Assessment of Anemia Status on Physical Development Skills of Children Under Two Years Old in Aceh, Indonesia

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Summary Anemia and iron deficiency can cause detrimental effects on brain development, and continued iron deficiency anemia is known to interfere with development which results in a permanent delay in mental and Motor development. This study investigated the impact of anemia on physical development skills of under two years children in aceh besar district. A cross-sectional study design was applied to 102 under-two years children selected using cluster random sampling technique using village as cluster. A structured questionnaire to determine general characteristics such as maternal age, maternal education, maternal occupational, family income, number of family members and toddlers. Anemia status was assessed by Hemocue 201+ tool, and physical motor development such as gross and fine motor development skills were determined using Denver II instrument. Almost two-thirds of children were anemia, as assessed by blood hemoglobin levels of <11 g/dL, while 34.3% of them were experienced delay in either fine development or gross development skills. The prevalence of children with fine and gross motor development delay was higher in children with suffering from anemia (27.1% and 17.1%) than non-anemia, respectively (3.2% and 9.4%). There was significant association anemia status on fine motor development ($r=0.291; p=0.003$), while not significant to gross motor development ($r=0.092; p=0.357$). The prevalence of anemia in children 12–24 mo old was very high, and has an impact on motor development delays, so anemia prevention programs and motor stimulation intervention for under two years children are needed.

Key Words anemia, motor development, hemoglobin, children

One of the important periods on a children’s life is during the period of two years. The period of two years is referred to the most vulnerable period of brain tissue growth due to the division of brain cells and the rapid development of nerve cells (1, 2).

Anemia is a condition when the production of red blood cells is low or the blood carrier concentration in the form of Hemoglobin (Hb) does not complete the physiological needs of the body (3, 4). The prevalence of anemia in infant at several regions in Indonesia is higher than the national anemia prevalence. Aceh is one of the provinces with the prevalence of anemia in toddlers above the national rate of 30.3% in the rural, and 25.8% in the urban (3). The research by World Vision Indonesia, the prevalence of anemia is quite high that found in the range of 11–24 mo years (77.0%) (5). In Aceh Besar district, of the 257 children (6–23 y months) there were 46.7% anemia, and 36.2% suffered from deficiency of iron (6).

The high prevalence of anemia in these children is considered as a serious public health problem that will adversely affect for future generations. The results of the McGregor and Ani (7) review, the effects of iron deficiency and anemia on infants and children aged 2 (two) y of first life are associated with a decrease in their cognitive, motor and mental development. Evaluated longitudinal observational studies consistently show that children who are anemia at the beginning of childhood (early childhood), then in middle childhood will have lack of cognitive and motor development and also low learning achievement.

Psychomotor development or frequently called motor development is one of the important developments in children. The development control body movements through coordinated activities between the central nervous system and organs. Motor development begins with gross movements that involve large parts of the body in the function of sitting, walking, running, jumping, and so on. The following is continued with fine coordination which involves smooth muscle groups in the functions of reaching, holding, throwing, etc. (8).

Study in Indonesia showed that 28.3% of children aged 0.5–1.9 y have developmental disorders, including motor development disorders (9). In addition to developmental factors affected by parenting factors, these developmental disorders are also influenced by food intake. Iron nutrient deficiency influences the specific mechanism of the central nervous system which can change the development of the baby such cognitive, behavioral and psychomotor (10, 11).
Iron deficiency caused anemia is interfered development which results in permanently delayed mental and motor development, both gross motor and fine motor skills (12, 13). Furthermore, according to Gibney et al., anemia children also appear to be more timid and withdrawn from social interaction (14). Anemia in school children no any achievement because cognitive and motor development problem The impact of anemia also occurs in primary school children, from 39 children with anemia, there is 53.8% had cognitive impairment (15).

MATERIALS AND METHODS

Study design and subject. This study uses a cross-sectional design of 102 mothers who have children aged 12–24 mo in Darul Imarah Sub-district, Aceh Besar District. The study was conducted in July until August 2015. Subject in this study was all children under two years aged 12–24 mo in Darul Imarah Sub-district, Aceh Besar District while the target populations were the chosen targets who met the criteria i.e. born at term ($\geq 37$ wk), not in the state of severe pain, lived with their mothers, and willing to participate. Sample was part of the planned target population which was randomly selected using stratified random sampling technique with proportional allocation. The classification was based on pre-prosperous household/prosperous I (Jeumpet village=56 people), prosperous II (Lambheu village=40 people), and prosperous III (Geugajah village=45 people) which stood as each layer/level. The minimum size of the sample obtained is 102 infants under 2 y.

Measures variables. Measurement variables of socio-economic general characteristics of the family (aged of children, sex of children, maternal age, maternal education status, maternal occupation status, income per capita, number of family members and toddlers number. All measurement variables into three aspects namely, a structured interview, assessment of blood hemoglobin to assess anemia status and assessment of motor development skills.

Blood drops were put in micro cuvette to determine Hb level. Measurement of Hb level was determined by Hemocue system (201+). Blood collection was carried out by health workers at the health centers Darul Imarah. According to WHO, Hemocue method is comparable with Cyannmethemoglobin method, in terms of validation and reliability. Anemia status of the children under two years was defined as Hb level $<11$ g/DL. Sample’s Motor development measurement was done by using the Denver Development Screening Test (DDST) II. Sample motor development data was measured using the DENVER II instrument according to age. Recording of motor developments is done by observing the aspects assessed for 5–10 min. and during the testing session, each child is stimulated to be able to do the highest milestone. Instructions are given to the child and/or caregiver to give encouragement for the child to carry out motor functions as much as the child can achieve. Data on fine and gross motor of samples are processed by scoring the results of the interpretation in the category to be normal if there is no delay and or at most one warning. Suspected categories (delay) if there are $\geq 2$ warnings and or $\geq 1$ delayed respond (16).

Data analysis. Data were entry, editing and coding using Microsoft Excel 2013, while to analized the data using SPSS version 16.0 for Windows and SAS version 9.1 for Windows. For the presentation of anemia categorized to anemia and normal, while yes and no delay to categorized child development status. To analyzed association anemia status and child development status using Chi-square Test at 95% confident level ($p<0.005$).

RESULTS

Family socio-demographic and characteristics of sample

Base on the Table 1 the results showed from 102 children under the age of two years, majority of subjects aged 12–18 y 66.7% (70), and female (56.9%). Most mothers of children are 25–28 y old (36.3%), senior high school (46.1%), worked as housewives (76.5%)
and ≤4 household members (67.6%). The majority of household income per capita is in 4th quintile that are one millions rupiah (20.6%) and most of family have <2 under fives children (71.6%).

Anemia status

The results of this study showed an average of haemoglobin are 10.0±1.3 g/dL, and the prevalence of anemia was 68.6% (Hb <11 g/dL) and most of anemia childrens are moderate category (62.9%).

Motor development status

Based on Table 2, it can be seen that there are delays in fine motor (19.6%) and gross Motor skills (14.7%) in the sample. It is higher percentage of delays in fine motor development compared to gross motor.

The relationship of anemia, motor development

The higher percentage of anemia in under-2-y-children was found having fine motor and gross motor development in the suspect category, respectively (27.1% and 17.1%) compared to those who were non anemia (3.2% and 9.4%). Whereas higher non-anemia individuals were found having fine motor and gross motor development in the normal category, respectively (96.9% and 90.6%) compared to non-anemia (72.8% and 82.8%). The results showed that there was a tendency for anemia in the infant to have a delay in gross Motor and fine Motor development rather than in the non-anemia group. Distribution of gross and fine motor development according to anemia status of under-2-y-children (Table 3).

DISCUSSION

The result of this study (Table 2) the percentage of anemia in infant is very high (68.8%), with Hb levels ranging from 7.0 to 12.4 g/dL. This result if compared to WHO cut off the prevalence of anemia considered to be a public health problem, it >5%, so anemia prevalence in under 2 y children in Darul Imarah Subdistrict is a public health problem and according to the classification anemia prevalence above 40%, the study included a heavy category (17).

The prevalence of anemia in the 12–24 mo age group in this study was almost as similar in Dolokasri study seven provinces in Indonesia, the prevalence of anemia in 12–23 mo old children was 63.33% (18). Others study the high prevalence of anemia was also found in children under 2 y in Kota Baharu, Kelantan, Malaysia amounted to 65.1% with an average hemoglobin level of 10 g/L (19).

The high problem of anemia in children aged 12–23 mo is associated with the increasing need for iron intake in the period of rapid growth along with the beginning of depletion of iron reserves at birth, maternal factors, dietary practices including exclusive breastfeeding and complementary foods (20). The babies who are breastfed more than six months have lower Hb levels compared to breastfed in 4–6 mo (21). The breastfeeding for more than 6 mo without receiving additional iron-fortified foods are risk of iron deficiency anemia in children aged 8–26 mo in Kelantan (20). Several factors affect anemia in children aged unders 2 y is low adequacy levels of energy and iron, fathers low with education, and fathers is young. Among some of the factors mention, iron adequacy level contributed greatly to the occurrence of anemia in children aged 12–24 mo (19).

The most worrying problem about iron deficiency in infants mainly due to iron malnutrition generally occurs in the period after 6–24 mo. This period is important because it coincides with the maximum period of brain growth and the expansion of various neural development processes (22). Iron deficiency in

| Table 2. Anemia Status and Motor Development Skills. |
|-----------------------------------------------|
| Anemia status                  | Frequency (n) | Percent (%) |
| Anemia (<11 g/dL)             | 70            | 68.6        |
| Normal (≥11 g/dL)             | 32            | 31.4        |
| (x±s.d) (g/dL)                | 10.0±1.3 g/dL |
| Severity of anemia            |               |             |
| Mild (10–10.9 g/dL)           | 26            | 37.1        |
| Moderate (7–9.9 g/dL)         | 44            | 62.9        |
| Fine Motor Development        |               |             |
| Normal                        | 82            | 80.4        |
| Suspension/delay              | 20            | 19.6        |
| Gross Motor Development       |               |             |
| Normal                        | 87            | 85.3        |
| Suspension/delay              | 15            | 14.7        |

| Table 3. The relationship of anemia status on Motor development. |
|-----------------------------------------------|
| Motor development                          | Anemia Frequency | Percent (%) | Normal Frequency | Percent (%) | p   |
|-----------------------------------------------|-----------------|------------|-----------------|------------|-----|
| Fine Motor                                  |                 |            |                 |            |     |
| Normal                                      | 51              | 72.8       | 31              | 96.9       | 0.003* |
| Suspension                                 | 19              | 27.1       | 1               | 3.1        |     |
| Gross Motor                                 |                 |            |                 |            |     |
| Normal                                      | 58              | 82.8       | 29              | 90.6       | 0.357 |
| Suspension                                 | 12              | 17.1       | 3               | 9.4        |     |

* Significant p<0.05.
the brain can cause an inhibitory effect on the learning process in the brain.

Based on the results of the test of proportions with the distribution F, there is a significant difference between the development of fine Motor on anemia and non-anemia (p-value: 0.000), whereas gross Motor development does not show significant differences (p-value: 0.256). This means that the category of delayed/suspension of fine Motor development in the anemia infant is higher than non-anemia. The correlation test results also showed that the anemia status was significantly associated with fine Motor development ($r=0.291; \ p=0.003$), while gross Motor development was not significantly associated ($r=0.092; \ p=0.357$). This means that there is a greater tendency anemia on under-2-years-infant to have suspicion on fine motor development.

Iron nutrition of anemia affects the specific mechanism of the central nervous system which can change the development of the baby both cognitive, behavioral and psychomotor (10, 11). Mild iron deficiency without anemia can adversely affect development and brain intelligence and psychomotor development of children (13). Infants with iron nutrition of anemia have low mental and Motor score, including in fine and gross motor coordination (11). There are significant differences in the tasks of fine Motor development such as pushing a car, flipping through pages in both anemia and non-anemia. While the tasks of developing gross motor skills such as sitting from a standing position, standing up and walking alone also differed significantly between anemia and not anemia (12).

Brain development reaches its peak several months before birth, but at birth brain development only reaches 27% of adult brain size and will continue to grow until the age of 2 y that reaches 80% (1). Since birth, adequate iron is needed for brain development. This is because iron is an essential nutrient, which plays a role in Motor function. Iron plays a role in the synthesis of monoamine, energy metabolism in neuro and glia cells, myelination, and neurotransmitter, and dopamine metabolism, an important redox reaction (22, 23). Iron deficiency in food in the first two years of life has a serious impact on development (24). This connection is found in the myelination process developed rapidly from the middle of pregnancy to the first 2 y of life (1), and increased myelination in the central nervous system is reflected in increased fine Motor skills (24).

Motor development is not only influenced by anemia or Hb levels. According to Soetjininghis and Ranuh (1), but it is also influenced by other factors such as biological factors (nutritional intake), physical environmental factors (sanitation), children’s characteristics, family factors, and psychosocial factors. Stimulation from the environment is also the most important thing for children development. Stimulation is one of the psychological factors which is an activity to stimulate children’s basic abilities to develop optimally (25). Children who get directed and regular stimulation will develop faster than children who get less stimulation (1). According to Hastuti (27), the higher of parenting score, the higher the Motor development score achieved by the children.

**CONCLUSIONS AND SUGGESTIONS**

There is a significant association anemia with motor development skill in under two years old, further investigation and nutritional intervention program on these population of concern in order to prevent the risk of anemia in children are needed.

**Disclosure of state of COI**

All authors declare they have no conflicts of interest.

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