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Nutritional Aspects in Pediatric Tuberculosis Cases Among Children Aged 0-5 Years

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ABSTRACT

Background: *Children aged 0-5 years are the age group at the highest risk of contracting tuberculosis. This infectious disease is closely related to nutritional aspects in children. These aspects include nutritional intake, exclusive breastfeeding, nutritional status, and history of infectious diseases. This study aims to explore the nutritional aspects of pediatric tuberculosis cases among children aged 0-5 Years.*
Methods: *This study employed a qualitative case-study approach, involving in-depth interviews with informants and document analysis. The study included five primary informants, namely mothers of children aged 0-5 years diagnosed with tuberculosis, and three supporting informants, comprising two village midwives and one tuberculosis program officer at Sumbang I Public Health Center, Sumbang Dist. Data analysis was conducted using thematic analysis.*
Results: *Loss of appetite and weight loss were observed in toddlers after tuberculosis infection, which gradually improved with treatment. There was a balanced distribution between good and poor nutritional status among the toddlers. Tuberculosis bacteria can infect children regardless of nutritional status if the immune system is suboptimal. Children who received exclusive breastfeeding were still susceptible to tuberculosis infection.*
Conclusion: *Mothers fulfilled the nutritional needs of toddlers. Nutritional status and exclusive breastfeeding did not directly influence the infection.*

INTRODUCTION

Tuberculosis (TB) is one of the most significant global health problems. It is a contagious disease that can affect people of all ages, but children, especially those under five years old, are among the highest-risk groups[1]. Data from the 2022 Global Tuberculosis Report indicates that in 2021, approximately 1.2 million cases occurred in children, making TB the second most fatal infectious disease after COVID-19 [2]. This vulnerability is due to a child's underdeveloped immune system, which can lead to tuberculosis in children, resulting in growth and development disorders, serious complications, and even death if not detected and treated early [3,4].

Additionally, childhood TB, especially in toddlers, has long-term health impacts, with toddlers accounting for approximately 40–50% of the child TB population in developing countries [5]

In Indonesia, the issue of childhood TB is also a concern. One of the regions with the highest number of childhood TB cases in Central Java is Banyumas Regency, which reported 1,115 cases in children aged 0–14 years in 2023, a significant increase from 357 cases in the previous year [6]. This upward trend is also evident at Puskesmas (Community Health Center) Sumbang I, Banyumas Regency, where childhood TB cases in children aged 0–14 years increased from 5 cases in 2021 to 38 cases in 2022. As of August 2023, there were 41 recorded TB cases in this age group, with 18 of them affecting children aged 0–5 years.

The relationship between TB and nutritional status is very close and bidirectional. TB infection can lead to appetite disturbances, nutrient malabsorption, and a decline in nutritional status, which ultimately affects disease severity, response to therapy, and even the risk of death [7]. Conversely, malnutrition increases the risk of developing active TB by up to 6–10 times.[8] Previous research has confirmed this link. Kant, Gupta, and Ahluwalia explained that malnutrition causes protein-energy and micronutrient deficiencies, leading to immunodeficiency and increasing susceptibility to infections, including TB [9]. In addition, antituberculosis drugs can affect patients' nutritional status and alter metabolic pathways, thereby influencing treatment effectiveness and patient outcomes [10]. Nutritional interventions can significantly reduce the incidence of TB, and nutritional support has been shown to improve immune recovery, lower TB-related morbidity, and increase adherence to therapy [8,10]

Some studies also highlight the epidemiological aspects and predictors of successful TB treatment in children. A study in Canada found that childhood TB can cause significant morbidity and high resource utilization, with a very high incidence in certain high-risk groups [11]. Meanwhile, a prospective study in Pakistan identified clinical factors that predicted unsuccessful TB treatment in children, even though more than 94% of children achieved successful treatment outcomes. This study also showed that the majority of the children studied (84.3%) were malnourished [12]

Based on a preliminary study in the working area of Puskesmas Sumbang I, it was found that Banteran Village and Tambaksogra Village have the highest number of toddlers and the highest prevalence of undernourished toddlers, at 20.83% and 22.22% respectively, of the total undernourishment cases in the area. This situation indicates a close relationship between nutritional problems and childhood TB cases in the community. The study aims to analyze the nutritional aspects of children with TB aged 0–5 years, especially the role of malnutrition in disease prognosis.

METHODS

This study used a qualitative case-study design to explore the nutritional aspects of childhood tuberculosis in children aged 0–5 years. Data were collected through in-depth interviews with selected informants and document analysis, and the study was conducted in the working area of Puskesmas Sumbang I, Tambaksogra Village, and Banteran Village, Banyumas Regency, Central Java. Data collection took place during December 2023.

The study involved eight informants, comprising five primary and three supporting informants. The primary informants were mothers of children aged 0–5 years with tuberculosis. In contrast, the supporting informants included two village midwives from Tambaksogra and Banteran Villages and one tuberculosis program officer at Puskesmas Sumbang I. Informant selection was conducted using purposive sampling based on specific criteria. The primary informants were selected according to the following criteria: mothers of children aged 0–5 years with tuberculosis and willing to participate in the study. The supporting informants were selected based on the following criteria: individuals involved in childhood tuberculosis cases among children aged 0–5 years and willing to participate in the study. Data from both the primary and supporting informants were obtained directly from the Tuberculosis program holder at Puskesmas Sumbang I.

The researcher acted as the primary instrument (human instrument) supported by recording devices, interview guides, and field notes. Interviews were documented using audio recordings and photo documentation, then transcribed for analysis. The interview guides were designed to ensure the collection of data relevant to the research objectives, while field notes recorded observations and insights during interactions with informants.

Data validity was maintained through credibility testing with source and technique triangulation. Source triangulation was performed by comparing data from primary and supporting informants, while technique triangulation was utilized in in-depth interviews and document analysis to verify the data. This approach ensured the validity and reliability of the research findings.

The research data sources included primary and secondary data. Primary data were obtained through in-depth interviews with primary and supporting informants, as well as documentation of the interviews. Secondary data, including tuberculosis history, treatment history, and patient conditions, were obtained from tuberculosis case records, the health profile of Puskesmas Sumbang I, and nutritional status data for children aged 0–5 years in the research area. The data were analyzed using a thematic analysis approach, which included steps such as understanding the data, coding, categorizing, and identifying themes to find relevant patterns and themes.

This study adhered to the research ethics principles set by the Health Research Ethics Committee of the Faculty of Health Sciences, Jenderal Soedirman University (No:

1272/EC/KEPK/XI/2023). The researcher provided informed consent, maintained data confidentiality, and ensured that informant participation was voluntary.

RESULTS

The study involved eight informants, consisting of five primary informants and three supporting informants, as shown in the following tables (Tables 1, 2, and 3).

Table 1. Characteristics of Primary Informants

Code	Informant's Age	Informant's Education	Child's Age	Month Child Was Infected with TB
U1	33 Years Old	Bachelor's Degree	1 Year 7 Months	March
U2	39 Years Old	Senior High School	2 Years 6 Months	July
U3	37 Years Old	Bachelor's Degree	3 Years 3 Months	July
			4 Years 6 Months	July
U4	24 Years Old	Senior High School	1 Year 6 Months	April
U5	24 Years Old	Senior High School	10 Months	August

Based on Table 1, the youngest primary informant in the study was 24 years old, and the oldest was 39 years old. The youngest child with tuberculosis was 10 months old, and the oldest was 4 years and 6 months old.

Table 2. Characteristics of Children from Primary Informants

Child Code	Child's TB Status	Treatment History	Exclusive Breastfeeding History	Nutritional Status During Treatment	Nutritional Status After Treatment
U1	Cured	Completed	Still Breastfeeding	Undernourished	Good Nutrition
U2	Cured	Completed	No Longer Breastfeeding	Undernourished	Good Nutrition
U3	Undergoing Treatment	4th Month of Treatment	No Longer Breastfeeding	Good Nutrition	Treatment Not Yet Completed
	Undergoing Treatment	4th Month of Treatment	No Longer Breastfeeding	Good Nutrition	Treatment Not Yet Completed
U4	Cured	Completed	Still Breastfeeding	Undernourished	Undernourished
U5	Undergoing Treatment	3rd Month of Treatment	Still Breastfeeding	Good Nutrition	Treatment Not Yet Completed

In this study, three children had been declared cured and three were still undergoing treatment. Two children were still consuming breast milk, and four others were not. Based on Table 2, a balanced comparison was observed in children's nutritional status, with three children having poor nutritional status and three toddlers having good nutritional status.

Table 3. Characteristics of Supporting Informants

No	Code	Age	Occupation
1	P1	39 Years Old	Village Midwife
2	P2	37 Years Old	Village Midwife
3	P3	35 Years Old	TB Program Officer

Based on Table 3, the youngest supporting informant was 39 years old, and the oldest was 35 years old. The occupations of the supporting informants were Village Midwife (2 people) and TB Program Officer (1 person).

Table 4. Thematic Analysis Results

Global Theme	Sub-theme
Nutritional status declines due to decreased appetite, leading to weight loss. This condition slowly improves after treatment and fulfillment of nutritional needs.	Children's appetite tends to decrease, leading to suboptimal nutritional intake, but it gradually improves after treatment. Nutritional intake is provided by changing the menu, creatively preparing food, and providing meals periodically until the child's nutritional needs are met. Informants often increase the child's protein intake to support recovery. Children tend to experience weight loss after being confirmed with tuberculosis.
In terms of nutritional status, a balanced comparison was found between children with good and poor nutritional status in terms of tuberculosis.	Primary informants tended not to know the child's nutritional status. Nutritional status monitoring is carried out through Posyandu (Integrated Health Post) and home visits with cross-program collaboration. There was a balanced comparison between good and poor nutritional status in children infected with tuberculosis.
In terms of nutritional aspects based on the history of exclusive breastfeeding, it was found that tuberculosis infection was higher in children who received breast milk.	Tuberculosis infection tended to be higher in children who received exclusive breastfeeding. This is believed to be related to the children's relatively small body size and close contact with adult patients. Some children were given other intake during the Exclusive Breastfeeding period, such as formula milk. There were no side effects of OAT (Anti-TB Drugs) on the child's desire to consume breast milk. The primary informants ensured the child's nutritional needs were met by providing a combination of foods, including animal protein intake through complementary foods.
Based on the history of infectious diseases, no recurrence was observed.	There were no other infections or recurrences of previous illnesses due to tuberculosis. Children tended to experience mild symptoms, such as fever, cough, and runny nose, for varying durations. All primary informants continued to make efforts to maintain the child's hygiene and sanitation to prevent infection with other diseases.

Nutritional Aspects based on Dietary Intake

Based on the in-depth interviews with the primary informants, it was found that the children's appetite tended to decrease after being diagnosed with tuberculosis, preventing them from getting optimal nutritional intake. The primary informants also stated that the children's appetite only began to improve after they received treatment. Conversely, one primary informant stated that their child did not experience a decrease in appetite either before or after treatment; the child consistently showed a high appetite. Meanwhile, another primary informant stated that their child's appetite actually decreased after treatment. However, all primary informants shared the same approach to addressing a child's decreased appetite: they continued to provide nutritional intake through various methods. As stated by a primary informant below:

"Her appetite is better than before treatment. Before treatment, she was a picky eater; her appetite went down. Thank God, after the treatment, she wants to eat more. (Nutritional intake) I replace it with fruit or biscuits; she also likes to snack. I don't force her to eat rice. If she doesn't want it, sometimes I deliberately boil an egg. It's okay if she only eats that; the important thing is that something goes in." (Informant U1)

"For the older one, her eating is just normal; she eats a lot. This one eats a lot, but she doesn't feel like eating. Her appetite also increases (after treatment). I usually just ask (about nutritional intake), what she wants to eat... If they're feeling lazy about rice, I sometimes give them fried potatoes, I boil eggs for them, and with meatballs, they usually eat everything." (Informant U3)

Meanwhile, the results of the interviews with all supporting informants revealed that there was indeed a decrease in appetite when the child was diagnosed with active tuberculosis. Still, the child's appetite gradually improved after receiving treatment. As explained by one of the supporting informants, a village midwife, as follows:

"Yes, it turns out that after getting TB, her appetite dropped, because she hadn't started treatment yet, but now with treatment, her appetite is getting better again." (Informant P1)

Furthermore, based on the results of the in-depth interviews regarding how the primary informants met the child's nutritional needs to support their recovery, the primary informants stated that they tended to increase the child's protein intake. Only one primary informant gave a different answer: to provide food supplements to meet nutritional needs, based on the doctor's advice.

"By increasing the protein, and then also giving fruit and vegetables. Not just plant-based protein, animal-based protein is also increased, and vitamins too, sometimes I give them honey." (Informant U1)

"For me, I give food supplements. The doctor said that even if she doesn't eat, it's okay; the important thing is to take the vitamins in the morning. So I give it to her, just as a replacement, it's okay." (Informant U5)

This statement is supported by the supporting informants' explanation that health workers provide information and education on meeting nutritional needs, specifically by ensuring adequate protein intake. In addition to providing education and information on protein needs, the supporting informants also explained the most common risk factors affecting nutritional intake in children with tuberculosis aged 0–5 years.

"... I motivate them, give them directions on how to manage this patient... their nutritional intake with protein fulfillment, and we usually do counseling. We usually meet them during home visits or at the Posyandu. (Risk factors) From a nutritional standpoint, it is mostly due to parenting styles. So if a child doesn't want to eat, the mother usually gives up. That's usually where undernourishment begins, and then they are automatically more susceptible to disease." (Informant P1)

"Regarding nutrition, it's about counseling on meeting protein needs, especially animal protein, to support growth, development, and treatment... (Risk factors) ... They still primarily rely on vegetables. Parenting styles and knowledge are still lacking. Also, there are still many dietary restrictions..." (Informant P2)

The decrease in appetite is related to the child's body weight. Based on the results of in-depth interviews with the primary informants, it was found that children with tuberculosis aged 0–5 years tended to experience weight loss after being diagnosed with active tuberculosis, and the primary informants realized this when they took the child to the Posyandu. However, one informant reported that their child did not experience weight loss. Regarding the duration of weight loss, the informants tended to report that it occurred within one month. Only one informant stated that the weight loss lasted for more than a month.

"There was a decrease... a drastic decrease. I realized it during the Posyandu visit because her weight was fluctuating drastically. When she was born, she was big. But then she started getting smaller. The drastic decrease was about three kilograms." (Duration) "It's not always consistent, sometimes it goes up this month, down the next, and then down again. It's been consistently going down for two months." (Informant U4)

"For this one, no, at most if she has a fever, it's normal, maybe she loses 2-3 ounces, but then when the fever is gone, it goes up again. The little one hasn't lost any weight; her weight at the Posyandu has always been going up. She only lost weight last month (one month) because of a cough and fever, after that, it's been going up." (Informant U3)

Meanwhile, based on the information obtained through in-depth interviews with the supporting informants, it was known that a decrease in body weight definitely occurs in children with active tuberculosis aged 0–5 years after they are diagnosed.

"It definitely decreases, yes, because one of the scoring criteria is based on body weight, body weight gain... it will usually go up after treatment." (Informant P3)

Nutritional Aspects based on Nutritional Status

Based on the results of in-depth interviews with the primary informants, who are mothers of children with tuberculosis aged 0-5 years, the primary informants tended to state that they did not know what the child's nutritional status was because they had never been educated and informed about it clearly, regardless of whether they regularly attended Posyandu or not.

"What is it? (I don't know). Maybe I've never been educated, probably because [my child's status] is still normal, so they didn't. Also, at the Posyandu, because here they mostly inform mothers of malnourished or stunted children, especially those on the yellow line, so if it's in light green and above, it seems to be considered normal." (Informant U2)

"Yes, this month I did, yesterday was my last Posyandu. I wasn't informed about the nutritional status. Well, at the Posyandu, if it hasn't entered the yellow line, it seems to be considered safe; they don't say anything. If it starts to get yellow, then there will be a detailed plan, and the toddlers will be asked to gather and be given counseling." (Informant U3)

Conversely, the supporting informants, who are village midwives, tended to state that a child's nutritional status is usually communicated to the toddler's mother. All supporting informants also stated that it is certain that there is a decrease in the child's nutritional status from before to after they are infected with tuberculosis.

"Yes, if there's a decrease or an abnormal condition, it's informed. After getting TB, her nutritional status went down because she hadn't started treatment yet." (Informant P1)

"Yes, it's informed. It goes down to the yellow line, some even to BGM (Below the Red Line). Yes, the nutritional status definitely decreases." (Informant P2)

Monitoring nutritional status by health workers was based on results from in-depth interviews with supporting informants. They all stated that the monitoring of children's nutritional status is carried out through Posyandu and home visits with cross-program collaboration.

"I mostly monitor through the Posyandu. Sometimes when we coordinate with cross-programs, here there's a TB program holder, we usually visit the patient's home to monitor their medication, environment, and also their nutrition." (Informant P1)

"Here, because all child TB suspect patients are referred. Mothers of toddlers who regularly come for weighing will always report it, and when they report to the village midwife, it will be forwarded to me. I usually coordinate with the village midwife, and most often, I do a joint visit with a nutritionist to provide nutrition education for children with TB to boost their weight and nutritional status." (Informant P3)

Based on the triangulation performed using nutritional status data for children aged 0-5 years at Puskesmas Sumbang I, the nutritional status of the six toddlers with childhood tuberculosis in Tambaksogra Village and Banteran Village was found to be as follows (Table 5):

Table 5. Nutritional Status in Pediatric Tuberculosis Cases

No.	Code	Confirmation Month (2023)	Nutritional Status Monitoring Month During Treatment	Nutritional Status		
				BW/A	H/A	BW/H
1	U1	March	April	Very Underweight	Very Short	Undernourished
2	U2	January	March	Normal	Normal	Undernourished
3	U3	July	August	Normal	Normal	Good Nutrition
		July	July	Normal	Normal	Good Nutrition
4	U4	April	August	Normal	Normal	Undernourished
5	U5	August	August	Normal	Normal	Good Nutrition

Nutritional aspects based on the history of exclusive breastfeeding

From the results of the in-depth interviews, it was found that the primary informants tended to state that their children were given Exclusive Breastfeeding. However, conversely, two primary informants stated that their children did not receive full breastfeeding during the initial 6-month period because other intake was given, namely, formula milk. As stated by the informants below:

"Exclusive breastfeeding, full breastfeeding for 6 months, no other intervals. She still breastfeeds until she's two." (Informant U2)

"She got it for 6 months. She wasn't eating yet, so it was mostly breast milk, and if I hadn't had time to get to her, but she was really thirsty, it was formula milk. She's still breastfeeding now; she's 19 months old." (Informant U1)

"For that one, no, from birth she was given formula directly because we were separated since I had Covid. But when she came home, I gave her breast milk, but the formula milk continued. How old is her younger sister? One year (received breast milk)." (Informant U3)

All supporting informants also stated that not all mothers can provide Exclusive Breastfeeding; some mothers give formula milk to their children. The supporting informants also explained that there is certainly a relationship between breastfeeding and the child's immune system's resistance to infectious diseases. As stated by one of the supporting informants, the TB Program Officer at the Puskesmas, below:

"Some breastfeed exclusively, some don't. Of course, there's a connection (between babies who receive breast milk and those who don't), because children who get breast milk have better immune systems. They don't get sick easily." (Informant P3)

All informants who were still breastfeeding stated that there were no side effects from OAT (Anti-TB Drugs), and the children still wanted to breastfeed. Informants who were no longer breastfeeding reported that OAT tended not to cause side effects that reduced the child's desire to eat. However, conversely, only one informant stated that there were side effects from the anti-TB drugs that caused the child's stomach acid to rise.

"There are none. With breast milk, they just want to breastfeed all the time." (Informant U4)

"Maybe the side effect of the bitter TB medicine is that it makes their stomach acid rise." (Informant U2)

"The patients I handle rarely have any drug side effects. So far, it doesn't interfere with the child's desire to eat or drink breast milk." (Informant P3)

The primary and supporting informants stated that they provide a combination of foods and give more animal protein, and children under one year old are usually given complementary foods (MPASI).

"A combination, yes. Sometimes we use a team with eggs, broccoli, chicken, a variety of proteins." (Informant U2)

"... For babies under one year old, they are usually also given complementary foods." (Informant P3)

Nutritional aspects based on the history of infectious diseases

The information obtained from all informants indicates that no other infections or recurrences of previous illnesses caused by tuberculosis occurred. Regarding the duration of the child's illness, the primary informants' statements varied. However, this was supported by the supporting informants, who stated that the duration of a child's illness indeed varies depending on their immune system, environment, and nutritional status.

There were differences in the informants' perspectives regarding the severity of the illness. The majority of the primary informants stated that their children were never hospitalized or experienced disruptions to their activities or growth and development during the tuberculosis treatment period. Conversely, two informants stated that their children experienced a severe illness that required hospitalization, which certainly disrupted the children's activities.

"Thank God, no [serious illness]; the child is active. She had a fever, but it didn't last long, maybe two days, and she recovered by taking paracetamol. Thank God she wasn't hospitalized." (Informant U4)

"No, there weren't any [serious illnesses]. She did get scabies, but that was from her sibling, for about a month. She was given ointment, and it cleared up right away. She was sick right after taking the medicine; she had an upset stomach and couldn't sleep for three days. Yes, she was hospitalized for three days." (Informant U2)

"No, there weren't any [serious illnesses]. It's just that they get coughs and colds more often, and a fever. It depends on the child's immunity, environmental conditions, and nutritional status. If there's a smoker and the child is undernourished or poorly nourished, it usually takes longer." (Informant P2)

All informants stated that they maintained the child's hygiene and sanitation (such as washing the child's hands and cleaning eating utensils) to prevent the child from contracting other diseases. This is in line with maintaining overall nutritional and health aspects. As stated by a primary informant below:

"Every time she is about to eat, her eating utensils must be thoroughly washed. If my child has just played outside and it's time to eat, she washes her hands before and after eating." (Informant U1)

"Oh, yes, that's it; hygiene is still number one, still a priority. Washing hands before and after meals, sometimes also before daytime and nighttime sleep." (Informant U5)

DISCUSSION

Based on the in-depth interviews, most of the children with TB aged 0-5 years in this study reported a decrease in appetite after infection. This decline can be caused by increased nutrient utilization in the body or by malabsorption due to an impaired immune system during bacterial infection.[13] Symptoms such as fever and weight loss are also often characteristic of the clinical presentation of TB in children, as found by Vázquez Rosales et al, where 50% of pediatric patients showed fever and 40% experienced weight loss [14].

This decrease in appetite tended to occur before the toddlers received TB treatment. However, their appetite gradually improved after the children received treatment, a finding consistent with previous research showing increases in appetite and body weight after TB therapy [15,16]. Treatment helps improve the body's infectious condition, thereby allowing increased nutritional intake and optimized nutrient utilization.

Parents showed good initiative in addressing their children's decreased appetite, such as replacing rice with other carbohydrate sources (e.g., fried potatoes, biscuits) and increasing protein intake (e.g., eggs, chicken, honey). This approach is relevant, considering that meeting protein needs is crucial in supporting growth, development, and recovery, as emphasized by health workers. Fâcă et al. emphasized that modern pharmacological approaches using polytherapeutic regimens, although effective, significantly affect patients' nutritional status and metabolic pathways [10]. Therefore, personalized nutritional support is highly necessary, as empirical evidence shows that it can improve immune recovery, reduce TB-related morbidity, and increase adherence to therapy.

The relationship between TB and malnutrition is bidirectional and complex. TB can cause malnutrition through anorexia, malabsorption, and increased body metabolism, which leads to weight loss and a weakened immune system. Conversely, malnutrition also increases a person's risk of contracting TB and worsens the disease condition [15–17]. Previous research has shown that the majority of children with TB experience malnutrition, especially at the beginning of treatment [8,18]. Malnutrition can worsen the condition of TB, slow down the healing process, and increase the risk of death [19].

In toddlers infected with TB, weight loss tends to occur due to decreased appetite and the pain they experience. Supporting informants confirmed that weight loss in children with TB aged 0-5 years definitely occurs, given that weight loss is one of the diagnostic scores for TB in children. This is consistent with research by R. P. Sari and Agustin, which reports that higher levels of infection in toddlers can reduce immune function and lead to weight loss [20].

The study by Limenh et al. found that normal nutritional status (AOR = 3.11) was significantly associated with a higher TB treatment success rate [21]. Similarly, Sahile et al. showed that patients who were underweight at the beginning and after two months of treatment had a higher risk for unsuccessful treatment outcomes [22]. This underscores the importance of routine monitoring of nutritional status through Posyandu and home visits, as has been done at Puskesmas Sumbang I. Early intervention and ongoing nutritional counseling have strong potential to enhance the effectiveness of TB management strategies and improve patients' quality of life [17,22].

Although poor nutritional status increases vulnerability, it is important to note that TB can affect children even with good nutritional status if their immune system is compromised [23]. Children with long-term, intense direct contact exposure or who have contact with adult TB patients have a higher risk of infection, and exposure to the bacteria can cause infection and development of the disease even if the child's nutritional status is good. However, this study is not entirely in line with several other studies that found a direct link between nutritional status and the incidence of TB in children, where poor nutrition leads to a decrease in immunity and increases susceptibility to infection [24]. This may indicate the presence of different contextual factors and exposure patterns in the research area.

Increased dietary intake of protein, vitamins, and minerals is very important in TB treatment. Adequate nutrition can help speed up the healing process, boost the immune system, and reduce the risk of complications. Previous studies have shown that providing adequate nutrition, both macronutrients and micronutrients, can improve body mass index and hemoglobin levels and accelerate recovery from TB symptoms [15,25]. Although the importance of nutrition in TB treatment is recognized, the implementation of nutritional interventions often

faces challenges, such as low patient adherence to nutritional counseling, especially in patients who experience symptoms like nausea and vomiting [26].

This study found that the number of infants infected with TB tended to be higher in those who received exclusive breastfeeding compared to those who did not. This may be due to other factors that trigger TB infection in children, such as exposure to cigarette smoke, contact with adult TB patients, and high housing density [27]. In the case of this study, the children who received exclusive breastfeeding still became infected with TB because they were in an environment with closer transmission contact, namely from their own family members. This highlights that although exclusive breastfeeding provides good immunity, intensive exposure remains a dominant risk factor.

After the period of exclusive breastfeeding, the primary informants consistently met the child's nutritional needs by providing Complementary Foods (MPASI) with a combination of foods and by giving more animal protein. This practice is important for supporting the baby's growth and development, preventing nutritional problems, and strengthening the child's immune system to better fight infectious diseases [28].

In children with TB, a history of fever, cough, and runny nose is common, but these symptoms do not last long, and the illness duration varies. According to the supporting informants, this depends on the child's immune system, environment, and nutritional status. This is consistent with a study by Pratama, which reported that children with TB generally experience fever and cough, with the flu resolving within a short time [29]. Nevertheless, two cases required hospitalization due to severe illness, indicating that serious complications can still occur. Severe malnutrition, anemia, and TB meningitis are among the predictors of mortality identified in other studies [19,30,31].

A history of infectious diseases is often associated with poor sanitary conditions, which can lower a person's immune resistance and increase their susceptibility to other infectious diseases [32]. In this study, all informants showed awareness and effort to maintain the child's hygiene and sanitation, such as washing hands and cleaning eating utensils. Practices of Clean and Healthy Living Behavior (PHBS), such as washing hands with Soap (CTPS), are very important for children who are susceptible to infectious diseases [33]. This aligns with the solutions identified by caregivers in Tanzania to address the impact of TB on households, namely transportation assistance and nutritional supplementation [34].

Overall, this study strengthens the evidence that malnutrition and childhood TB mutually worsen each other in a cyclical relationship. Nutritional challenges such as decreased appetite and weight loss are common. Still, proper nutritional interventions, strict nutritional status monitoring, and good caregiver support can significantly improve the prognosis and reduce morbidity in children with TB. Addressing risk factors such as undernutrition and ensuring access

to early diagnosis, appropriate treatment, and comprehensive socio-economic support are key to achieving the elimination of childhood TB.

CONCLUSION

This study confirms that nutritional aspects play a crucial role in childhood tuberculosis (TB) cases in children aged 0-5 years. Children with TB often experience decreased appetite and weight loss, which contribute to the risk of malnutrition or worsen pre-existing nutritional status. The proactive efforts of parents in ensuring adequate nutritional intake, especially by increasing protein consumption, are crucial to supporting the healing process and treatment success.

Regular and systematic monitoring of nutritional status is essential for early detection of nutritional problems. It enables prompt intervention, as normal nutritional status is significantly associated with a higher treatment success rate. Although exclusive breastfeeding has been shown to provide a better immune foundation, close exposure to the environment remains a risk factor for TB infection. Furthermore, good hygiene and sanitation practices play a vital role in preventing secondary infections in vulnerable children with TB. Overall, these findings strengthen the understanding of the complex interaction between malnutrition and TB in children, emphasizing the need for a holistic approach to management.

Based on the study's findings, we recommend several operational steps to improve the management of childhood TB. More intensive and clearer nutritional education for parents is crucial, covering the importance of a balanced protein intake, creative strategies to address appetite loss, and encouraging independent weight monitoring. We also suggest strengthening nutritional status monitoring programs at Puskesmas through Posyandu and home visits to facilitate early detection and timely intervention. To ensure optimal nutritional support, a personalized approach requires collaboration among medical officers, nutritionists, and families. Furthermore, a focus on preventing secondary infections by promoting good hygiene and sanitation at home and in the surrounding environment is essential, given the vulnerability of children with TB. Lastly, we encourage further research with a broader scope and diverse methods to more precisely measure the impact of nutritional interventions and understand the relevant socio-economic factors in the management of childhood TB.

DECLARATIONS

Ethics approval

This study was approved by Ethical approval obtained from the Health Research Ethics Committee of the Faculty of Health Sciences, Jenderal Soedirman University (No: 1272/EC/KEPK/XI/2023).

Conflict of interest

The authors declare no conflict of interest.

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