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Incidence of stunted in toddlers related to maternal history of anemia during pregnancy

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Abstract

Anemia is the one of global community problem. Anemia during pregnancy reaches 44.3% in Indonesia, and 27.6 % in DKI Jakarta. The impact of anemia during pregnancy includes intrauterine growth restriction (IUGR), which measured by anthropometric measurement. This study is a descriptive-analytical study with a retrospective approach to data presented by Karang Kitri primary health center registry on 34 mothers from 158 mother whom meet the inclusion criteria. The results of this study shows that 37.5 % toddlers are stunted with maternal history of moderate anemia, and 41.7 % in mild level anemia during pregnancy. In this study, 5 toodler (21%) meets criteria stunted without maternal history of anemia during pregnancy.

Keywords: Anemia; Pregnancy; Stunted; Toddlers

1. Introduction

Child period especially under of age 3 years is important in the process of human growth and development. Growth and development at that time determine the child's growth and development in the next periode of life. There is rapid growth process and will never be repeated (irreversible) so that called the golden age or golden periode. [1,2]

In general, stunting caused by nutritional problems experienced by the mother, which results in stunted growth and development of the fetus in the womb. Anemia or iron deficiency in pregnant women is one of the factors that can affect the growth and development of the fetus during pregnancy or after delivery. [3] It is estimated that 41.8% of pregnant women worldwide experience anemia, according to the World Health Organization (WHO), anemia in pregnant women if the hemoglobin level is ≤ 11 mg/dL. The prevalence of anemia in pregnancy in 1993-2005 in Southeast Asia covered 48.2% of the population or an average of 18.1 million people. [4] In Indonesia, anemia in pregnancy reaches 44.3% or as many as 1,950,000 people. DKI Jakarta is one of the 20 provinces in Indonesia with the highest prevalence of anemia in women, 27.6% according to the Ministry of Health report and 13.6% according to basic health research (Riskesdas).[5]

Anemia significantly impacts public health and social and economic development. According to WHO publication data in 2008, anemia affects 1.62 billion people globally, with the highest incidence in preschool children (0-4.99 years) at 76.1% and pregnant women at 69.0%. [4] Anemia occurs in 37.1 % of pregnant women in Indonesia, 36.4% in urban areas, and 37.8% in rural areas. [5] Anemia in pregnant women will further increase the risk of low birth weight (LBW) babies, and mothers will be at risk of bleeding before and during delivery. Women with severe anemia can cause death to both mother and baby. [4] Associated with anemia during pregnancy, mothers who experience anemia during pregnancy can harm the growth and development of children, especially under the age of 3 years. This periode is critical, and a golden period of physical, intellectual, mental, and emotional growth for children. At this time, all forms of the

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disease, malnutrition, and lack of affection may occur; therefore, a good and correct parenting pattern is needed to avoid these risks.[6]

Stunting is a problem resulting from long-term malnutrition which impact on linear growth in toddlers marked with a z-score for height for age showing a number below -2 SD from growth chart by WHO 2005. Stunted is a term used to describe malnutrition based on indicators of height/age. Malnutrition at an early age of childhood can cause growth disturbances, affeact to stature of children, morbidity, and mortality. [7]

Stunting itself has a high risk of reducing the intelligence, productivity, and quality of human resources in the future and can cause degenerative diseases in adulthood. The quality of human resources can be seen from the community development index or the human development index (HDI). Compared to countries in the Southeast Asian region, Indonesia's HDI is among the lowest. Meanwhile, children with low productivity and quality will find it difficult to escape the cycle of poverty in the future. [5,8]

The high prevalence of stunted in toddlers is a public health problem in almost all developing countries. This problem is a global problem faced by many countries in the world. It is estimated that there were 162 million stunted children under five in 2012; if the trend continues without efforts to reduce it, it is projected to be 127 million in 2025. As many as 56% of stunted children live in Asia and 36% in Africa. In Indonesia, the prevalence of stunted is relatively high compared to countries in South East region. In 2013, prevalence of stunted was 37.2%; increased compare to 35,6 % in 2010, and 36.8% in 2007. East Nusa Tenggara is province with the highest prevalence of stunted (51.7%), followed by West Sulawesi (48.0%), West Nusa Tenggara (45.3%). [9,10]

2. Literature Review

Anemia is a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic needs. Specific physiologic needs vary with a person's age, gender, residential elevation above sea level (altitude), smoking behaviour, and different stages of pregnancy. [11] Anemia is a decrease in the normal number of erythrocytes, hemoglobin concentration, or hematocrit. In general, these three parameters are related to each other. The function of red blood cells is carried out by hemoglobin, and the consequences caused by anemia are a consequence of a lack of hemoglobin to bind and transport oxygen to various tissues, so anemia is defined as a condition with a hemoglobin concentration less than normal. WHO defines anaemia in children aged under 5 years and pregnant women as a haemoglobin concentration <110 g/L at sea level, and anaemia in non-pregnant women as a haemoglobin concentration <120 g/L. [4,11,12]

According to Means and Glader, functional anemia is the inability of red blood cells to transport oxygen to peripheral tissues. Determination of anemia itself can be determined through three concentrations, namely hemoglobin (Hb) with units of grams (Hb) per deciliter (g/dL), hematocrit (Ht) with percent or decimal units, and red blood cell concentrations with units of cells per microliter (10^6/ μL) or cells per liter (10^{12}/ μL). In general, anemia is often determined by measuring Hb because it is easy and inexpensive. [11,13] Anemia in pregnant women, according to WHO, is if the hemoglobin level is ≤ 11 g/dL. Anemia that occurs during pregnancy is a major problem that occurs in many developing countries, including Indonesia. Anemia affects almost half of pregnant women worldwide, 52% in developing countries and 23% in developed countries. Based on the results of basic health research in 2013, the prevalence of anemia in pregnant women in Indonesia was 37.1%. [14]

Anemia or deficiency of hemoglobin (Hb) levels in pregnant women is a health problem prone to occur during pregnancy. Anemia in pregnant women increases the risk of having a low birth weight baby (LBW), the risk of bleeding before and during delivery, and can even cause death for the mother and her baby. Hemoglobin level is a biochemical indicator to determine the nutritional status of pregnant women. In normal pregnancy, there is a slight decrease in hemoglobin concentration due to hypervolemia which occurs as a physiological adaptation in pregnancy. Hemoglobin concentration < 11 gr/dL is an abnormal condition unrelated to hypervolemia and suffers from severe anemia. [15]

The determination of anemia in pregnancy is based on the Hb value. According to WHO, pregnant women are declared anemic when their Hb level is below 11g/dL, or their hematocrit is below 33%. [16] Iron deficiency anemia is a major problem of nutritional deficiency in pregnant women. Anemia in the mother can cause preterm labor and birth, increased risk of postpartum hemorrhage due to impaired contractions, and susceptibility to infection. Meanwhile, anemia can cause growth disorders and low birth weight babies in the fetus. [17] Iron is needed during pregnancy to form hemoglobin, which increases in each trimester of pregnancy. Increased formation of erythrocytes, iron reserves and, lack of nutrients, chronic infections are the causes that make pregnant women often suffer from iron deficiency anemia. Blood tests in the first trimester or first visit are necessary to screen for anemia. So that it can be known as soon as possible and corrected if pregnant women suffer from anemia. Iron deficiency anemia can be identified by examining hemoglobin and ferritin levels. Ferritin shows iron stores in the body and is an accurate test. If you only rely on hemoglobin levels, the diagnosis of iron deficiency anemia is often unknown (hidden). The hemoglobin level of pregnant women can be normal, but iron reserves are already lacking (ferritin level less than 30 ng/mL). [18]

During pregnancy, there will be an increase in blood volume starting from the first trimester. This increase in blood volume results from an increase in plasma and erythrocytes. This increase in blood volume has several functions, including meeting the increased metabolic demands due to the enlarged uterus, providing nutrition for the fetus, and protecting the mother from the adverse effects of blood loss during childbirth. The mother's blood volume will increase rapidly in the second trimester. The blood volume, including the concentration of hemoglobin and hematocrit, is slightly reduced during pregnancy due to increased blood volume or hypervolemia. This decrease in hemoglobin concentration is called delusional anemia. The peak of delusional anemia is in the second trimester of pregnancy. A decrease in hemoglobin levels occurs by 1-2g/dL at the end of the second trimester and begins to stabilize during the third trimester when maternal plasma volume decreases. During pregnancy, the need for iron increases. For every 1000 mg of iron needed during pregnancy, about 300 mg of iron will be actively delivered to the fetus and placenta. The increased need for iron is caused by erythropoiesis or erythrocyte formation. [19]

Stunting is a linear growth disorder in toddlers that describes chronic malnutrition during the growth and development period from the beginning of life. Marked by a z-score for height for age (TB/U), it shows a number below -2 standard deviations (SD). [20,21]

The process of stunting can occur in various child life cycles that begin during intrauterine life and last for at least the first two years of life. The period between conception and the second birthday (the first 1000 hearts of life) is suspected as a critical period of child development. [22] The incidence of stunting is never separated from the intake of macronutrients such as energy, protein, and fat. However, the intake of microminerals such as iron and zinc also needs attention. Low iron intake can disrupt the cognitive function and growth of toddlers; besides that, iron also plays a role in the immune system so that toddlers are not susceptible to disease. In addition to iron intake, zinc also needs to be considered. Insufficient zinc intake can inhibit the effects of growth metabolites, causing the synthesis and secretion of Insulin-like growth factors (IGF)-1 to decrease. Decreased secretion can cause stunting. [20, 21]

Stunting in toddlers can hinder children's development, with negative impacts that will last in later life, such as intellectual decline, vulnerability to non-communicable diseases, decreased productivity leading to poverty, and the risk of giving birth to babies with low weight. [23] Many factors affect stunting, including birth length, family economic status, education level, parental height, and lack of fulfillment of nutrients during pregnancy. [24,25]

Intrauterine growth disorders can cause proportional (if the disturbance starts in the second trimester) or disproportionate (if the disturbance starts in the third) fetal growth. Fetal growth is regulated by a complex interaction between maternal nutritional status, endocrine-metabolic signals, and placental development. Physiologically, there is a transfer of energy toward homeostasis of metabolism in failure to thrive, which ends in stunting. The energy used for linear growth is limited, along with the relative insulin resistance that occurs in periods of starvation. Insulin resistance contributes to the addition of energy through catabolic processes, especially during starvation and sepsis. Several hormonal changes occur in catabolic conditions, namely, an increase in serum GH with a decrease in IGF-1 levels and their expression. In children, malnutrition and illness are associated with decreased growth rates, whereas recovery and re-feeding result in accelerated linear growth, often called "catch-up" growth. Optimal linear growth generally only occurs in healthy and well-nourished individuals. The growth deficit accumulated during this period will only partially recover if the disease is cured. When conditions that inhibit growth are overcome, linear growth generally returns to normal and exceeds normal levels for their age. This phenomenon is called "catch-up growth." Stunting is caused by accumulated stress episodes that have been going on for a long time, which are not balanced by catch-up growth. This results in decreased growth compared to children who grow up in a supportive environment. [26]

Growth is alteration in the child's physical dimensions, especially the height (length) of the body. Body weight will be more closely related to nutritional status and fluid balance (dehydration, fluid retention) but can be used as additional data to assess children's growth. [12] The normal pattern of post-natal growth in children is divided into infant, childhood, and puberty phases with their respective characteristics. The characteristics of the growth phase will be seen in a child regular growth monitoring. As a result of this growth pattern, at the age of 2 years, the average height has reached ± 45-50% of adult height, while at the end of the childhood phase or the beginning of puberty, the average height has reached 80-85% of adult height. [28]

In the infant phase, the main drivers of growth, as in the intrauterine phase, are nutrition, well-being, and IGF. In the infant phase, the catch-up and catch-down / lag-down phenomena that can occur in 40%-60% of infants need to be considered. This phenomenon occurs because, in this phase, a child programs himself to grow to his genetic potential. A child born under his genetic potential will quickly grow (catch up) to enter his genetic growth pathway, or channeling, and vice versa. The catch-down phenomenon occurs from 3-6 months; most have reached it at 13 months. Most of the canalization process has been achieved in 24 months. This phenomenon can be seen from the growth pattern of body length, body weight, and head circumference, which align with the ideal growth path according to their genetic potential. [28, 29]

In normal growth, the process of growth and development, including linear growth, is important for children, influenced by genetic, hormonal, and environmental factors. The average increase in height from birth to 12 months of age is 23-27 cm, then decreases to 7.5-13 cm per year at the age of 1-3 years, and after the age of 3 years, the growth rate is 4.5-7 cm per year until now before puberty. At puberty, there is an increase in growth rate to 8-9 cm per year in girls and 10.3 cm in boys. Girls generally start the growth spurt and reach its peak two years later. After puberty, the rate of growth continues to decrease until growth stops. Children experience rapid growth twice within a certain period, namely early childhood and puberty. Children with normal and optimal physical growth will show a characteristic curvature of the growth curve, which illustrates the child's genetic potential. [30]

The hormones that play a role in growth are growth hormone (growth hormone, somatotropin), IGF, sex hormones, thyroid hormones, and glucocorticoids. Linear growth occurs due to the elongation of long bones due to ossification chondrogenesis in the growth plates. Growth plates are thin cartilage layers present at the ends of long bones. The growth plate consists of 3 zones, namely the resting zone, the proliferation zone, and the hypertrophy zone. The rate of chondrogenesis, which is identical to the rate of linear growth, is regulated by a complex interaction between nutrition, hormones, inflammatory cytokines, local growth factors, extracellular matrix, and intracellular proteins. Thus, gene mutations that play a role in growth plate chondrogenesis can result in growth disorders. [31]

In caloric deficiency, most effects on growth plates are mediated by the endocrine system, such as decreased levels of IGF-1, sex steroids, and thyroid and increased glucocorticoids. Malnutrition can also reduce growth plate response because increased fibroblast growth factor (FGF) in low-calorie intake conditions inhibits the action of growth hormone on chondrocytes. Insuline-like growth factor (IGF) acts as a growth-promoting factor in the growth process and mediates growth hormones. Inflammatory cytokines such as Tumor Necrosis Factor-a (TNF-a), Interleukin-1B (IL-1), and Interleukin-6 (IL-6) inhibit chondrogenesis and suppress IGF-1 secretion. The GH-insulin-like growth factor-I (GH/IGF-1) axis is central to linear growth and is susceptible to various defects. GH action is mediated by the IGF system either directly (on the growth plate) or indirectly. [32] Prenatal growth depends primarily on maternal nutrition, while postnatal growth is controlled by GH receptor (GHR) / GH interactions that stimulate IGF-1 production. Disruption of the GH/IGF-1 axis results in an IGF-1 deficiency syndrome characterized by growth retardation due to failure of GH production or GH resistance. GH resistance arises from GHR mutations, defects in post-receptor signaling, and defects in IGF-1 synthesis or may be secondary to chronic disease, malnutrition, or circulating GH or GHR antibodies. [33] Serum protein levels of the IGF system have been reported to be altered in malnutrition. The primary clinical use of IGF-1 measurement is in assessing pituitary GH status, but serum levels have also been known to reflect nutritional status, decreasing during fasting and starvation. After one week of starvation, levels were comparable to those observed in hypopituitarism. The decrease in levels appeared to be greater in those with protein-energy malnutrition than in those with only energy malnutrition. [32]

In utero, insulin, IGF-1, and IGF-II are responsible for fetal growth. Insulin primarily affects fetal adiposity. IGF-II is the main hormone responsible for early fetal growth, and after organogenesis, IGF-1 is more important for fetal growth. The production of IGF-1 in the fetus is influenced more by nutrition than endocrine factors. Low levels of IGF-1 and IGFBP-3 were found in low birth weight and small for gestational babies. Growth hormone (GH) and thyroid hormone do not affect fetal growth because the differentiation of these two hormones does not result in short newborn length. [31]

In humans, brain and body growth, especially during the rapid fetal growth phase, requires a relatively high supply of energy and metabolism. Cellular energy metabolism depends on oxygen. Iron (Fe) deficiency decreases oxygen-dependent cellular energy metabolism due to decreased heme and Hb synthesis, decreased red blood cell (RBC) synthesis, and decreased RBC survival due to increased oxidative stress in RBC, Hb autoxidation, generation of toxic oxygen radicals scramble and increased uptake by macrophages. As a result, iron deficiency anemia causes impaired cognitive abilities and linear growth. [30]

Malnutrition can occur in all age groups, but what needs more attention is in the infant and toddler group. The age of 0-2 years is the optimal growth and development period (golden period), especially for fetal growth, so if there is a disturbance during this period, it cannot be fulfilled in the next period and will harm the quality of the next generation. [31]

Research conducted by Bhatia et al. in assessing the growth status of 117 anemic (Hb 7-10 g/dL) and 53 normal (11 g/dL) children (3-5 years). Children with anemia have lower weight and height for their normal age. Treatment with iron capsules (40 mg elemental iron/day) to both groups of children for six months resulted in a significant increase in Hb levels in both groups (1.6 g/dL in anemic and 0.8 g/dL in non-anemia) compared to them, each control receiving a sugar placebo. The growth performance of anemic children who were supplemented with iron was higher than children who were treated with a placebo compared to children who were treated with a placebo, which was indicated by better weight gain and significantly higher body weight. In summary, iron deficiency anemia in children, especially during the first two years of life, results in significantly impaired growth, which can be corrected with adequate iron therapy.[34]

Based on data from the Centers for Disease Control, Anemia occurs if Hb level in the first and second trimesters of pregnancy is less than 11 g/dL and less than 10.5 g/dL in the third trimester. According to research conducted by Shaboo in 2017, there was a relationship between maternal anemia or Hb less than 11 g/dL in the first trimester and an increased risk of low birth weight babies (LBW). One of the causes of stunting is LBW which mostly occurs in mothers who suffer from anemia. [35] Iron transfer from mother to fetus is supported by the substantial increase in maternal iron absorption during pregnancy and is regulated by the placenta. Most iron transfer to the fetus occurs after the 30th week of gestation, corresponding to the peak efficiency of maternal iron absorption. The acute iron transfer system regulates the transport of iron to the fetus. When the mother's iron status is poor, the number of placental transferrin receptors increases, so the placenta takes up more iron. [20]

3. Research Method

This study aimed to determine the incidence of stunting in toddlers (12-36 months) related to maternal history of anemia during pregnancy from January to July 2018 at Karang Kitri public health center, Bekasi, East Java. The method used in this study is descriptive-analytic, with a retrospective approach. Sampling used the total sampling method, where all populations that meet the inclusion and exclusion criteria will be used as research samples. The secondary data collected from medical records of patients, found on maternal and child health with a history of anemia during pregnancy to delivery as risk factors for stunting in children of Karang Kitri health center patients in Bekasi city. The population in this study were all pregnant women having routine pregnancy examination, and routine child health and growth examination. From January 2018 - July 2018, there were 158 mothers at the Karang Kitri Health Center in Bekasi city, where 34 mothers experienced anemia during the period of pregnancy to post-pregnancy. Hence, the number of patient data processed in this study was 34 patients. Data management is done through several stages: editing, coding, data entry, and data cleaning.

4. Result and Discussion

There were 22% mothers indicated a history of anemia during pregnancy at the Karang Kitri Health Center in Bekasi (Fig. 1). The existing distribution data shows that pregnant women aged 26-30 years(57%) have the highest risk of developing anemia during pregnancy followed by age range 20-25 years (33%) at the Karang Kitri Health Center in Bekasi (Fig.2).

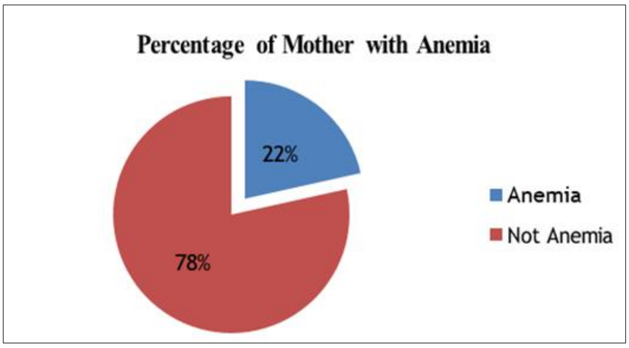

Figure 1 Percentage of Anemia Mothers in the Karang Kitri health center, Bekasi city

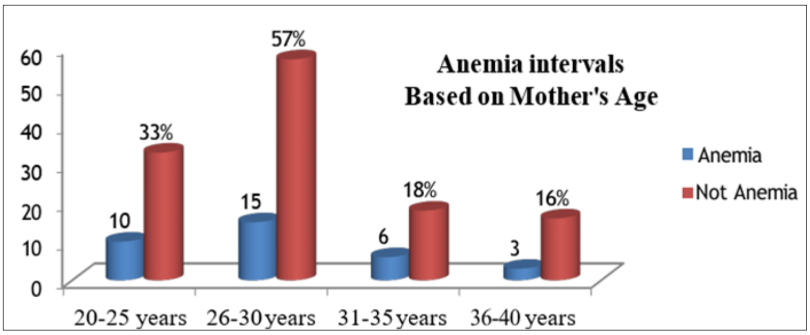

Figure 2 An interval of Mothers with Anemia Based on Mother's Age

From the age distribution figure for stunted children from anemic mothers, it can be seen that mothers with a history of anemia during pregnancy have an impact on the growth of the child's body length from birth to the golden period of growth and development (Fig. 2). Girls have a higher risk than boys (59 % vs 41 %) of experiencing stunting (Fig. 4).

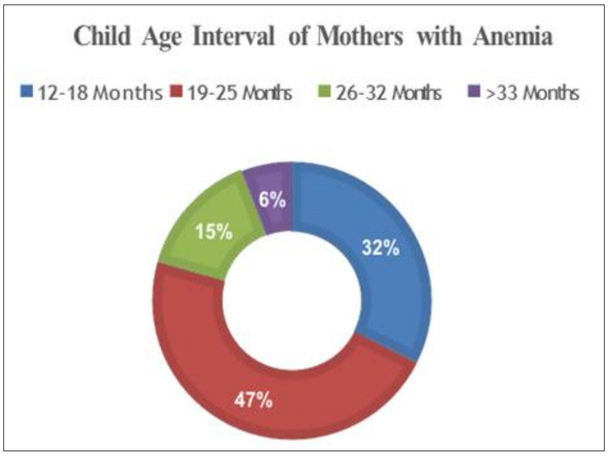

Figure 3 Child Age Interval of Anemia Mothers

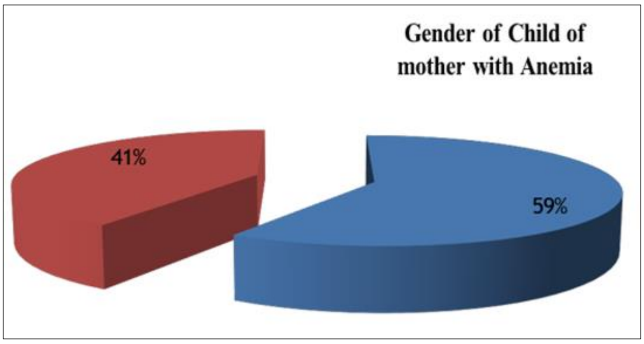

Figure 4 Gender distribution of stunted children from anemic mothers

Stunting can occur in various child life cycles that begin during intrauterine life and last for at least the first two years of life. The first 1000 days of life is a golden period for a child to experience a period of growth and development. It will determine whether the child problems with growth and development or not. This is related to the nutritional intake that the child receives from when he is in the womb to the additional intake and nutritional adequacy received by the child during his growth period. [22] In this study, age of 19 months is the most age that child to experience stunting, followed by toddlers aged 13, 20, 23 to 24 months (Fig. 5)

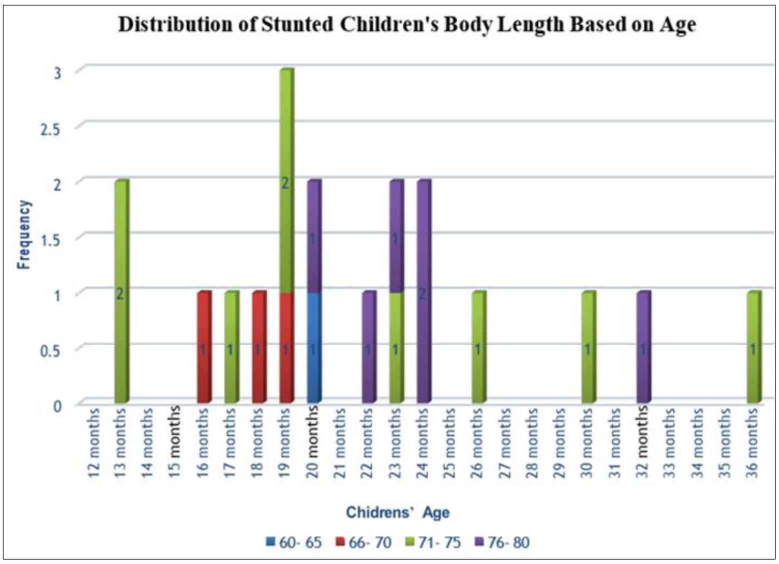

Figure 5 Distribution of Children's Body Length by Age

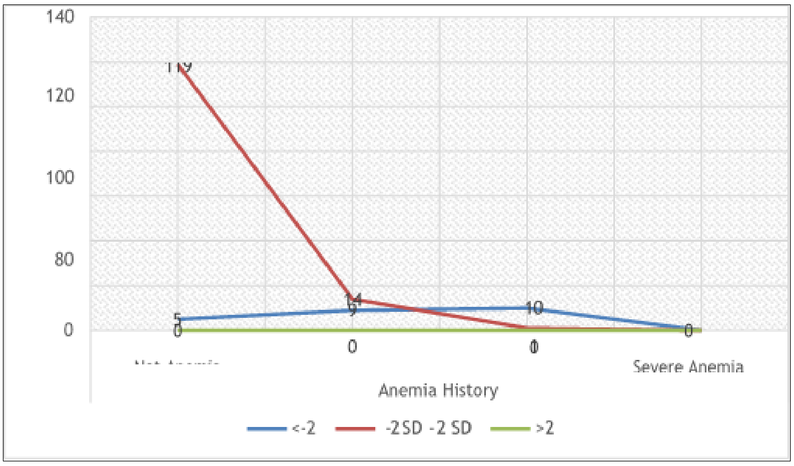

Figure 6 Hb Distribution for Pregnant Women with Z-Score for Newborns

This study shows there are 9 toddlers (37,5 %) were stunted (Z-score <-2SD) with history of mild anemia during pregnancy, and 10 toddlers (41.7%) with a history of moderate anemia. There are mothers who during their pregnancy did not experience anemia but had babies Z-Score <-2SD (20.8 %).

Based on descriptive-analytic research based on maternal and child health books at the Karang Kitri Public Health Center, Bekasi City, it was found that 34 data from 158 mothers who controlled pregnancy, childbirth, and controlled the development of toddlers (aged 12-36 months) met the criteria in this research. This study shows that mothers who during their pregnancy have a history of anemia will have an increased risk of babies being born experiencing stunted. The data from the Karang Kitri Health Center in Bekasi City shows that mothers who experience anemia also has a close relationship with the child related to the weight of the baby born, where most of the babies born have low birth weight. All of these things are related to the lack of maternal Hb levels during pregnancy which can affect the growth rate of the fetus. Various causes can affect children born with stunting, including the mother's Hb level. Where Hb levels during pregnancy can show the level of nutritional intake that the mother receives. If the mother's intake is lacking, it can affect the formation rate of red blood cells, which in turn will affect the rate of nutrient intake received by the fetus so that the process of fetal growth experiences restriction or inhibition of the growth process in the long period during pregnancy. It will later make the body length of the baby born not optimal or not according to the threshold that has been set.

In the research data that has been processed and presented, it can be seen that from the 34 data, there are several possibilities. Among them, 15 mothers experienced anemia during pregnancy, but the babies born had normal weight (not stunting). A normal Z-score indicated it in the range of -2SD to 2SD. Then five mothers did not experience anemia during pregnancy, but the babies born were stunted. And 19 mothers had anemia, and their children had stunting. It can be said that the Karang Kitri health center in Bekasi city still has stunting problems, which are influenced by the mother's Hb levels during pregnancy.

5. Conclusion

Based on the results of the above study, it can be concluded that: a) There are 34 mothers (22%) were obtained during pregnancy and indicated anemia and carried out pregnancy control, childbirth, and child growth control at the Karang Kitri Health Center in Bekasi city; b) In the sample frequency distribution, it was found that there were 19 cases (12%) of stunting incidents which were indicated by the low maternal Hb level during the gestation period; c) Incidence stunted based on age in this study, most prevalent in the age range 19-25 months (47%); and d) In the frequency distribution of Hb levels (mothers experiencing anemia during pregnancy) with the incidence of stunting in this study, there were 5 toddlers who experienced stunting or 21% but no history of anemia was found during the mother's pregnancy/during the pregnancy process. However, in this study, 19 toddlers were born stunted with anemic mothers with moderate criteria, as many as ten toddlers or 37.5%, and there were 41.7% of toddlers who were stunted with a history of anemia with mild criteria.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest in this manuscript.

Statement of informed consent

Informed consent was obtained.

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