Comparison of short-term memory between stunting and non-stunting children in urban and rural elementary school students in Kupang 2019
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Abstract
Background: Inadequate chronic nutrition can cause disruption of bone growth and brain development. Impaired bone growth can cause stunting in children, and a disruption of brain development will affect cognitive function, one of them is short-term memory. This study aimed to compare the short-term memory between stunting and non stunting in urban and rural elementary school students in Kupang.

Methods: This research used analytic observational method with cross sectional design conducted on urban and rural elementary school students in Kupang City. One hundred and sixty students who met the inclusion and exclusion criteria were selected using consecutive sampling method. Characteristics data were collected by the interview, while the stunting data was known by measuring height and assessed by WHO anthroplus application, short-term memory data was obtained from digit span test. Stunting is a nominal data scale, while the short-term memory is an ordinal data scale. This study was analyzed bivariately using chi-square test with significant p value ≤ 0.05.

Results: Chi-square test results of short-term memory between stunting and non stunting in urban and rural elementary school students obtained p = 0.144, which means there is no significant difference in short-term memory between stunting and non stunting in urban and rural elementary school children in Kupang.

Conclusions: There is no significant difference in short-term memory between stunting and non stunting in elementary school children, both in urban and rural areas of Kupang.

Keywords stunting, short-term memory, rural, urban

Introduction
Stunting is an impaired growth in children.¹ Stunting represent a chronic malnutrition, which means the pathological process begins in the womb.²,³ Stunting is defined as a short or very short body condition with z-score height-for age below -2 standard
deviations from the World Health Organization (WHO) child growth standards median.\(^1\)

The highest prevalence of stunting according to WHO, The United Nations Children's Fund (UNICEF) and The World Bank Group are in the developing and third world countries with middle to lower income.\(^4,5\) In year 2000, stunted children reached 32.7% of the child’s population in the world. While in 2015 it reached 23.2% with more than half of the population is in Asia and more than one third in Africa.\(^5\)

In Indonesia, the prevalence of stunted children aged < 5 years in 2018 was 30.8% consists of 11.5% very short and 19.3% short.\(^6\) If the nutrition of those stunted children is not improved, it can be continued until school age.\(^7\) The prevalence of stunting in Indonesia of school age children in 2007 was 36.8%, while in 2013 the prevalence of stunting on children aged 5-12 years was 30.7%.\(^8,9\) The East Nusa Tenggara province is one of the 15 provinces in Indonesia which has a short and very short prevalence above the national prevalence.\(^8\)

Stunting is influenced by the condition of the first 1000 days of life that starts from conception to the first two years of life and this period is called critical windows, because during this period there is a rapid development of body cells including bone so that if nutritional needs is not fulfilled, it can cause stunting.\(^10\) Stunting can cause disruption of child's growth and development, intellectual impairment, lower immunity, vulnerable to risk of non-communicable diseases, decreasing the level of creativity and productivity, increasing the risk of morbidity and mortality.\(^11\) Stunting describes as a chronic state of malnutrition in which the supply of nutrients needed by the body including the brain is deficient.\(^1,12\) This causes unoptimal brain development, therefore it can affect the cognitive function of children.\(^13\)

Stunting is related to decreased cognitive abilities in children. Inadequate nutrient intake for a long time will directly affect the development and maturation of brain function. Disruption of brain development and maturation is associated with decreased cognitive abilities. Decreased cognitive abilities will have an impact on children’s learning processes. Short-term memory is important for the learning process and the formation of long-term memory.\(^14\)

Short-term memory is the capacity to store a limited amount of information. New information received from the environment will be stored in memory, activated and combined with old memory that has been formed.\(^15\) Memory describes a person’s capacity for learning and is closely related to the role of the hippocampus.\(^16\) There are various factors that can affect one's memory including: age, stress, sleep, nutrition and physical activity.\(^17\)

The research that was conducted by Horiuchi et al\(^18\) in Cambodia in 2018 on the differences of the nutritional status in urban and rural areas of school-age children found that the children in rural areas had a higher prevalence of stunting than urban areas, this was highly associated with the differences of food intake between the two regions. Another research that was conducted by Addiniya et al\(^19\) in 2014 on the comparison of intelligence based on short-term memory tests in urban and rural students in Jatinangor Region using digit span forward, digit span backward and symbol digit modality tests found that the digit span backward and symbol digit modality tests in children in urban areas were scored higher than those children in rural areas. This shows that stunting rates and short-term memory abilities of elementary school students differ between urban and rural areas.

Based on this background, researcher felt the need to conduct a research on the impact of stunting and the short-term memory in urban and rural elementary school students in Kupang of East Nusa Tenggara Province.

**Methods**

This research is using analytic observational method with cross sectional design, where the independent variables (stunting and non-stunting) and the dependent variable (short-term memory) are measured at the same time. The instrument that was used to measure the independent variable was the WHO anthropus, the method of measurement is by measuring the height of the student and assessed the data by WHO anthropus application. The instrument that was used to measure short-term memory was digit span, the method of this measurement is by mentioning a few numbers and then asking the student to reiterate the figures. The measurements of stunting and short-term memory
were carried out by researchers. Digit span questionnaire was tested for validation and reliability. Measurements of sleep quality, physical activities, socioeconomic parents, and occupation were collected by a direct interview with questionnaires asked by researchers, since these are some factors that could affects child’s short-term memory. Measurement of food intake was measured using a food frequency questionnaire. This research was conducted in two places, Inpres Bertingkat Kelapa Lima 1 elementary school (urban) and Inpres Noelbaki elementary school (rural) from September to October 2019.

The population in this study were elementary school students grades three through five in Inpres Bertingkat Kelapa Lima 1 elementary school and Inpres Noelbaki elementary school with the total number of 452 people. There are 160 elementary school children who met the inclusion criteria that currently on grade 3-5, aged 9-11 years, children were able to hear and talk and willing to be the subject of the research. The exclusion criteria were children who suffer from disability, experiences stress or have a mood feeling questionnaire score (MFQ>11), history of head trauma, seizures, central nervous system infection, comma, spinal disorders and congenital equinovarus (clubfoot), diarrhea and intestinal worms. The sampling technique in this research used consecutive sampling technique. This study was analyzed univariately and bivariately. The bivariate analysis s using Chi Square test with significant p value ≤ 0.05. This study has been approved by the Research Ethics Committee of the Medical Faculty Nusa Cendana University (Approval Number: 64/UN15.16/KEPK/2019).

Results

A total of 160 children participated in this study. Table 1 shows the baseline characteristic data of subjects. Table 2, Table 3, and Table 4 shows physical activities, quantity and quality of sleep, parents’ income and occupation, respectively. As for food consumption patterns, it is shown in Table 5.

Table 6 shows the univariate analysis results of stunting and non-stunting children, based on WHO child growth chart for height-for-age. Comparison of short-term memory between stunting and non-stunting group of children is shown in Table 7.

Discussion

This study found that (1) the variation of food from the daily intake of the subjects in urban and rural areas is still low. According to UNICEF and WHO the variation of food for children should be at least consist of 4-5 kind of foods. The results from Food Frequency Questionnaire (FFQ) shows that subjects only consumed 2-3 food ingredients each day. (2) There was an inadequate sources of omega 3 food such as salmon, mackerel, catfish, sardines, shrimp, squid, fish oil and nuts. Omega 3 plays an important role in morphological, biochemical and molecular development of the brain, so that if the daily intake of omega 3 is insufficient, it will reduce the intelligence of children that can be seen by their low short-term memory. Based on FFQ results, the daily consumption of fish which is a source of omega 3 in urban and rural areas were still relatively low.

Bone growth in school-aged children is influenced by food intake, if the child's food intake is inadequate, the bone growth will be disturbed and the child will be stunted. Food ingredients that contain nutrients for bone growth are protein, calcium, phosphorus, vitamins, magnesium and zinc. Protein is important to form new bone tissues and replace the damaged bone tissue. Protein sources are divided into 2 types, (1) animals-source such as beef, chicken, eggs, and fish and (2) vegetables-source such as tofu, tempeh and beans. Based on the results of FFQ, subjects in rural areas often consume animal protein i.e. fish and subjects in urban areas often consume vegetable source protein such as tofu and tempeh. The essential role of calcium is to form bones and teeth, the main source of calcium comes from milk. Based on FFQ results, daily milk consumption in urban areas was higher than in rural areas.

Phosphorus plays a role in bone and tooth mineralization. Food sources that contain phosphorus are tofu, spinach and cassava leaves. Based on the results of the FFQ, the daily consumption of tofu in urban areas and in rural areas was still relatively low. Vitamins that play a role in helping bone growth are vitamin A and vitamin C. Vitamin A plays an
Fish is a source of omega 3, where omega 3 areas be seen that the daily consumption of fish in rural training. While the external factors intake, sleep can be followed by adequate food consumption to optimize the subject's short-term memory. External factors such as stimulation/repetitive exercise will improve the ability of short-term memory of the subject.

A research conducted by Sadikin was also supported by the research conducted by Sokolovic et al. in India of 1040 elementary school students who were stunted after a nutritional intervention for six months found that the short-term memory abilities, retrieval abilities, and visuospatial abilities were not significantly different before and after the intervention with the p value > 0.1.

In contrast to the results of the research conducted by Woldehanna et al. in 2017 in children aged 5-8 years with a total sample of 2000 children in Ethiopia was found that the stunted children had lower cognitive abilities (which can also be described by short-term memory function) with a significance value of p < 0.01 compared with children who are not stunting.

Some studies suggest that the hippocampus is assumed to have a crucial role in determining the power of the brain in capturing and storing the memory. This adequate nutrition early in life will affect the hippocampus. Based on these findings, height-for-age correlates with inadequate nutrition at the beginning of growth because height reflects the nutritional status in the past.

Short-term memory is the capacity to store a limited amount of information. Low short-term memory in children will affect the learning process of children in school, children who have low short-term memory must be given a stimulus repeatedly so that the new information obtained can be stored in their memory. The ability that can be disrupted in children who have low short-term memory is the ability to read and write, while in elementary school children this ability is taught as the basis of their knowledge which will be applied to further
education. If the ability to read and write is disrupted it will have an adverse effect during adult.\textsuperscript{30} The results of this study indicate that stunting and non-stunting children don’t have significant differences in cognitive abilities, especially in short-term memory. This is caused by various factors such as parental education, socioeconomic and environment.\textsuperscript{31} Parental education background was not examined by the researcher. However, the socioeconomic factors obtained in the characteristics is that the majority of parents have a low income <1 million rupiah which illustrates that most of the subjects have a low economy capacity, this could affect their food availability in household which then resulted in low nutritional intake of the subject.\textsuperscript{32} The intake of omega 3 nutrients that affect the short-term memory in stunting and non-stunting children was still very low. So there was no significant difference between stunting and non-stunting children. For the occupational factors, the majority of subject’s father worked as a farmer and the mother as a housewife. Having most of the subject’s mothers as a housewives is a positive thing because mothers have enough time for parenting, rising, and caring for their children. Parental genetic factors can also contribute to cognitive development. In general, these factors will affect the child's growth and development process. However, it depends on different stimulations and responses that can affect the child's growth and development process.\textsuperscript{31}

Conclusions

Based on the results of the study it can be concluded that there is no significant differences in short-term memory between stunting and non stunting in elementary school children, both in urban and rural areas of Kupang, but in rural elementary schools the prevalence of subjects in stunting group with short-term memory abilities is relatively low, 21.2 % higher compared to urban elementary schools.

| Table 1. Baseline characteristics of subjects (n=160) |
|-----------------------------------------------|
| Characteristics                  | n(%)  |
| Age (years)                      |       |
| 9                              | 85 (53.1) |
| 10                             | 59 (36.9) |
| 11                             | 16 (10.0) |
| Elementary school grade         |       |
| 3                              | 18 (11.3) |
| 4                              | 81 (50.6) |
| 5                              | 61 (38.1) |
| Gender                          |       |
| Female                          | 80 (50) |
| Urban                           | 44 (55) |
| Rural                           | 36 (45) |
| Male                            | 80 (50) |
| Urban                           | 36 (45) |
| Rural                           | 44 (55) |
Table 2. Characteristics of subjects based on physical activity

| Physical activity | n(%) |
|-------------------|------|
| **Type of activity** |      |
| Light Urban       | 36(22.5) |
| Light Rural       | 21(26.3) |
| Light             | 15(18.8) |
| Moderate Urban    | 109(68.1) |
| Moderate Rural    | 63(78.8) |
| Moderate          | 15(9.4) |
| Heavy Urban       | 13(16.3) |
| Heavy Rural       | 2(2.5) |
| **Constancy**     |      |
| Irregular Urban   | 47(29.4) |
| Irregular Rural   | 22(46.8) |
| Regular Urban     | 113(70.6) |
| Regular Rural     | 58(51.3) |
| **Frequency**     |      |
| < 3x/week Urban   | 75(46.9) |
| < 3x/week Rural   | 34(45.3) |
| ≥ 3x/week Urban   | 85(53.1) |
| ≥ 3x/week Rural   | 46(54.1) |

Table 3. Quantity and quality of sleep of subjects

| Quantity and quality of sleep | Percentage (%) |
|-------------------------------|----------------|
### Table 4. Parents’ income and occupation

| Socioeconomics conditions | n(%) |
|---------------------------|------|
| Parents income:           |      |
| < 1 million rupiah/month  | 93(58.1) |
| 1-5 million rupiah/month  | 57(35.6) |
| > 5 million rupiah/month  | 10(6.3) |
| Father’s occupation       |      |
| Entrepreneur              | 26(16.3) |
| Government employee       | 14(8.8) |
| Farmer                    | 40(25.0) |
| Laborer                   | 17(10.6) |
| Teacher                   | 6(3.8) |
| Seller                    | 4(2.5) |
| Doesn’t work              | 13(8.1) |
| Other                     | 40(25.0) |
| Mother’s Occupation       |      |
| Entrepreneur              | 6(3.8) |
| Government employee       | 12(7.5) |
| Farmer                    | 7(4.4) |
| Teacher                   | 7(4.4) |
| Seller                    | 11(6.9) |
| Housewife                 | 109(68.1) |
| Other                     | 8(5.0) |

### Table 5. Food consumption patterns

| Food Material     | Frequency | Total |
|-------------------|-----------|-------|
|                   | > 3x/day | ≤ 3x/day | > 3x/week | ≤ 3x/week | Never | n | % |
| Rice              | 32 | 20 | 124 | 77.5 | 4 | 2.5 | 0 | 0 | 0 | 0 | 160 | 100 |
| Noodles           | 4 | 2.5 | 27 | 16.9 | 20 | 12.5 | 98 | 61.3 | 11 | 6.9 | 160 | 100 |
| Bread             | 10 | 6.3 | 51 | 31.9 | 16 | 10 | 73 | 45.6 | 10 | 6.3 | 160 | 100 |
| Wet Fish          | 7 | 4.4 | 36 | 22.5 | 10 | 6.3 | 80 | 50 | 27 | 16.9 | 160 | 100 |
| Dried Fish        | 7 | 4.4 | 46 | 28.8 | 13 | 8.1 | 78 | 48.8 | 16 | 10 | 160 | 100 |
| Egg               | 8 | 5 | 49 | 30.6 | 16 | 10 | 81 | 50.6 | 6 | 3.8 | 160 | 100 |
| Chicken Meat      | 6 | 3.8 | 17 | 10.6 | 16 | 10 | 107 | 66.9 | 14 | 8.8 | 160 | 100 |
| Meat              | 2 | 1.3 | 15 | 9.4 | 15 | 9.4 | 106 | 66.3 | 22 | 13.8 | 160 | 100 |
| Tofu              | 13 | 8.1 | 61 | 38.1 | 14 | 8.8 | 63 | 39.4 | 9 | 5.6 | 160 | 100 |
| Tempeh            | 13 | 8.1 | 62 | 38.8 | 17 | 10.6 | 62 | 38.8 | 6 | 3.8 | 160 | 100 |
| Cassava Leaves    | 5 | 3.1 | 13 | 8.1 | 8 | 5 | 81 | 50.6 | 53 | 33.1 | 160 | 100 |
| Spinach           | 6 | 3.8 | 36 | 22.5 | 11 | 6.9 | 75 | 46.9 | 32 | 20 | 160 | 100 |
| Kale              | 7 | 4.4 | 86 | 53.8 | 13 | 8.1 | 47 | 29.4 | 7 | 4.4 | 160 | 100 |
| Carrot            | 6 | 3.8 | 26 | 16.3 | 14 | 8.8 | 74 | 46.3 | 40 | 25 | 160 | 100 |
| Cabbage           | 8 | 5 | 23 | 14.4 | 8 | 5 | 72 | 45 | 49 | 30.6 | 160 | 100 |
| Cauliflower       | 3 | 1.9 | 10 | 6.3 | 7 | 4.4 | 63 | 39.4 | 77 | 48.1 | 160 | 100 |
| Mustard Greens    | 7 | 4.4 | 40 | 25 | 10 | 6.3 | 60 | 37.5 | 43 | 26.9 | 160 | 100 |
| Long beans        | 4 | 2.5 | 17 | 10.6 | 13 | 8.1 | 75 | 46.9 | 51 | 31.9 | 160 | 100 |
Table 5. Food consumption patterns (continued)

| Food Material | Frequency | Total |
|---------------|-----------|-------|
|               | > 3x/day | ≤ 3x/day | > 3x/week | ≤ 3x/week | Never | n | % |
| Fruits        |          |          |           |           |        |    |    |
| Banana        | 11       | 6.9      | 30.6      | 12        | 7.5    | 80 | 50 |
| Orange        | 1        | 0.6      | 14.4      | 12        | 7.5    | 99 | 61.9 |
| Watermelon    | 3        | 1.9      | 15.6      | 12        | 7.5    | 96 | 60 |
| Papaya        | 7        | 4.4      | 25.6      | 5         | 3.1    | 85 | 53.1 |
| Pineapple     | 0        | 0        | 8         | 5         | 3.1    | 61 | 38.1 |
| Mango         | 5        | 3.1      | 104       | 65        | 9.4    | 29 | 18.1 |
| Drink         |          |          |           |           |        |    |    |
| Tea           | 10       | 6.3      | 73        | 12        | 7.5    | 36 | 22.5 |
| Coffee        | 0        | 0        | 17        | 5         | 3.1    | 43 | 26.9 |
| Milk          | 11       | 6.9      | 67        | 13        | 8.1    | 48 | 30 |

Table 6. Univariate analysis of subject according to WHO growth chart for height-for-age

| Height-for-age | n(%)|       |
|----------------|-----|-------|
| Stunting       | 52(32.5)|   |
| Non stunting   | 108(67.5)|   |

Table 7. Comparison of short term memory between stunting and non-stunting group

| Height-for-age | Low n(%) | Moderate n(%) | p value* |
|----------------|----------|---------------|----------|
| Stunting       |          |               |          |
| Urban          | 13(25)   | 8 (15.4)      | 0.144    |
| Rural          | 24 (46.2) | 7 (13.4)      |          |
| Non stunting   |          |               |          |
| Urban          | 32 (29.6) | 27 (25)       |          |
| Rural          | 32 (29.6) | 17 (15.8)     |          |
Conflict of Interest

Authors declared no conflict of interest regarding this article.

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