



## Research article

**Optimization of growth and quality of life for short children through micronutrient supplementation**

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**ABSTRACT**

The effect of Zinc (Zn) and Iron (Fe) supplementation in short children is relatively varied in its effect on growth and quality of life. To confirm the variation in the results of the study, in addition to optimizing the growth of stunted children from lost generation, this research is important. The purpose of this study was to optimize the growth and quality of life of stunted children through micronutrient supplementation of Zn and Fe. The study was designed experimentally with a randomized pretest-posttest control group design pattern. The subjects of the study were children under five who were randomly selected, who met the following criteria: living in the local area, age 36 - < 60 months, Z score TB/U < -2 SD, not suffering from chronic diseases and congenital defects, their parents were willing to become respondents and their children become research subjects. The number of subjects was 60 children, divided into two groups, namely 30 children in the treatment group and 30 children in the control group. The data collected include the characteristics of the subject, nutritional status (indices of BB/U and TB/U), blood Hb status, and quality of life of children (quality of physical, motor, cognitive, social, autonomy, negative mood, and positive mood) with interview method using a questionnaire. Data analysis was carried out descriptively and using a different test with Independent t test and Paired t test. The results showed that Zn and Fe supplementation significantly affected changes in height, weight and blood Hb levels. The margin of change in height, weight and blood Hb levels in the treatment group was significantly greater than that in the control group. While the condition of the quality of life for short children is relatively normal, they cannot be categorized as healthy children. Generally experience disturbances in the quality of cognitive function and negative mood. For this reason, it is recommended to give Zn and Fe supplements in an effort to handle the incidence of stunting in children so that they can spur increased growth and quality of life.

**Keywords:** Stunting, Zinc, Iron, Micronutrient, Toddlers

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**INTRODUCTION**

Handling the problem of malnutrition in Indonesia, especially stunted children, is more focused on improving survival than quality of life. In terms of the phenomenon of short children, it will not only cause physical growth barriers, high child morbidity and mortality, but also intellectual and mental development retardation. Short children have behavioral difficulties at home compared to normal nutrition children. Their education level was also lower in arithmetic, spelling and reading tests <sup>[1]</sup>.

Short toddlers are children with a height of less than -2 SD (< 3rd percentile) according to age and gender, or children with a height significantly smaller than the genetic potential (-2 SD mid parental height). Short toddlers cause medical implications that are greater than their psychosocial aspects, because growth is the most sensitive sign in children, although it is not specific. Research in toddlers, found that the effect of malnutrition in the form of short

toddlers was relatively small (-4.3%), but significantly suppressed children's quality of life, especially motor function, autonomy, social, cognitive and positive mood <sup>[2]</sup>. Meanwhile, in Kupang City, NTT Province, found the prevalence of stunted children under five was very high (41%) and significantly suppressed children's quality of life (-13.9%). It was also found that short children generally show decreased interaction with their environment, which ultimately leads to poor developmental outcomes and quality of life. This situation is relevant to a previous study that children who are underweight, stunted, have iron or zinc deficiency show decreased activity, are fussier and do not feel happy and do not show curiosity than children who are well nourished.

Optimizing the growth and quality of life of short toddlers is a strategic step to prevent lost generation. UNICEF also emphasizes the importance of nurturing and caring for children as the

third element that causes malnutrition, in addition to insufficient food and health services. Meanwhile, another study recommended three groups of quality children's basic needs, namely the need for care (adequate nutrition), compassion (love), and sharpening (stimulation) [3]. Indonesian Health Ministry also recommends adequate stimulation to stimulate the brain so that the development of movement, speech and language skills, socialization and independence in children under five takes place optimally according to their age. This last point is important because brain development is modified by environmental quality.

Short children, among others, are caused by certain micronutrient deficiencies, namely iron and zinc which are the most common. Iron is an important nutrient with a very narrow therapeutic-toxic ratio. Both deficiency states and excess have great potential to cause very dangerous effects, including impaired growth and organ development, especially neurological disorders [4]. Zn deficiency can interfere with thyroid gland function and metabolic rate, appetite disturbances, decreased sense of taste and slow wound healing. Meanwhile, another study found that 12-year-old soccer players who were given the micronutrient supplement Fe with Zn experienced a height growth of 3.04% versus 1.35% placebo. In addition, serum Hb and IGF-1 levels were positively correlated with growth. However, whether Fe and Zn micronutrient supplementation can trigger an increase in growth in stunted children is a matter that needs to be investigated [5].

Besides efforts to correct the diet for short toddlers, providing psychosocial stimulation is an important step to help short toddlers achieve optimal levels of development and quality of life. Research found that children who were cared for by caregivers who received psychosocial training had a higher average IQ than children who were cared for by untrained caregivers. Another study also concluded that psychosocial stimulation provided in the form of education and training accompanied by the implementation of the Ibu Guru Kami program using the home study group method had a significant positive effect on the child's care and development environment [6].

Based on the above description, the research is directed to assess the effectiveness of micronutrient supplementation, especially the effect of Fe and Zinc supplementation for optimizing growth and quality of life of stunted children.

## MATERIALS AND METHODS

The research was carried out in two places within the working area of the Alak Health Center, Kupang City, namely in Namosain Village and Nunbaun Delha Village. The study was conducted from October to November 2021. The ethical approve was received from The Health District of Kupang City, file number

DINKES.440.870/1022/IX/2021. The research design used was an experimental design with a randomized pretest posttest control group design. The subjects in this study were children aged under five who were obtained through data from the Alak Health Center, and were taken using a simple random sampling method that met the criteria: residing in the local area, aged 36 - < 60 months, Z TB/U score < -2 SB, not suffer from chronic diseases and congenital disabilities, their parents are willing to be respondents and their children are research subjects. The number of subjects was 60 children, divided into two groups, namely 30 children in the treatment group and 30 children in the control group. Subject's height was measured using a microtoa and the child's weight was measured using a digital scale.

The treatment group was given supplements: (a) ZnSO<sub>4</sub> (Zinc Sulfate) syrup in the form of 100 ml Sangobion syrup, where every 5 ml contains Ferrazone 113 mg iron (eq. Fe element 15 mg). Its use is taken every night 1 (one) teaspoon; and (b) ZnSo<sub>4</sub> in the form of 100 ml L-Zink syrup, where every 5 ml contains Zn sulfate monohydrate equivalent to 10 mg zinc element with 1 (one) teaspoon every morning taken. Health nutrition education is also given related to the processing of nutrient-dense foods, healthy and intelligent parenting patterns, and the consumption of drugs for healthy child growth and development; Furthermore, the control group was not given ZnSO<sub>4</sub> and FeSO<sub>4</sub> supplements as well as health nutrition education.

The data collected include nutritional status (index of BW/U and TB/U), blood Hb status; Furthermore, data were also collected on food habits, parenting patterns and children's quality of life (quality of physical function, motor, cognitive, social, autonomy, negative mood and positive mood) by means of interviews using questionnaires. Data analysis was carried out descriptively and with Independent t test and Paired t test for data that were normally distributed.

## RESULTS AND DISCUSSION

The initial characteristics of the research subjects included age, household expenditure, Z TB/U scores, Z BB/U scores and blood Hb of children under five as shown in Table 1.

**Table 1:** General Description of Subject Characteristics at the Beginning of the Research by Treatment and Control Group

| Variable                   | Treatment (n=30)    | Control (n=30)      | Value     | p     |
|----------------------------|---------------------|---------------------|-----------|-------|
| Age (months)               | 48.6 ± 9,3          | 47.7 ± 8,8          |           |       |
| Expenditure (Rp/cap/month) | 1.215.855 ± 496.160 | 1.363.900 ± 591.924 | t= -1.050 | 0.324 |
| Food expenditure (%)       | 65.2 ± 15.1         | 58.3 ± 13.9         | t= 1.851  | 0.083 |
| Z score TB/U               | -2.1 ± 0.8          | -1.96 ± 0,9         | t= -0.634 | 0.529 |
| Z score BB/U               | -2.6 ± 1.1          | -2.2 ± 0.8          | t= -1.692 | 0.096 |
| Hb (g/dl)                  | 8.5 ± 1.3           | 8.2 ± 1.3           | t= 0.888  | 0.945 |

**Source** processed from primary data

From the expenditure side which is a reflection of

household income, it shows the average amount of income. the treatment group was lower than the control group. Meanwhile, for the characteristics of age, proportion of food expenditure, Z score for TB/U, Z score for BB/U and blood Hb level, the treatment group was relatively higher than the control group (Table 1). However, the results of the mean difference test (Table 1) found no significant difference between the treatment group and the control group. Meaning that the characteristics of the research subjects, both the treatment group and the control group have the same characteristics.

After 1 month of supplementation, the average height (cm), body weight (kg), Z TB/U scores, Z BW/U scores and blood Hb levels in the treatment group were relatively higher than the treatment group (Table 2). Similarly, the results of the average difference test for the characteristics of the subjects between the two groups, found no significant differences in height, weight, Z TB/U scores, Z BW/U scores and blood Hb between the two groups after being given supplementation during one month.

**Table 2:** General description of the characteristics of the subject at the end of the study according to the treatment and control groups

| Variable     | Treatment (n=30) | Control (n=30) | Value     | p     |
|--------------|------------------|----------------|-----------|-------|
| Height (cm)  | 94.9 ± 6.3       | 92.2 ± 5.9     | t= 0.114  | 0.731 |
| Z score TB/U | -2.3 ± 0.9       | -1.9 ± 0.7     | t = 0.135 | 0.710 |
| Body Weight  | 12.3 ± 2.1       | 11.0 ± 1.9     | t = 0.520 | 0.474 |
| Z score BB/U | -1.9 ± 0.8       | -1.9 ± 0.9     | t= 0.985  | 0.309 |
| Hb (g/dl)    | 8.9 ± 1.3        | 7.9 ± 1.3      | t =0.005  | 0.945 |

Source: processed from primary data

The difference test in the treatment group (Table 3) showed that height and blood Hb were significantly different before and after supplementation ( $P<0.05$ ), while body weight showed no significant difference ( $P>0.05$ ) after supplementation. Table 3 also shows that height, weight and blood Hb levels in the control group were significantly different ( $P<0.05$ ) before and after supplementation.

**Table 3:** Results of the Difference Test (Paired) of Height, Weight and Hb between Treatment and Control Groups Before and After Supplementation

| Variable         | Treatment (n=30) |       | Control (n=30) |       |
|------------------|------------------|-------|----------------|-------|
|                  | Value            | p     | Value          | p     |
| Height (cm)      | t = -2.774       | 0.010 | -1.997         | 0.055 |
| Body Weight (kg) | t = -0.038       | 0.970 | -3.635         | 0.001 |
| Hb (g/dl)        | t = 2.291        | 0.029 | -5.459         | 0.000 |

Source processed from primary data

Further testing of the margin of change that occurs before and after supplementation between the treatment and control groups is shown in Table 4. It shows that the mean height, weight and blood Hb in the treatment group tend to be higher than the control group. Margin changes in height, weight and blood Hb levels showed an increase, while changes in the control group tended to decrease for weight and blood Hb levels. However, the results of the different test results in the average margin of change in height, weight and blood Hb levels showed a significant difference ( $P<0.01$ ) between the treatment group and the control group. This confirmed that the treatment group was significantly higher ( $P<0.05$ ) than the control

group, in terms of the margin of change in height, weight and blood Hb levels.

**Table 4:** Results of the Difference Test (Paired) on the Changes in Average Height, Weight and Hb between the Treatment and Control Groups

| Variable         | Treatment (n=30) | Control (n=30) | Value    | p     |
|------------------|------------------|----------------|----------|-------|
| Height (cm)      | 0.71 ± 0.25      | 0.10 ± 0.05    | t= 2.321 | 0.001 |
| Body Weight (kg) | 0.16 ± 0.07      | -0.05 ± 0.04   | t= 2.557 | 0.052 |
| Hb (g/dl)        | 0.71 ± 0.13      | -0.10 ± 0.04   | t= 5.909 | 0.000 |

Source processed from primary data

### Children's Quality of Life

Quality of life is a broad complex concept, including multi-dimensional life, which is a subjective perception of how an individual feel about himself which is related and not related to health status. In other words, quality of life refers to an individual's perception, including feelings about his life, values related to health or otherwise, emotional and social functioning, and his relationship with family and friends.

In this study, children's quality of life is intended as parents' subjective perception of values related to their child's health status in seven sectors, namely physical function, motor function, autonomy, cognitive, social, positive mood and negative mood. The quality of life of children under five is measured using a health-related quality of life instrument, where each sector of the quality of life of children consists of 8 questions (adapted from Verrips et al., 1999). The quality of life of normal and or at-risk children refers to the standards proposed by Skarr et al; (2002). The quality of life of children is normal, if the total score is 65.48 ( $\geq 1$  SD) and the quality of life of children is "at risk" if the total value is <65.48. The average quality of life for children under five, broken down by quality of life sector can be seen in Table 2.

The average value of the children's quality of life was 66.89 ± 15.94; meaning that children under five are in normal quality of life status, which has an average quality of life 65.48. When compared to the population of healthy children, that is, if they have an average total score of 81.38 ± 15.90 (Skarr et al., 2002), then these children under five cannot be classified into the population of healthy children. When reviewed by group, it was found that the average quality of life of children in the treatment group had a higher quality of life score (73.69 ± 15.52) or better than children in the control group (66.49 ± 16, 45). Thus, overall the children who were given treatment and control were generally in normal condition.

The quality of life of children under five in terms of quality of life sectors (Table 5), it was found that children under five in the treatment group had physical, motoric, autonomy, cognitive, social, and positive mood functions in normal status, with an average value of 65, 48. Meanwhile in the control group, it was found that children under five tend to have cognitive function and negative moods are in the at risk status (value <65.48) or the risk of experiencing

disturbances. This condition indicates that generally malnourished children under five in this area have negative mood function disorders and are prone to cognitive function disorders.

**Table 5:** Average Quality of Life Score Scores for Toddlers Given Treatment and Control by Quality of Life Sector

| Child Quality of Life Sector | Rata-rata Skor Kualitas Hidup<br>Average Quality of Life Score by Group |                      |
|------------------------------|-------------------------------------------------------------------------|----------------------|
|                              | Treatment (n:30)                                                        | Control (n:30)       |
| Physical Function            | 81.56 ± 17.44                                                           | 73.86 ± 18.97        |
| Motor Function               | 74.81 ± 21.97                                                           | 69.28 ± 20.75        |
| Autonomous Function          | 75.60 ± 23.04                                                           | 66.91 ± 23.67        |
| Cognitive Function           | 67.16 ± 20.96                                                           | 65.85 ± 18.36        |
| Social Function              | 76.95 ± 16.76                                                           | 66.19 ± 24.21        |
| Positive Mood Function       | 77.28 ± 21.31                                                           | 70.80 ± 20.22        |
| Negative Mood Function       | 62.49 ± 20.72                                                           | 52.55 ± 19.32        |
| Children's Quality of Life   | <b>73.69 ± 15.52</b>                                                    | <b>66.49 ± 16.45</b> |

Source processed from primary data

The characteristics of the subjects at the beginning of the supplementation showed no significant difference between the treatment and control groups, meaning that this study was appropriate because it had the same initial characteristics, allowing the respondents to be dispersed proportionally. Likewise, after supplementation, there was no significant difference between treatment and control in terms of height, weight, Z TB/U values, Z BW/U scores and blood Hb levels between the treatment and control groups. This is possible because the measurement time is relatively short, namely supplementation lasts one month from the target for 3 months.

Although the supplementation time was short, it was found interestingly that for the treatment group there was a significant increase in height and blood Hb levels; On the other hand, for the control group, there was a change in the direction of decreasing/stagnant in terms of height, weight and blood Hb levels. In particular, the margin of change in body weight and blood Hb levels showed that the treatment group was significantly larger than the control group.

The difference in the margin of change in body weight and blood Hb levels between the treatment and control groups after Zn and Fe supplementation is relevant to a study which were given daily 10 mg of Zn supplementation in children aged 4-36 months in Vietnam with failure to thrive; it was found that the supplementation significantly increased the growth and plasma concentration of insulin-like factor I (IGF-I) so that it would trigger the growth rate. It is known that IGF-I is a growth hormone mediator, which can trigger growth rates because of its role as growth promoting factor in the growth process. Deficiency of growth hormone can cause growth failure due to decreased concentration of IGF-I, which is caused not only due to protein deficiency but also due to Zn deficiency. Furthermore, a study of a meta-analysis of 25 studies on the effect of zinc supplementation on children's growth showed that zinc

supplementation was statistically significant and gave a better effect on linear growth and weight gain of children [16,17].

Besides the role of Zn, iron nutrition plays an important role in the immune system. When iron deficiency occurs, it is associated with decreased immune function as measured by changes in several components of the immune system that occur during iron deficiency. The consequence of changes in immune function is resistance to infectious diseases. In children, iron deficiency is associated with lethargy, low grasping power, irritability and decreased learning abilities. For this reason, it is asserted that if there is iron deficiency at the age of 6-24 months, that is, when there is rapid growth, it will result in impaired energy use and physical growth.

The findings of this study that children under five in Kupang City, especially in the treatment and control groups were in a normal quality of life status, but could not be classified into the healthy children population. Generally, they are in a status at risk or have a risk of experiencing impaired cognitive function and negative mood. Many factors influence the incident, including the physical environment, social environment, mother's upbringing, history of illness, malnutrition status and level of child development. The results found in a study that the factors disclosed can have a real influence on the total quality of life of children, reaching 42% [2]. Social environmental factors have the largest significant influence (48.7%) on children's quality of life, followed by the physical environment 20.1%, mother's upbringing 8.2%, child development 7.4%, history of illness -5.2%, and malnutrition (short children) by -4.3%. It was uniquely revealed that the direct effect of malnutrition was relatively small (4.3%), but significantly suppressed children's quality of life. Besides that, malnutrition can indirectly suppress children's quality of life through an intermediate variable mechanism, namely child development. It was previously stated that malnutrition suppresses children's development by -4.7%, which results in children's quality of life being not optimal. This situation is possible because the quality of life of children is sensitive to changes in child development. As a result of physical and intellectual development following the growth of children. This is in accordance with the opinion that quality of life is a concept that is sensitive to changes in child development. As a result, physical and intellectual development will follow the child's growth, where his perception of health and wellness will change.

Short children will show changes in behavior, including decreasing their interaction with their environment and resulting in decreased quality of life of children, including the quality of cognitive function and negative mood. Short children generally show decreased activity, fussy and unhappy and low curiosity, which in

turn will experience mental and social developmental delays. It is a result of language delays, which in itself will experience difficulties in social interaction and problem solving. This phenomenon is also explained that malnourished children will experience structural and functional changes in the brain [4]. Children of short stature (stunted), who have iron or zinc deficiency show behavioral changes. These children showed decreased activity, were fussier and did not feel happy and showed less curiosity (low exploratory instincts) when compared to well-nourished children. Nutritional factors play an important role for children who are in a period of physical and intellectual growth and development, which will ultimately lead to the child's quality of life. Low and long-lasting nutritional intake causes metabolic changes in the brain, resulting in an inability to function normally, thus hampering the development of children's intelligence.

The association of the influence of short children in suppressing children's quality of life to be low is understandable. It is known that nutritional factors play an important role for children who are in a period of growth and physical and intellectual development. If the food does not contain enough nutrients needed, and this situation lasts a long time, it will cause metabolic changes in the brain, resulting in an inability to function normally. In more severe and chronic conditions, malnutrition causes impaired body growth, a smaller body followed by a smaller brain size. The number of cells in the brain decreases and there is immaturity and imperfection of the biochemical organization in the brain. This situation affects the development of children's intelligence. It is also stated that the brain is an organ used for thinking and a center for receiving stimuli from outside, where this activity requires nutrients in large quantities. The brain is an organ that requires a fuel source of glucose (monosaccharide) and consumes the largest proportion of energy compared to other organs in the body. The brain also needs protein, essential fatty acids, and various vitamins and minerals. These nutrients are used to increase nerve cells, facilitate the passage of nerves (neurotransmitters) and various activities related to other brain functions

Associated with neural travel, protein and amino acid intake plays an important role in influencing brain function and mental health. Many of the neurotransmitters in the brain are made of amino acids, including the neurotransmitter dopamine, which is made of tyrosine, and the neurotransmitter serotonin, which is made of tryptophan. If the required amino acids are not available, the level of certain neurotransmitters in the brain will decrease, and brain function and mood will be affected. When the body is low on tryptophan, there is not enough serotonin production, and low brain serotonin levels are associated with low mood, some individuals may

even exhibit aggressive behavior. Regarding the findings of this study, it shows that children under five generally experience negative mood function disorders, namely sad, aggressive, quick-tempered, anxious, jealous and worried attitudes. This is a phenomenon due to the high prevalence of children under five experiencing a consumption deficit (energy and protein) as well as chronic and acute malnutrition problems in toddlers.

Another study also found that children with poor nutritional status had an IQ score of 13 points lower than children with normal nutritional status. Nutritional status is the most strongly associated factor with children's IQ scores. Similarly, children who experience Protein Energy Deficiency (PEM) have a lower IQ score of 10-13 compared to children who do not have PEM [7]. Protein is a source of macronutrients that contribute greatly to brain function, especially essential amino acids needed to regulate the formation of neurotransmitters in the brain. It was further revealed that the lack of macronutrients and micronutrients, particularly zinc, selenium, iron, and vitamins, can cause immune deficiency and increase the incidence of infection in children. Malnutrition that occurs during pregnancy, neonatal maturation, and weaning can impair normal immune system development and differentiation [8].

## CONCLUSIONS

Zn and Fe supplementation significantly affected changes in height, weight and blood Hb levels. The margin of change in height, weight and blood Hb levels in the treatment group was significantly greater than that in the control group. While the condition of the quality of life for short children is relatively normal, they cannot be categorized as healthy children. Generally experience disturbances in the quality of cognitive function and negative mood.

Based on the results of this study, it is recommended to provide Zn and Fe supplements in an effort to handle the incidence of stunting in children in order to spur increased growth and quality of life

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