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Head Circumference Profile of Infants Aged 9–15 Months Related to Intelligence in Sukabumi and Cirebon

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Abstract Golden period is any child's period needing attention for their growth, and it would cause permanent damages if not utilized well. Early detection of an infant's growth needs to be implemented with anthropometric measurements, Head Circumference (HC) as one of the nutritional status references. HC correlates with brain volume, and it indicates an infant's intelligence. This study aims to discover the HC measure of infants aged 9-15 months related to their intelligence in the Sukabumi City and Cirebon Regency. The design of this study was a non-experimental quantitative design with a descriptive study approach and cross-sectional method. The data were taken by measuring the infants' HC directly and interviewing infants' mothers. The results of the examination were confirmed and classified based on WHO charts, namely the z-score chart. The results showed that the HC status of most of the infants (86.36%) in Sukabumi City and Cirebon Regency could be categorized in the normal category. The results of the study were mostly in good HC status, but some infants had growth problems, such as 13.64% of infants were included in microcephaly based on head circumference according to age that could have been caused by various factors such as nutrition, and this may be able to affect the intelligence of these children in the future.

1. INTRODUCTION

The 1000 First Days of Life (FDL) of a baby, which are 270 days inside its mother's womb (during pregnancy) and 730 days (2 years) that start from the baby is born, which is also known as the golden period, will cause permanent damages if it is not utilized properly (Saraswati A and Muwakhidah, 2018). This period of 1000 first days of life is the time when children need more attention, including their growth, especially in infants aged 9–15 months.

Growth is a change due to the number addition of cells and the formation of new proteins, thereby increasing the number and size of cells in all parts of the body. Growth is the increase of the number and size of cells throughout the body that are quantitative and measurable; with units of weight (grams/kilograms), units of length (centimeters/cm, meters/m), bone age, and metabolic balance (retention of calcium and nitrogen in the body) (Sembiring, 2017).

Based on the Regulation of the Minister of Health of the Republic of Indonesia Number 66 the Year 2014 regarding Monitoring of Child Growth, Development, and Developmental Disorders, one of the efforts in early detection of growth deviations is the measurement of Head Circumference (HC) by grouping the measurement results based on the z-score graph from the World Health Organization (WHO) (Ministry of Health of the Republic of Indonesia, 2014). Head circumference itself is a standard procedure in pediatrics, and practically it is one of the parameters for assessing brain growth, usually for early detection and examining the pathological state of head size or an

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abnormal increase of head size (Wahidiyat, 2014; Hidayat, 2009).

Z-score is a score that describes the distance or difference in a person's score to the mean score of the group of people and is expressed in the form of Standard Deviation (SD) units in the same population group or from different populations group (Soetjiningsih, 2017). However, the WHO growth standards do not include data for premature or very low birth weight infants (less than 1500 g). The growth of premature infants (less than 37 weeks) after discharge from the neonatal intensive care unit can be monitored using the WHO Child Growth Standards with certain age adjustments (Pediatric Child Health, 2010).

Martin Cr, et al (2016) states that neurodevelopment can be assessed after an infant reaches six months old in addition to the increase of its head circumference size and motor development at that time is very rapid and vulnerable. Therefore, this study included monitoring the detection of appropriate child growth. This is similar to Catena A, et al (2017) who found that the period between zero and four years was the optimal time for brain growth.

According to the Regulation of the Minister of Health of the Republic of Indonesia Number 25 the Year 2014 regarding Child Health Efforts, what is called an infant is a child from zero to 11 months old. Infants are often also referred to as children who are in their earliest stages of extra-uterine life, from the first month after birth to 24 months. (Ministry of Health the Republic of Indonesia, 2017; Health Department of The Republic of South Africa, 2012).

The growth of an infant which is characterized by the size of its head circumference can be influenced by several factors, comprising internal factors and external factors (prenatal factors, labor factors, and postpartum factors). These factors can affect the intelligence of the child in the future (Ministry of Health of the Republic of Indonesia, 2014). Based on this assertion, the results of measuring head circumference relate to the infant's intelligence.

Some experts define intelligence as the ability to deal with and adapt to new situations quickly and effectively, which can be in the form of the ability to learn, the overall knowledge which is gained, the ability to adapt successfully to new situations, or the environment in general (Yusuf, 2010). Intelligence according to Nar'aeni (2012) can also be influenced by congenital or hereditary factors (genetic), environmental factors, and nutritional factors.

There are several growth disorders related to head circumference size, including microcephaly where the HC size is less than -2 SD and macrocephaly with the HC size greater than +2 SD based on the z-score adjusted for age and sex (Harris, 2015). Microcephaly is included in the eight most common types of congenital abnormalities, reported in the period from September 2014 to March 2018 (Ministry of Health of the Republic of Indonesia, 2018). Microcephaly is a rare case with an incidence of one in several thousand babies born with microcephaly (WHO, 2018). If this problem is not handled, it is feared that it will increase the cases of microcephaly in Indonesia. In the examination conducted in DKI Jakarta, there were 7 out of 500 children with microcephaly (Ministry of Health of the Republic of Indonesia, 2010).

Based on these problems, it is necessary to identify the early detection of infant growth, especially among children aged between nine and 15 months old in Sukabumi City and Cirebon Regency by acquiring information about the status of the sizes of the infants' heads circumference that can relate to their intelligence and the factors that may have influenced it.

2. METHOD

The research design used was quantitative non-experimental research with a descriptive study approach of cross-sectional method in Sukabumi City and Cirebon Regency in August 2018.

The population in this study was infants aged nine to 15 months old in Sukabumi City and Cirebon Regency. This research was led by Prof. Dr. Meita Dhamayanti, dr., SpAK., M.Kes through the Competency Research Grant for Lecturers provided by the University of Padjadjaran. As many as 142 respondents were selected using the random sampling technique. Based on the government's database collected in 2017, the number of children under five in Sukabumi City was 14,821 (infants and toddlers) and in Cirebon Regency was 94,293 (infants and toddlers). While the samples taken were 132 respondents who met the inclusion criteria, namely babies who were aged nine to 15 months old at the time of the study, domiciled in Sukabumi City or Cirebon Regency, respondents with complete data including a history of gestational age when the infant was born and was not experiencing chronic pain or suffering from a long-standing illness.

The permits needed in the study were for the sampling in Sukabumi City and Cirebon Regency, and it was submitted to the Research Ethics Committee of Universitas Padjadjaran, Bandung in August 2018.

The data collection was done by taking primary data or carrying out measurements and interviews with the infants' mothers in person. The instrument was used as a measuring tape (metline) with units of centimeters (cm). Anthropometric measurements using reference techniques of head-circumference measurements are stated in the Minister of Health Regulation Number 66 the Year 2014 regarding Monitoring of Growth, Development and Developmental Disorders of Children.

Table 1. Characteristics of infants aged 9–15 months in Sukabumi and Cirebon

Variable	Sukabumi		Cirebon		Total	
	F	%	F	%	F	%
Sex						
Male	30	22.73	37	28.03	67	50.76
Female	38	28.79	27	20.45	65	49.24
Age Group						
9 Months – 11 Months 30 days	66	50.00	14	10.61	80	60.61
12 Months – 15 Months	2	1.52	50	37.88	52	39.39
Birth Classification Based on Gestational Age						
Preterm infant	2	1.52	6	4.55	8	6.06
Term infant	66	50.00	58	43.94	124	93.94
Post-term infant	0	0.00	0	0	0	0.00

The analysis of the data was carried out with the univariate analysis to determine the description of each variable studied, namely, growth that can be seen from the results of measuring the Head-Circumference. While discrete variables (categories) that were confirmed and classified based on WHO charts (z-score) were the nutritional status of Head Circumference for age assisted using WHO Anthro Plus Software 2010. If an infant was born before 37 weeks of pregnancy, the infant's age was reduced by the lack of (weeks) gestation.

3. RESULT AND DISCUSSION

This study involved respondents, namely infants aged nine to 15 months old in Sukabumi City and Cirebon Regency, to determine the nutritional status of the infants based on head circumference according to age along with characteristics such as gender, age group, classification of gestational age at birth, and nutritional intake. Based on the infant classification table, based on sex the numbers of male and female respondents were almost equal. A total of 6.06% of all infants were premature infants or born before 37 weeks of gestation. The age group in the table relates to the period of child growth, namely infancy with an age range of from zero to 11 months old and children under five years old with ages ranging from 12 to 59 months old. In infancy, there is rapid growth, and the maturation process takes place continuously, especially the increase of the function of the nervous system, resulting in changes in nutritional needs. In infancy, infants have nutritional needs in the form of breast milk, the introduction of complementary foods according to age, are given immunizations according to a schedule, and receive appropriate parenting styles. In children under five years of age group, the growth rate begins to decline and there is progress in their motor development and excretory function (Ministry of Health of the Republic of Indonesia, 2014).

The respondent data above also show the factors that can affect their growth and development, namely the internal factors such as gender and age. The other factors are prenatal and delivery factors (Sembiring, 2017). Therefore, respondents with a history of short gestational periods (born before 37 weeks of pregnancy) had different calculations adjusted for the lack of their gestational weeks that they should have been in, which is 40 weeks (Pediatric Child Health, 2010).

Table 2. The Head-Circumference (HC) means of infants aged 9– 15 months

Age Group	F	Mean HC (cm)
9 months – 11 months 30 days	81	44.00
12 months – 15 months	51	44.45
Total	132	44.17

The results of measuring the head circumference of infants in Table 2 show an average of 44.17cm, with the highest result of 48cm, and the lowest was 34 cm. The infants belonging to the age range of nine months to 11 months and 30 days had an average of 44cm while those in the range of 12 months to 15 months had an average of 44.45cm.

The World Health Organization (WHO) provides a new growth chart, from birth to five years old and from five to 18 years old, and countries including Indonesia have been strongly encouraged to adopt this new chart at the national; this chart includes Head Circumference measurements according to age and gender (Purwati, 2016).

Table 3. The Head-Circumference (HC) anthropometry index of infants aged 9–15 months in Sukabumi and Cirebon

Head-circumference status (HC-for-age)	Sukabumi		Cirebon		Total	
	F	%	F	%	F	%
Microcephal (<-2SD)	5	3.79	13	9.85	18	13.64
Normal (-2SD to 2SD)	63	47.73	51	38.64	114	86.36
Macrocephal (>2SD)	0	0.00	0	0.00	0	0.00
Total	68	51.52	64	48.48	132	100.00

Based on the distribution of the frequency of HC according to age status, most of the infants' HC status in Sukabumi City and Cirebon Regency are normal, with a percentage of 86.36%. However, there were 13.64% of the infants included in the category of

microcephaly or less than -2 SD. This can also be seen from 20.31% of respondents in Cirebon Regency included in the microcephaly category.

Head circumference reflects intracranial volume including brain growth. If the brain does not grow along with age, the head will be small; if the head does not grow, the brain will also not develop. Therefore, in a smaller-than-normal head circumference or microcephaly, mental retardation often occurs. Conversely, if there is a blockage in the flow of cerebrospinal fluid in hydrocephalus, the head volume will increase so that the head circle is larger than normal (Kusbiantoro, 2015).

In general, microcephaly is HC that was less than -2 standard deviations (SD) compared to the sample according to age and sex. The definition is supported by pediatric neurologists, developmental pediatricians, pediatric endocrinologists, and geneticists. Microcephaly itself is divided into two types, namely primary microcephaly that occurs from birth, and secondary microcephaly that occurs after birth. The causes of microcephaly include genetic syndromes, environmental teratogens, and structural brain anomalies. Although there is no specific intervention to increase brain growth, secondary microcephaly can be prevented in some conditions so that preventive efforts are very important, especially since the baby is still in its mother's womb (Harris, 2015).

Table 4 shows that most of the infants, which was 89.39%, received nutrition in the form of exclusive breastmilk for the first 6 months, and when the data were collected, most nutritional intakes were in the form of breastmilk and complementary foods amounting to 80.30%. All respondents had been given complementary foods because they were more than six months old.

Nutritional intake is a factor that can affect the status of an infant's head circumference because it is included in the external factor category in the postpartum factors (Sembiring, 2017). One of the other factors that affect the infant's head circumference is radiation. Exposure to radium and X-rays can cause fetal abnormalities such as microcephaly. If it is not balanced with good nutrition in the postpartum period, it is feared that it can affect the growth of the infant's head circumference resulting in impairment (Ministry of Health of the Republic of Indonesia, 2014).

These factors are related to intelligence factors comprising genetic, environmental, and nutritional factors. These nutritional and environmental factors are closely related to parenting styles, so that the role of parents is very important for the growth and development of their infants, especially in monitoring head circumference. One of the most influential nutrients is exclusive breastmilk. According to research conducted by Utami SH et al. (2018) infants aged six to 12 months old who are exclusively breastfed and have a normal head circumference are more likely to experience age-appropriate motor development. In contrast to the findings in the study done by Cahyaningrum ED, et al (2016), the results of Stimulation, Detection and Early Intervention of Growth (Kegiatan Stimulasi, Deteksi, Intervensi Dini Tumbuh Kembang/ SDIDTK) in infants who were not exclusively breastfed based on the results of the weight body according to length body examination, head circumference examination, Development Pre-screening Questionnaire (Kuesioner Pra Skrining Perkembangan/ KPSP), and hearing tests were all in the normal category.

The findings from the data show that the infants with microcephaly who did not receive nutrition of exclusive breastfeeding were 1.52%. In other words, it was not more than the number of infants with microcephaly who had been given exclusive breastmilk as their nutritional intake, which was 12.1%. Therefore, the history of exclusive breastfeeding as an infant's nutritional intake can affect the infant's head circumference but not significantly.

According to Malekzadeh et al. (2019) in their study entitled Growth Indices of Exclusively Breastfed Until 6 Months Age and Formula-Fed Infants in Southwest of Iran, infants with exclusive breastfeeding intake were found to have larger head circumferences. This is like research conducted in Southeast Aceh Regency, Indonesia discovering that infants with normal head circumferences were found to be exclusively breastfed (Ara et al., 2018).

Head circumference is a measurement of a child's brain volume growth is also related to the intelligence level of the child. Brain size and human intelligence are interrelated because this connection has been suspected

Table 4. Nutritional intake of infants aged 9–15 months in Sukabumi and Cirebon

Nutrition	Sukabumi		Cirebon		Total	
	f	%	f	%	f	%
Exclusive Breastmilk						
Exclusive	61	46.21	58	43.94	118	89.39
Non-Exclusive	7	5.30	7	5.30	14	10.61
Current Nutritional Intake						
Breastmilk + complementary food	54	40.91	52	39.39	106	80.30
Breastmilk + breastmilk substitute + complementary food	7	5.30	5	3.79	12	9.09
Breastmilk substitute + complementary food	7	5.30	7	5.30	14	10.61

Table 5. The Head-Circumference (HC) status of infants aged 9–15 months related to exclusive breastmilk intake

Head-circumference status (HC-for-age)	Exclusively Breastfed		Non-Exclusively Breastfed		Total	
	F	%	F	%	F	%
Microcephal (<-2SD)	16	12.1	2	1.52	18	13.64
Normal (-2SD to 2SD)	102	77.3	12	9.09	114	86.36
Macrocephal (>2SD)	0,00	0.00	0.00	0.00	0.00	0.00
Total	118	89.39	14	10.61	132	100.00

for more than 150 years. A total of 88 studies examining the effect of these measurements showed a significant positive correlation between brain volume and IQ generalizing age, IQ domain (full scale, performance, and verbal IQ), and gender. This positive association of brain volume and IQ has been overestimated in the previous literature, but it remains strong even when accounting for different types of dispersion bias, although the reported effects have decreased over time. (Pietschnig J et al., 2015). In general, according to researchers, intelligence is the speed level of the brain to process any form of a task.

According to Jackel et al. (2018), research on head growth and intelligence shows that celestial investigations from birth to adulthood indicate that head growth is a proxy of brain development and intelligence. The increase in head circumference growth has also been shown to result in a higher IQ in the first 5 years of life (Kirkegaard et al., 2020). The findings of Wright (2019) are compatible with a large study in the United States that found that half of the children with very small heads (<-3 SD) had an IQ of <70, but among those with head sizes between -2 to -3 SD, there were 10% of children with learning difficulties compared to 3% of those with heads within the normal range.

In the study of Lainhart JE et al. (2006) regarding the relationship between children's head circumference and intelligence in children with autism, the findings also showed that there was a relationship between the size of the head circumference and the level of intelligence; the larger the size of the head circumference in autistic children (macrocephaly) the more delay they suffer in terms language development. This was due to the size of the head circumference of children with autism that tended to be microcephaly.

A study conducted by Hofman et al. (2014) also presented the finding regarding a relationship between head circumference at birth and IQ in adolescents; head circumference at birth became a stronger factor for better intelligence than birth weight (Jensen RB, 2015).

Head circumference is also proven to be significantly related to the overall development of children as well as aspects in it such as gross motor development, fine motor skills, language, and personal-social skills (Shabariah, 2019). Based on research conducted by Caesar Ensang Timuda, the relationship between nutritional status and gross motor development of infants and toddlers (0–59 months) at Pandanwangi Public Health Center (Puskesmas) in Malang City, that there was a relationship between nutritional status and gross motor development of infants and toddlers (0 -59 months) in the working area of the Pandanwangi Public Health Center, Malang City (Timuda, 2014).

The research conducted by Utami et al. (2019) also showed that infants aged 6 to 12 months old who had been exclusively breastfed and had normal head circumference size had a greater chance of experiencing motor development according to age although the results of the analysis of the relationship between head circumference and motor development infants were not statistically significant (Utami, 2018).

Problems with nutritional status are feared to have an impact on children's growth and development. Children who are malnourished will experience impaired physical, mental, and intellectual growth (Almatsier, 2010). Following the various studies above, babies with small head circumferences are more likely to experience a lower level of intelligence than other children of their age. This can be found in the results of their IQ scores and skill development, especially motor development. Therefore, the discovery of the cases of microcephaly in this study sets off the alarm, and certain interventions in monitoring child growth and development are urgently required. This is because this problem can have a major undesirable effect on the children's intelligence and development.

4. CONCLUSION

The results of the examination on infants aged nine to 15 months old showed that most of them had a good head circumference status, but there were babies with microcephaly (13.34% of the total respondents). This might have been caused by several factors including nutrient intake, and this problem can negatively affect the intelligence of these children in the future. Most infants previously were given exclusive breastmilk, and there was a possibility that the breastmilk as the main nutrient had affected the infants' head circumference status. There is a need for prevention efforts and follow-up monitoring of infants with microcephaly. These efforts can include health promotional efforts regarding the importance of measuring infants' head circumference to the community and the implementation of monitoring children's head circumference which can be carried out at a posyandu regularly. Posyandu is an abbreviation

that means an integrated service post, which is a monthly clinic for children and pregnant women.

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