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Vitamin D, Zinc Supplementation, And Counselling Diet To Prevent Tuberculosis Infection In Toddlers Household Contacts With Bacteriologic Pulmonary Tuberculosis In Jakarta

Ika Dewi Subandiyah[1], Nurhayati Adnan[2], Nastiti Kaswandani[3], Ratna Djuwita[4]
[1,2,4]Department of Epidemiology, Faculty of Public Health, University of Indonesia, Depok, Indonesia
[3]Department of Pediatrics, Faculty of Medicine, University of Indonesia, Indonesia
Email: ikadewi32@gmail.com, nprihart@gmail.com, nkaswandani@ikafkui.net, djuwita257@gmail.com

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ABSTRACT

Vitamin D and zinc deficiencies increase the risk of infection, while public understanding of balanced nutrition is still low. Vitamin D and zinc supplementation, plus structured dietary counseling, are important strategies to reduce TB incidence in this high-risk group. This study aims to determine the effect of vitamin D and zinc supplementation and dietary counseling on the incidence of tuberculosis (TB) infection in toddlers who have household contact with bacteriologically confirmed pulmonary TB patients in DKI Jakarta. This study used a quasi-experimental design. The research sites were health centers in DKI Jakarta which were divided into two clusters: West and South Jakarta as intervention groups, and North and East Jakarta as controls, with a total study duration of 4 months. Samples were taken by consecutive sampling with a minimum number of 196 samples after taking into account the possibility of loss to follow-up. The results showed that the intervention of vitamin D supplementation (400-600 IU/day), zinc (10-20 mg/day), and intensive dietary counseling significantly reduced the incidence of TB infection among under-five household contacts by 73%, from 26% in the control group to 5% in the intervention group (RR 0.27; 95% CI 0.15-0.49; p<0.001). Supplementation also increased vitamin D and zinc consumption to meet daily requirements, improved nutritional status and reduced the prevalence of malnutrition based on BB/U from 35% to 25% and stunting based on TB/U from 38% to 28%. Although energy adequacy was not significantly affected (p=0.14), protein adequacy increased significantly (p=0.008), with the proportion of protein-deficient children under five declining from 47% to 37%. This finding confirms the effectiveness of nutritional interventions in the prevention of TB infection among household contact children.

Keywords: Bacteriologic, toddler, zinc, TB, vitamin D

Introduction

Tuberculosis (TB) is the 10th biggest disease that causes death in the world. In 2020, it is estimated that there will be 9.9 million TB sufferers spread across various countries, with a death toll of around 1.2 million (14% in children under 15 years). TB cases can affect everyone, regardless of age and gender. WHO estimates that there are 11% of all TB cases in children (Chakaya et al., 2021). Even in modeling studies in countries with a high TB burden, the incidence of childhood TB is 15-20% of all TB cases. The incidence of TB, especially childhood TB, could be higher in TB-

endemic countries because data surveillance is not yet optimal. Many cases of TB in children have not been diagnosed due to lack of awareness and capacity of health workers, especially in primary care (Kyu et al., 2017).

Indonesia is a country that accounts for 8.4% of TB cases in the world. Based on WHO estimates, there are 842 thousand TB cases in Indonesia with an incidence of 301 cases per 100,000 population in 2020, and deaths at 98 thousand cases (34 per 100,000 population). The number of pediatric TB cases, both new and relapsed (relapse) in Indonesia is estimated at 11.7% of the total number of TB cases, but only 9% have accessed treatment. The large number of pediatric TB cases is an indicator of the large number of TB transmission in the community (Hu et al., 2013).

Although TB reactivation usually occurs in adulthood, primary infection usually begins in childhood. Therefore, efforts to prevent TB infection in children must be made to reduce the incidence of TB. Study conducted by Haerana et al in Makassar, the prevalence of TB infection in children under 5 years of age who had household contact with TB sufferers in Makassar was 38.10%. Meanwhile, in a meta-analysis study, among children in contact, 35% had evidence of TB infection. (Haerana et al., 2021; Hu et al., 2013).

The possibility of getting TB infection and also developing active TB depends on several factors, including the level of infection in the index case, the closeness and duration of contact with the index case, individual susceptibility including socio-economic, behavioral, and environmental factors such as lack of nutrition, crowding, pollution. air, smoking and alcohol use. Of these various factors, lack of nutrition is the main factor in every limited environmental condition.

The prevalence of malnutrition in children is high in countries where TB is endemic. 26% of TB cases in 22 countries with a high TB burden including Indonesia is associated with nutritional deficiencies (*undernutrition*) (Chhetri, Mishra, Jain, & Bhandari, 2018; Patel & Detjen, 2017). The prevalence of stunting in Indonesia according to the 2021 Nutrition Status Study by the Ministry of Health reached 24.4%, while malnutrition reached 17.1%. Research on children under 5 years of age who had household contact with pulmonary TB patients, reported that in children who were stunted, the risk of developing TB was 2 times higher than those who were well-nourished. Other research also proves that stunting is related to the incidence of TB and the type of TB (Nurwitasari & Wahyuni, 2015a). Malnutrition (moderate and severe), male children, not receiving BCG immunization and high intensity of contact with TB cases are causes of TB transmission in children with household contacts (Cintron et al., 2021).

In research conducted by Bhanu Williams in 2008, 65% of active and latent TB cases who visited the clinic suffered from a lack of vitamin D in their serum. (Williams, 2008). A recent study on TB contacts found that 94% of contacts suffered from vitamin D insufficiency and administration of 2.5 mg of vitamin D significantly increased anti-mycobacterial immunity in vitro (Venturini et al., 2014). In a prospective cohort study of infants conducted by Martinez et al in Cape Town, vitamin D deficiency was associated with tuberculin test conversion from negative to positive. Vitamin D deficiency can be caused by several factors, including low socioeconomic status, poor nutrition, cultural factors and lack of sun exposure (Nnoaham & Clarke, 2008).

Various studies on the role of nutrition, namely vitamin D, zinc and a balanced diet in preventing TB infection, are still limited and varied. As far as the author's research is concerned, there has been no research on the combined use of vitamin D, zinc and diet to prevent TB infection in children under household contact. Research on nutrition has indeed been carried out on TB patients and is associated with clinical improvements in TB sufferers. It also has various doses and duration of administration. Moreover, if you use diet counseling as an intervention to fulfill nutrition and prevent the incidence of TB infection. Many studies use additional food such as milk to improve nutrition in TB patients. As in research conducted by Suparman et al. In research on 40 latent TB patients and 40 controls, it was shown that the diet for latent TB included meeting energy and protein needs with a specific diet as well as providing supplementation (Zinc15mg, Vitamin A 5000 IU, Vitamin D 2000IU) for 1 month, increasing immune response and performance. patients and nutritional status in latent TB. ($p < 0.05$) (Suparman, 2019). The study aimed at performance

in latent TB patients. Meanwhile, preventing latent TB infection has not been done.

Based on this, there is a need for intervention to prevent TB infection through increasing nutrition, both macronutrients and micronutrients, which have an influence on immunity and are long-term, especially in high-risk groups, namely children under five in household contact. So that later the incidence of latent TB in children living in household contacts can be reduced and the long-term effect will be a reduction in the incidence of TB.

This study aims to determine the effect of intervention in the form of providing vitamin D, zinc supplementation and dietary counseling on the incidence of tuberculosis (TB) infection in toddlers who have household contact with bacteriologically confirmed pulmonary TB patients in DKI Jakarta. The novelty of this research lies in the holistic approach that combines micronutrient supplementation (vitamin D and zinc) with dietary counseling, which has not been widely studied before in the context of preventing TB infection in high-risk groups such as toddlers in household contacts with bacteriological TB. This approach is expected to provide a more effective prevention strategy to reduce the incidence of TB in vulnerable populations.

LITERATURE REVIEW

Tuberculosis epidemiology

In 2021, it is estimated that there will be around 10.6 million TB sufferers spread across various countries and 11% of them will be pediatric TB cases. This disease contributes to around 1.2 million deaths across all ages and genders, 14% of which occur in children under 15 years (WHO, 2020). Even in modeling studies in countries with a high TB burden, the incidence of childhood TB reached 15-20% of all TB cases. The death rate for children who do not receive treatment can reach 21.9% and increases to 43.6% for children under 5 years of age. The incidence of TB, especially childhood TB, could be higher in TB endemic countries because data surveillance is not yet optimal. Many cases of TB in children have not been diagnosed due to lack of awareness and capacity of health workers, especially in primary care (Kyu et al., 2017).

Indonesia is a country that accounts for 9.2% of TB cases in the world. Based on WHO estimates, there are 969 thousand TB cases in Indonesia with an incidence of 354 cases per 100,000 population in 2021, and the death rate is 150,000 cases (55 per 100,000 population (WHO, 2022). The number of pediatric TB cases, both new and relapsed (relapse) in Indonesia is estimated at 11.7% of the total number of TB cases, but only 9% have accessed treatment (WHO, 2020).

Etiology of Tuberculosis (TB)

In TB etiology, the disease is caused by bacterial agents. The bacteria that are most commonly found and can be transmitted to other humans through droplets in the air include Mycobacterium tuberculosis, Mycobacterium bovis, Mycobacterium africanum, Mycobacterium microtia, and Mycobacterium canettii. M.tuberculosis (M.TBC) (Indonesian Ministry of Health, 2020d). consuming unpasteurized cow's milk, especially from cows infected with M. bovis. Bakt

Until now there has been no discovery that animals are agents of M.TB transmission. However, a person can be infected with M. bovis if the erythrocytes penetrate the gastrointestinal mucosa and invade the person's oropharyngeal lymph tissue, causing disease (Ministry of Health of the Republic of Indonesia, 2020d).

Pathophysiology of Tuberculosis (TB)

The pathophysiological process of TB germs begins with the inhalation of M.TB bacteria into the body through the respiratory tract. Then it will nest in the lung tissue so that a pneumonia nest will be formed, which is called the primary nest or primary affect. These primary nests may arise anywhere in the lung, unlike reactivation nests. From the primary nest, inflammation of the lymph channels leading to the hilus will be seen (local lymphangitis). When this inflammation forms, it may spread hematogenously and homogeneously. This inflammation is followed by enlargement of the lymph nodes in the hilus (regional lymphadenitis). Primary affect together with regional

lymphangitis is known as primary complex. The presence of this primary complex will give a positive result if a tuberculin test is carried out which shows that the individual is infected with Mycobacterium Tuberculosis. The incubation period from inhalation of M.TBC until the formation of the primary complex is 2-12 weeks. This primary complex will experience one of the following fates, namely a. Heals without leaving any defects at all (restitution ad integrum) b. Heals leaving a few scars (including Ghon nests, fibrotic lines, and calcified nests at the hilum) c. Spreads in a continuous manner spreading around it.

Latent Tuberculosis Infection

Latent Tuberculosis Infection (ILTBC) is a condition where the body is infected with Mycobacterium tuberculosis but the body does not produce symptoms of TBCC disease because the immune system can control TBCC bacteria and TBCC germs become dormant (Jain & Lodha, 2019). In people with latent tuberculosis infection, the results of a thorax x-ray examination are normal and the results of a sputum examination are negative, but if you carry out a Tuberculin Skin Test (TST) or an Interferon Gamma-Release Assay (IGRA) examination, the results will be positive (Ministry of Health of the Republic of Indonesia, 2020d).

RESEARCH METHODS

This research is research *quasi-experimental* which was carried out by providing intervention, namely providing dietary supplementation and counseling in a structured and intensive manner to one group while the other group served as a control. The supplements given are vitamin D 400IU and zinc 10mg/day for ages 0-11 months, and vitamin D 600 IU and zinc 20mg/day for ages 1-5 years as well as intensive and structured diet counseling using the *recall 24 jam* for 3 months given to the intervention group.

This research was conducted at the Community Health Center which carries out TB treatment in DKI Jakarta. There are 5 administrative cities and 1 district in DKI Jakarta. Then grouped into 2 clusters, namely Cluster 1 which is a combination of 2 areas, namely West and South Jakarta for the intervention group, then cluster 2 which is a combination of North and East Jakarta areas for the control group. The research was conducted for 4 months, with an estimated 1 month for collecting samples and 3 months for intervention.

The population in this study were all toddlers in household contact with bacteriologically confirmed pulmonary TB patients diagnosed at Community Health Centers in 25 Districts in 4 Administrative Cities in DKI Jakarta. The sampling technique was carried out by *consecutive* sampling, namely all samples that meet the inclusion criteria found when the research is carried out are taken as samples until they meet the minimum sample size. Based on research objectives and research design. So the hypothesis test sample calculation formula is used to test the population relative risk hypothesis according to Lemeshow, namely:

$$n = \frac{(z\ 1\text{-}\alpha/2\ \sqrt{2p(1-p)} + Z1\text{-}\beta\sqrt{(p1(1-p1)+p2(1-p2))^2}}{(p1-p2)^2}$$

Information:

n = Number of samples

$WITH_{a/2}$ = Significance Level (95%)

$WITH_b$ = Strength (80%)

p1 = Proportion of the intervention group who were infected

p2 = Proportion of the non-intervention group who were infected

Assuming the study power (β) is 90%, and the significance is 95%, the sample size is obtained as follows:

p1= p2xRR

p1= 0.47 x 0.52 = 0.24

$$p = (p1+p2)/2 = (0.24+0.47)/2 = 0.35$$

$$n = \frac{(1.96\sqrt{(2x\ 0.35(1-0.35))} + 1.282\sqrt{(0.24(1-0.24) + 0.47(1-0.47))^2}}{(0.24-0.47)^2}$$

n = 89, then total sample size = 178 samples. Assuming that amount *lost to follow up* is 10%, then the minimum sample size is 196 samples.

Once collected, data processing is then carried out to obtain correct information through the stages of data editing, coding, entering data into a computer, and data cleaning. Data analysis in this research was carried out using SPSS version 26 software with several stages, namely descriptive analysis, bivariate analysis, multivariate analysis with GEE (General Estimation Equation with matrix correlation independent, poisson distribution, link logit, incidence and percentages, mean difference tests, and t or nonparametric tests depending on the data distribution.

RESULT AND DISCUSSION

In this study, the incidence rate obtained was a cumulative incidence calculation. The number of toddlers infected with TB who appeared in the 3rd month was calculated in both groups and compared with the total number of toddlers. In this study, the incidence of TB infection obtained was 14.2%. The results of this study are slightly different compared to research conducted by Haerana et al in Makasar on children with household contacts of bacteriological pulmonary TB which stated that the incidence of TB infection was 26%. In an experimental study using community interventions in Uganda and Cameroon, exposure to TB among household contacts was the main risk factor for the incidence of TB. In children aged under 5 years in household contact, 19% will develop TB after 2 years without preventive therapy. (Marx & Villiers, 2023). Another study stated that the prevalence of latent TB was 25.4% in children under 15 years of age and household contacts with bacteriologically confirmed TB patients. (Swathy et al., 2024).

The intervention carried out in this study was the provision of vitamin D and zinc as well as diet counseling. This is based on the ability of vitamin D and zinc to increase the body's immunity. Vitamin D and zinc deficiencies in TB patients will worsen treatment results. (Maaz et al., 2024). Vitamin D activates the immune response and has the potential to reduce Tuberculosis susceptibility by regulating inflammatory reactions and apoptosis in infected cells (Santos-Mena et al., 2024) (Yang et al., 2024). So that TB infection can be reduced. The results of the intervention provided in this study can prevent the incidence of TB infection. Based on research, intervention can reduce TB infections to 0.27 times. This shows that intervention at the population level could reduce the incidence of TB by 73%. The magnitude of this risk is also statistically significant with a p-value of 0.001.

In this study, it was found that the majority of cases of TB infection occurred in toddlers with insufficient consumption of vitamin D and zinc. In toddlers who did not consume enough vitamin D, 14.5% of toddlers were infected, while in toddlers who did not consume enough zinc, 18.4% of toddlers were infected with TB. These results are in line with an RCT study in Taiwan which found that TB patients had a significantly higher proportion of vitamin D deficiency compared with controls (51.6% vs 29.8%) and lower mean vitamin D levels (21.25 ng/ml vs 24.45 ng/ml). The risk for TB is higher in people who have lower vitamin D levels (25(OH)D < 20 ng/ml) (Hsu et al., 2024). A study of 50 TB patients in Sudan found that serum zinc and copper levels were significantly lower in patients with pulmonary tuberculosis compared with controls (p = 0.00, p = 0.00). (Hussein and Albashir, 2018)

Intervention and Prevention of TB Infection Based on Energy Sufficiency

The effect of interventions on preventing TB infection may vary according to energy adequacy. In this study, 33 (13.6%) of the 242 toddlers who had sufficient energy and were infected were infected. Meanwhile, 4 (25%) of the 16 toddlers who lacked energy were infected and lacked energy. The risk of TB infection in toddlers who have sufficient energy is 0.23 (95% CI 0.09-0.5). Meanwhile, for toddlers who lacked energy, it was 0.67 (95% CI 0.37-

1.2). However, statistically, the difference in RR is not significant (p-value>0.05). This insignificant difference is probably because the proportion of infected toddlers in the two groups is not significantly different. In addition, to see the interaction between intervention and energy adequacy, a larger sample is needed, because in this study the proportion of toddlers who lacked energy and had sufficient energy was very different. proportional. The contact toddlers in this study who had sufficient energy were 93%. Meanwhile, those who lack energy are only 7%. So the calculation of the interaction between intervention and energy adequacy is less meaningful. However, the results of the study show that in both under and under-five children, the intervention has the effect of preventing TB infection. In toddlers who have enough, this preventive effect is greater than in toddlers who lack energy.

Lack of energy intake in toddlers if it continues can cause problems with the toddler's nutrition. Toddlers can become malnourished or stunted. In a study conducted in Surabaya involving 130 children, nutritional status was related to the incidence of pulmonary TB in children (p value 0.019) and toddlers whose nutritional status was less related to TB (P value 0.513). (Manilaturrohmah et.al, 2022). Another study stated that malnutrition was associated with a two-fold increase in the risk of developing TB. This is caused by a compromised immune system in malnourished individuals, which makes them more susceptible to infections, including TB (Franco et al., 2024).

Intervention and Prevention of TB Infection Based on Protein Adequacy

In this study, the number of contact toddlers who had sufficient protein was 223 toddlers (86%). Meanwhile, those who lack protein are 37 toddlers (14%). The intervention has a preventive effect on TB infection regardless of protein adequacy. Based on the analysis, 4 toddlers in the intervention group had sufficient protein and were infected with TB (4.9%). Meanwhile, 3 toddlers in the intervention group lacked protein and were infected with TB (6.3%). The number of infected toddlers was greater in the control group, both those with sufficient protein and those with less protein. The relative risk of toddlers being infected according to the protein adequacy category is not significantly different, namely for those with sufficient protein, the risk of toddlers with the intervention being infected with TB is 0.25 (95% CI 0.08-0.7). Meanwhile, for those who lack protein, the risk of children under intervention being infected with TB is also 0.25 (95% CI 0.02-3.1). This indicates that, in both conditions, whether inadequate or sufficient, the risk of TB infection in children under intervention does not change.

A study in China found that TB patients did not get enough animal protein intake, which is the main source of high-quality protein (Zheng et al., 2024). Therefore, it is necessary to overcome this nutritional deficiency to improve the nutritional status of TB patients and reduce the risk of transmission. In an experimental study in Jharkhand India, household contacts in the intervention area were given food (750 kcal and 23 g protein/day) and it was found to significantly reduce the risk of TB infection. (Bhargava, 2021). This confirms that adequate protein is very important to reduce TB infection. In this study there was no significant difference in preventing TB infection based on protein adequacy due to the disproportionate number of samples in the two groups. So the interaction test between intervention and protein adequacy was not significant (p-value 0.97).

Intervention and Energy Sufficiency

Diet counseling that is carried out intensively and structured is expected to influence energy adequacy in toddlers. In this research, there was no difference in energy adequacy before and after the study between the intervention and control groups (p value>0.05). If we look at the intervention group, before the research the average energy adequacy was 101.05% and after the research it was 101.7%. This means that from the start, contact toddlers get sufficient energy intake in their daily lives (minimum daily energy limit of 70%). There was an increase in energy adequacy before and after the study, although it was not statistically significant. If we look at age groups, the average toddler gets enough energy (>70%). Toddlers aged 0-6 months get sufficient energy but less than toddlers aged 7-60 months. This difference in energy consumption can be caused by several factors:

a. It is difficult to measure the amount of energy obtained by toddlers aged <6 months because it is difficult to estimate the volume of breast milk given

b. Toddlers >6 months already receive additional food.

Based on data from the 2014 Individual Daily Consumption Survey conducted by the Ministry of Health, the average energy consumption for toddlers (0-59 years) in DKI Jakarta is 114.4%+ 25.2. In a previous study, counseling for mothers of stunted toddlers in East Lombok was able to increase the mother's level of knowledge about nutrition (Ririnisahawaitun, 2022). Study in Brazil, nutritional counseling for parents of toddlers, reduces intake of foods high in calories, fat and sugar in toddlers. (Vitolo et.al, 20120. Individual nutritional counseling has been proven to improve complementary feeding practices, leading to more diverse eating patterns and reduced consumption of fast food among toddlers (Kumar et al., 2021).

Factors that influence the success of counseling are the staff's skills, time and location of counseling, ability to handle parents' objections, counseling media, counseling techniques, socio-economic and cultural conditions, parents' knowledge (Emanuela et al, 2020, Mertens and Kelfie, 2020, Torna et. al 2021). In this study, the diet counseling carried out in the intervention group was carried out by nutrition officers who had at least a Bachelor's degree in Nutrition. To assess energy adequacy, a 24-hour recall is carried out which has the potential for recall bias, and there may be different behavior during counseling due to various causes, including:

a. The implementation of the recall may not be carried out in a closed room (individually) so that the person being counseled does not concentrate and does not answer truthfully.

b. The second counselor is different from the first counselor.

c. Subjects know the purpose of the research so that subjects who are given supplements have the potential to answer questions better than those who are not given intervention.

One of the main limitations of the 24-hour recall method is recall bias, where participants may forget or inaccurately report their food intake. This can be overcome by using drawing tools or carrying out several recalls on non-consecutive days (Whitton et al., 2023) (Guo, 2022). Then another problem is the need for standardization and training. Effective implementation of the 24-hour recall method requires strict standardization in the survey process and thorough training for interviewers to ensure consistency and accuracy in data collection (Florist, 2023) (Ambikapathi et al., 2022). A further limitation is related to the variability of food intake. This method may not accurately capture the intake of commonly consumed foods due to day-to-day variability. Studies suggest using multiple non-consecutive days to increase accuracy, as this approach accounts for within-person variability and provides a more reliable estimate of typical intake (Guo, 2022).

To avoid this, the researcher made efforts, including, counseling was carried out individually and the counselors were the same person until the end of the research. (Florist, 2023) (Ambikapathi et al., 2022). Apart from that, carrying out a 24 hour recall also uses display media to ensure the weight of the food consumed. (Whitton et al., 2023) (Guo, 2022). According to research conducted by Guo in 2022 at the NCI (National Cancer Institute) in Beijing, which stated that implementing the 24-hour recall method would be better for looking at food consumption patterns if carried out over a longer period and including holidays would be better than the previous period. short and only done on weekdays (Guo, 2022). In this study, 24-hour recall was only carried out one day a month due to limited facilities and personnel. This is one of the limitations in the research.

Based on the analysis, the control group experienced a decrease in the average energy adequacy before and after the study. in the control group the average energy consumption was 100.9% before the study to 98.8% after the study. The average decline was 4.2%. However, in statistical analysis, the difference in average energy adequacy before and after the study between the intervention and control groups was not significant. Likewise, if we analyze the effect of intervention on energy adequacy based on time, it turns out that the results do not show any effect of time. However, the RR value changes every month as follows: in month 1 RR 1.07 95% CI (0.93-1.24), Month 2 RR 0.57 95% CI (0.25-1.31) Month 3 RR 0.79 95% CI (0.32-1.97). Based on the data above, it can be seen that in the group of toddlers who were given the intervention, the risk of energy deficiency was lower than the control group and every month the

potential for energy deficiency decreased. This is in line with research conducted by Fiore et al in the USA, that providing oral supplementation and nutritional counseling for 4 months can lead to a significant increase in the percentage of children with adequate food intake, from 3% at the start of the study to 72% after four month (Fiore et al., 2002). This suggests that counseling can play an important role in overcoming energy insufficiency and promoting growth.

Interventions and Nutritional Status

In this study, the nutritional status of all toddlers in both the control and intervention groups was different before and after the study in the categories of BB/U, TB/U and BB/TB. The number of children under five with malnutrition and stunting decreased before and after the research. Analysis based on the Zscore BB/U, there was a difference in the Zscore before and after the study between the intervention and control groups (pvalue 0.004). The mean Z score in the intervention group was significantly different before and after the study, namely from -1.1 to -0.9. Meanwhile, in the control group, the mean Z score also changed, from -0.9 to -0.7. Malnutrition for children under five in the intervention group decreased from 46 (35.3%) to 32 (24.6%). Likewise, in controls, the proportion of undernourished toddlers before the study was 36 (27.6%) and after 26 (20%).

In the TB/U category, the mean Z score before and after the study was significantly different (p value <0.001). There was a difference in Zscore before and after the study between the intervention and control groups (p value 0.002). In the intervention group the average Z score before the study was -0.65 and -0.77 after the study. Meanwhile, in the control group, the average Z score changed from -0.75 to -0.94. The proportion of stunted toddlers in the intervention group before the study was 50 (38.4%) and after 37 (28.4%). Meanwhile, in the control group, the proportion of toddlers who were stunted before the study. 31(23.8%) and after research 27 (20.7%).

In the BB/TB category, the average Z score before and after the study was significantly different (p value <0.001). The difference in Zscore before and after the study between the intervention and control groups was not significant (p value 0.87). However, the differences before and after the study in each group were significantly different (intervention Pvalue 0.001, control Pvalue 0.002). In the intervention group the average Z score before the study was -0.83 and -0.59 after the study. Meanwhile, in the control group, the average Z score changed from -0.65 to -0.51. The proportion of malnourished toddlers in the intervention group before the study was 35% and after 25%. Meanwhile, in the control group, the proportion of undernourished toddlers before the research was 28% and after the research, it was 20%.

Based on the research results above, it can be concluded that the intervention has an influence on nutritional status. For the toddlers who were given the intervention, the mean Z score before and after the study was significantly different from the control toddlers, even though in both groups the toddlers had less malnutrition and stunting. The proportion of malnourished children under five in the intervention group was reduced by 10%, while in the control group it was reduced by 4%.

Nutrition counseling has an influence on increasing the knowledge of parents of toddlers (Imardiani et al., 2024). Food intake and growth in toddlers with malnutrition. (Fiore, 2022 A study conducted by Fiore in 2022 stated that providing additional nutrition along with nutritional counseling could improve). However, there are obstacles and challenges related to the success of interventions, especially counseling. These obstacles can come from staff or patients. For patients, the main obstacles are related to food recipes and socio-economic conditions which according to them make it difficult to adapt the menu to nutritional needs. As in the study conducted at the Bawomataluo Community Health Center, internal factors that influence toddler nutrition services are the availability of health services, budget for nutrition services, SOPs for nutrition services, health efforts through the availability of nutrition counseling rooms, lack of human resources, a nutritional status reporting system that is still manual. Meanwhile, external factors include work partners, support from the government, community creativity in managing food, low economy, damaged infrastructure, community behavior, and a culture that pays little attention to the nutritional needs

of toddlers. (Piuskosmas, 2022). This certainly influences the results of nutritional counseling for toddlers in this study. This requires further research regarding the factors that influence the success of reducing the proportion of children with undernutrition and stunting among children in household contact.

CONCLUSION

This research shows that intervention in the form of vitamin D supplementation (400–600 IU/day), zinc (10–20 mg/day), and intensive dietary counseling can significantly reduce the incidence of TB infection in household contacts of toddlers by 73%, from 26% in the control group to 5% in the intervention group, with a relative risk of 0.27 (95% CI 0.15–0.49; $p<0.001$). Energy and protein adequacy did not interact with intervention effectiveness, but supplementation increased vitamin D and zinc consumption to meet daily requirements. In addition, the intervention improved the nutritional status of toddlers, as seen from the reduction in the prevalence of malnutrition based on BW/U from 35% to 25% and the prevalence of stunted toddlers based on TB/U from 38% to 28%. Although energy adequacy did not differ significantly ($p=0.14$), protein adequacy showed a significant difference between groups ($p=0.008$), with the proportion of toddlers who were protein deficient decreasing from 47% to 37% after the intervention. These findings emphasize the importance of structured nutritional interventions for preventing TB infection in children under household contact.

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