     |         |
| Mother’s occupation                    |                       |          |                           |          |         |
| Work                                   | 17                    | 14.8     | 5                         | 14.3     | 1.000   |
| Doesn’t work                           | 98                    | 85.2     | 30                        | 85.7     |         |
| Number of household members            |                       |          |                           |          |         |
| >5 persons                             | 41                    | 35.7     | 8                         | 22.9     | 0.227   |
| <5 persons                             | 74                    | 64.3     | 27                        | 77.1     |         |

Table 2. Height of children born to 3 y old.

| Height                  | Cognitive development |          | Appropriate to age | OR (95% CI) | p-value |
|-------------------------|-----------------------|----------|-------------------|-------------|---------|
|                         | n                     | %        | n                 |             |         |
| Birth                   |                       |          |                   |             |         |
| Short                   | 29                    | 25.2     | 10                | 28.6        | 0.843   |
| Normal                  | 86                    | 74.8     | 25                | 71.4        | (0.362–0.964) | 0.694 |
| 6-mo old                |                       |          |                   |             |         |
| Short                   | 39                    | 33.9     | 7                 | 20.0        | 2.053   |
| Normal                  | 76                    | 66.1     | 28                | 80.0        | (0.823–5.119) | 0.108 |
| 12-mo old               |                       |          |                   |             |         |
| Short                   | 55                    | 47.8     | 14                | 40.0        | 1.375   |
| Normal                  | 60                    | 52.2     | 21                | 60.0        | (0.637–2.966) | 0.414 |
| 3-y old                 |                       |          |                   |             |         |
| Short                   | 92                    | 80.0     | 20                | 57.1        | 3.000   |
| Normal                  | 23                    | 20.0     | 15                | 42.9        | (1.334–6.747) | 0.009** |
Table 3. Changes in nutritional status (length/height-age) of children at birth and age 3 y old.

| Changes in nutritional status | Cognitive development | OR (95% CI) | p-value |
|------------------------------|-----------------------|-------------|---------|
|                              | Delayed | Appropriate to age |               |         |
|                              | n   | %     | n   | %     |         |
| Short to Normal              | 2   | 33.3  | 4   | 66.7  | 1       |
| Remained Short               | 27  | 81.8  | 6   | 18.2  | 9.00 (1.33–61.03) | 0.049* |
| Normal to Short              | 65  | 82.3  | 14  | 17.7  | 9.29 (1.55–55.78) | 0.021* |
| Remained normal              | 21  | 65.6  | 11  | 34.4  | 3.812 (0.60–24.22) | 0.303 |

Table 4. Psychosocial care patterns and cognitive development of children 3 y old.

| Aspects                        | Cognitive Development | OR (95% CI) | p-value |
|--------------------------------|-----------------------|-------------|---------|
|                                | Delayed | Appropriate to age |               |         |
|                                | n   | %     | n   | %     |         |
| Learning Stimulation          | Poor   | 59   | 51.3 | 7    | 20.0  | 4.214 (1.704–10.421) | 0.001** |
|                                | Good   | 56   | 48.7 | 28   | 80.0  |                         |         |
| Language Stimulation          | Poor   | 41   | 35.7 | 6    | 17.1  | 2.678 (1.027–6.982) | 0.031* |
|                                | Good   | 74   | 64.3 | 29   | 82.9  |                         |         |
| Academic Stimulation          | Poor   | 41   | 36.0 | 3    | 8.6   | 5.991 (1.727–20.779) | 0.001** |
|                                | Good   | 73   | 64.0 | 32   | 91.4  |                         |         |
| Modelling                     | Poor   | 7    | 6.1  | 2    | 5.7   | 1.079 (0.214–5.540) | 1.000 |
|                                | Good   | 107  | 93.9 | 33   | 94.3  |                         |         |
| Warmth and Acceptance         | Poor   | 11   | 9.6  | 2    | 5.7   | 1.762 (0.371–8.359) | 0.451 |
|                                | Good   | 103  | 90.4 | 33   | 94.3  |                         |         |
| Parenting Variation           | Poor   | 66   | 57.4 | 15   | 42.9  | 1.796 (0.836–3.858) | 0.132 |
|                                | Good   | 49   | 42.6 | 20   | 57.1  |                         |         |
| Reward and Punishment         | Poor   | 33   | 28.9 | 6    | 17.1  | 1.969 (0.748–5.183) | 0.151 |
|                                | Good   | 81   | 71.1 | 29   | 82.9  |                         |         |
| Physical Environment          | Poor   | 36   | 31.6 | 9    | 25.7  | 1.333 (0.567–3.134) | 0.504 |
|                                | Good   | 78   | 68.4 | 26   | 74.3  |                         |         |
| Psychosocial Caregiving       | Poor   | 54   | 47.0 | 7    | 20.0  | 3.541 (1.432–8.758) | 0.003** |
|                                | Good   | 61   | 53.0 | 28   | 80.0  |                         |         |

Study from Leroy and Frongillo (3) showed that linear growth retardation is associated with delayed development in adulthood and chronic diseases. Study from Mendez and Adair in the Philippines found that children who were short from birth to 2 y old had low cognitive scores compared to normal children (18). Meanwhile, the study from Hizni et al. (4) stated that stunted children have a higher risk of delays in language development. Stunting is one of the problems of long-term malnutrition according to the index (height/age) which can affect the structure of the brain and the ability of brain nerve cells that affect the development of toddlers (Georgieff 2007). Other studies from Hanum and Khomsan (19) have different results. The results showed
that based on the Pearson correlation test there was no correlation between nutritional status based on index (height/age) and the cognitive development of children under five (p>0.05) (19).

Changes in nutritional status based on height index by age (height/age) at birth to age 3 y showed that children born stunting but turned normal at 3 y of age had better cognitive development than children born stunting and remained stunting at 3 y of age and children born normal but stunting at the age of 3 y.

Changes in nutritional status based on height index by age (height/age) at birth to age 3 y showed that children born stunting but turned normal at 3 y of age had better cognitive development than children born stunting and remained stunting at 3 y of age and children born normal but stunting at the age of 3 y. This study in line with Study from Fink and Rockers (20) in 3,327 children aged 8–15 y old collected in Ethiopia. India. Peru. and Vietnam. The study showed that 36% of children stunted at age 8 y old managed to catch up with their peers by age 15 y old, and those who caught up had smaller deficits in cognitive scores than did children who remained stunted. The results presented in the study suggest that children who succeed in catching up with respect to their physical growth after age 8 y old have cognitive testing scores very similar to those of children never stunted despite the fact that they are on average 0.3 y behind in their educational attainment (20). Changes in nutritional status from stunting to normal will improve the cognitive development of children.

Other studies from García-Parra et al. (21) defined that children who were stunted and did not recover for the second evaluation had 3.4 times higher risk of being stunted in the third evaluation, than children who were firstly diagnosed as stunted but they recovered in the second evaluation, whereas children who started with a normal nutritional status and in the second evaluation were diagnosed as stunted, had a higher risk of 5.7 times of being stunted in the third evaluation than children who remained with a normal nutritional status in the second evaluation (21).

The other hand, other study from Sokolovic et al. (22) have different results. The result of the study showed that there was no significant difference in the change in cognitive scores following nutritional interventions over a 6-mo period between those who remained stunted and those who were no longer stunted (p>0.10) (22).

The relationship of psychosocial caregiving with cognitive development of 3-5-y-olds showed that 3 of the subscales, namely learning stimulation, language stimulation and academic stimulation showed a significant relationship. Psychosocial caregiving in the family as a whole has an effect on cognitive development of 3-y-olds with OR = 3.541 (95% CI = 1.432–8.758; p = 0.003).

These results are in line with the study of Ashari et al. (11) which showed that there was a significant relationship between caregiving of parents and children’s cognitive development. which meant caregiving greatly affected the level of cognitive development of children in children aged 3–4 y in PAUD South Magelang District. According to Setijaningsih and Noviana (23) shows that children continue to learn to speak because they are stimulated by encouragement to imitate the sound that they hear that are spoken by others. The environment also influences language development (23).

While according to Santrock (24) found that the quantity of parental conversations to children is directly related to the growth of children’s vocabulary. Babies whose mothers speak more often to them have more vocabulary. Stimulation of language development can be done by everyone involved with the child, namely by the mother and father who is the closest person to the child. substitute for the mother or caregiver, other family members and community groups in their respective household environments in daily life (24).

Disclosure of state of COI

No conflicts of interest to be declared.

REFERENCES

1) Victoria CG, de Onis M, Hallal PC, Blössner M, Shrimpton R. 2010. Worldwide timing of growth faltering: revisiting implications for interventions. Pediatrics 125(3).

2) Granttham-McGregor S, Cheung YB, Cueto S, Glewwe P, Richter L, Strupp B. 2007. International Child Development Steering Group. Developmental potential in the first 5 years for children in developing countries. Lancet 369(9555): 60–70.

3) Leroy JL, Frongillo EA. 2019. Perspective: What does stunting really mean? A critical review of the evidence. Adv Nutr 10(2): 196–204.

4) Hizni A, Julia M, Gamayanti IL. 2009. Status Stunted dan Hubungannya dengan Perkembangan Anak Balita di Wilayah Pesisir Pantai Ulara Kecamatan Lembahwungkuk Kota Cirebon. The Indonesian J Clin Nutr 6(3): 131–137.

5) Georgieff MK. 2007. Nutrition and the developing brain: Nutrient priorities and measurement. Am J Clin Nutr 85: 614S–620S.

6) Crookston BT, Dearden KA, Alder SC, Porucznik CA, Stanford JB, Merrill RM, Dickerson TT, Penny ME. 2011. Impact of early and concurrent stunting on cognition. Matern Child Nutr 7: 397–409.

7) Crookston BT, Schon W, Cueto S, Dearden KA, Eagle A, Georgiadis A, Lundeen EA, Penny ME, Stein AD, Behrman JR. 2013. Postinfancy growth, schooling, and cognitive achievement: Young lives. Am J Clin Nutr 98: 1555–1563.

8) Moura DRD, Costa JC, Santos IS, Barros. A JD, Matijasevich A, Halpern R, Durnit S, Karam S, Barros, FC. 2010. Risk factors for suspected developmental delay at age 2 years in a Brazilian birth cohort. Paediatr Perinatal Epidemiol 24: 211–221.

9) Caldwell BM, Bradley RH. 2003. Home Observation for Measurement of the Environment: Administration manual. Tempe. AZ: Family & Human Dynamics Research Institute. Arizona State University.

10) Khomsan A, Anwar F, Hernawati N, Suhanda NS, War...
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1. sitio O, Herawati T. 2013. Growth, cognitive development and psychosocial stimulation of preschool children in poor farmer and non-farmer households. Mal J Nutr 19(3): 325–337.

11) Ashari CD, Utami NW, Susmini. 2017. Hubungan pola asuh orang tua dengan perkembangan kognitif anak usia 3–4 tahun di Paud Kecamatan Magelang Selatan. Nursing News 2(2).

12) Ernawati F, Rosmalina Y, Ridwan E, Permaesih D, Safitri A, Susilawati MD, Permanasari Y, Luciasari E. 2012. Studi Longitudinal Faktor Risiko Terjadinya Stunting Pada Anak Bawah Dua Tahun [Laporan Penelitian]. Bogor: Pusat Teknologi Terapan Kesehatan Dan Epidemiologi Klinik Balitbangkes RI.

13) Bayley N. 2005. Bayley Scales of Infant and Toddler Development. Third Edition: Administration Manual. Harcourt Assessment. San Antonio, TX.

14) Semba RD, de Pee S, Sun K, Sari M, Akhter N, Bloem MW. 2008. Effect of parental formal education on risk of child stunting in Indonesia and Bangladesh: a cross-sectional study. Lancet 371: 322–328.

15) Jayanti LD, Effendi YH, Sukandar D. 2011. Perilaku Hidup Bersih dan Sehat (PHBS) serta Perilaku Gizi Seimbang Ibu kaitannya dengan Status Gizi dan Kesehatan Balita di Kabupaten Bojonegoro Jawa Timur. J Gizi Pangan 6(3): 192–199.

16) Sari P, Hapsari D, Dharmayanti I, Kusumawardani N. 2014. Faktor-faktor yang berpengaruh terhadap risiko kehamilan 4 terlalu pada wanita usia 10–59 tahun (analisis riskesdas 2010). Media Litbangkes 24(3): 143–152.

17) Bernal R. 2008. The Effect of Maternal Employment and Child Care on Children’s Cognitive Development. Int Economic Review 49(4).

18) Mendez MA, Adair LS. 1999. Severity and timing of stunting in the first two years of life affect performance on cognitive tests in late childhood. J Nutr 129: 1555–1562.

19) Hanum NL, Khomsan A. 2012. Pola asuh makan, perkembangan Bahasa, dan kognitif anak balita stunted dan normal di Kelurahan Sumur Batu. Bantar Gebang, Bekasi. Jurnal Gizi dan Pangan 7(2).

20) Fink G, Rockers PC. 2014. Childhood growth, schooling, and cognitive development: further evidence from the Young Lives study. Am J Clin Nutr 100(1): 182–188.

21) García-Parra E, Ochou-Díaz-López H, García-Miranda R, Moreno-Altamirano L, Solís-Hernández R, Molina-Salazar R. 2016. Are there changes in the nutritional status of children of Oportunidades families in rural Chiapas, Mexico? A cohort prospective study. J Health. Popul Nutr 35(1).

22) Sokolovic N, Selvam S, Srinivasan K, Thankachan P, Kurpad AV, Thomas T. 2013. Catch-up growth does not associate with cognitive development in Indian school-age children. Eur J Clin Nutr 68: 14–18.

23) Setijaningsih T, Noviana W. 2017. Pelaksanaan stimulasi perkembangan bahasa dan bicara anak usia 0–3 tahun dalam keluarga di posyandu serumi kelurahan bengkura kecamatan sanan kota blitar. Jurnal Ners dan Kebidanan 4(2): 160–167.

24) Santrock JW. 2007. Perkembangan Anak. Jilid I. Edisi Sebelas. Erlangga, Jakarta.