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THE RELATIONSHIP BETWEEN HAIR ZINC LEVELS, FEEDING PATTERNS, AND INFECTIOUS DISEASES ON THE INCIDENCE OF STUNTING IN CHILDREN AGED 24-59 MONTHS IN THE CITY OF NORTH JAKARTA, PROVINCE OF DKI JAKARTA

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ABSTRACT

Globally, stunting is a severe public health concern, especially in low- and middle-income nations like Indonesia. It is typified by stunted growth and development due to recurrent infections and chronic malnutrition. North Jakarta has a 19.8% stunting incidence, according to the 2023 Indonesian Health Survey. This indicates the critical need for additional research into the factors contributing to stunting, such as hair zinc levels, dietary habits, and infectious infections. This study employs an observational case-control design conducted in North Jakarta in March 2024. Stunting incidence and hair zinc levels are significantly correlated (p=0.000), affecting 87.5% of children with low hair zinc levels. Stunting is also correlated considerably (p=0.000) with incorrect feeding patterns; 75.7% of children who exhibit these patterns are stunted. On the other hand, there was no statistically significant correlation (p=0.806) between the incidence of stunting and a history of infectious illnesses. The mother's level of education, the child's age, gender, and family income did not significantly correlate with stunting.

KEYWORDS *Hair Zinc Levels, Feeding Patterns, Infectious Diseases, Stunting*

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INTRODUCTION

Stunting is a severe problem globally, especially in low- and middle-income nations like Indonesia (Black et al., 2013). Presidential Regulation No. 72 of 2021 states that stunting is a condition in which children have stunted growth and development as a result of repeated illnesses and chronic malnutrition. According to WHO growth standards, stunting is defined as a child's height-for-age (HAZ) being less than -2 standard deviations (SD). This is a general indicator of chronic malnutrition (Bhutta, 2017). This indicates that the child's height is significantly shorter than expected for their age, reflecting chronic malnutrition and inadequate growth during critical periods of development (Leroy & Frongillo, 2019).

A youngster shorter than average for their age is said to be stunted. Stunting in the context of child health may point to more general problems with the social and economic environment, such as poverty, access to quality medical treatment, and dietary deficits (Perumal et al., 2018). Stunting is characterized by a child's stunted growth and development due to inadequate psychosocial stimulation, recurrent infections, and poor nutrition (Scheffler et al., 2020). As previously mentioned, stunting is generally assumed to be caused by malnutrition (Raiten & Bremer, 2020).

Stunting is a condition where a child experiences impaired growth, typically measured by a height lower than the standard for a specific age and gender. Stunting is linked to several health issues in later life and can harm a child's physical and cognitive development (Desmond & Casale, 2017). It is a significant public health concern that necessitates a multi-sectoral strategy for management and prevention, including enhancing access to healthcare services, teaching parents about healthy eating habits, and improving nutrition (De Onis et al., 2019).

Multiple, direct, and indirect variables contribute to stunting. Inadequate food intake and infections are two direct causes of stunting. Indirect reasons include food handling, poor hygiene, and poor caring techniques (Dewi et al., 2021). Stunting has significant impacts on children both in the short and long term. One of the most prevalent and apparent effects is shorter stature in comparison to other kids their age, and sicker kids are more likely to get sick. Both immediate and long-term effects include elevated rates of morbidity and death, stunted brain development impairing learning ability, elevated risk of infectious and non-communicable diseases as an adult, and diminished financial and productive potential (Torizellia et al., 2023).

The first 1,000 days of life are critical for maximizing a child's nutritional requirements to promote optimal growth and development and prevent stunting (Setiyawati et al., 2024). Approximately 149 million (21.9%) children under the age of five were stunted globally in 2018 (Dewi et al., 2021). According to the 2018 Basic Health Research (Riskesdas) statistics, 30.8% of Indonesians were stunted (Kementerian et al. Indonesia, 2019). The Indonesian Health Survey (SKI) statistics from 2023 showed that the country's stunting rate was 21.5%, with the highest rates

occurring in the provinces of DKI Jakarta (17.6%) and North Jakarta (19.8%) (Kementerian et al. Indonesia, 2023).

North Jakarta is a city along the coast, characterized by a hot climate, numerous industrial zones, and capture and aquaculture fishing areas. Coastal areas are places where all kinds of waste accumulate, both liquid and solid waste, carried by water. Trash is often scattered along the beach and is increasingly found near settlements, especially those behind the coastline. Such settlements are categorized as slums, where sanitation facilities and environmental cleanliness are inferior buruk (Pemerintah et al. Jakarta, 2021).

Prioritizing health issues is crucial in enhancing the community's overall quality of life and well-being (Aguirre et al., 2020). Health problems are one of the impacts of declining water quality in the province of DKI Jakarta. Unquestionably, improper waste management has resulted in high bacterial contamination levels, which have raised the prevalence of diseases, especially in youngsters. Children ages 0 to 4 are the most susceptible to illness, and East and North Jakarta have the highest rates of cases (Dinas et al. Jakarta, 2019). Infectious diseases commonly occur in children and are associated with poor environmental sanitation, affecting inadequate food intake.

Besides environmental sanitation, food intake greatly influences the occurrence of stunting, where parents play an essential role in food selection, provision, and interaction, which affects the dietary intake of toddlers (Van der Horst & Sleddens, 2017). Feeding practices include rules used to control the type, amount, and timing of food for toddlers. Studies conducted in Tanjung Pinang indicate a correlation between feeding habits and the prevalence of stunting in children between the ages of one and thirty-six months (Pujiati et al., 2021). Feeding patterns refer to the methods or ways in which food is prepared and consumed. Feeding patterns can affect overall health, including metabolism, body weight, and disease risk (Flanagan et al., 2021). Differences in feeding practices for children can lead to inadequate nutritional needs, affecting the growth and development of toddlers. According to research conducted in the Southwest Aceh District, the frequency of toddler stunting was significantly correlated with proper nutritional intake. This aligns with UNICEF's theoretical framework, which states that inadequate food intake contributes to stunting (Wati & Musnadi, 2022).

Efforts to improve nutrition face macronutrient intake issues and the lack of micronutrients, such as essential minerals, contributing to poor micronutrient status. One such micronutrient is zinc deficiency. Zinc deficiency affects over one-third of the world's population and is frequently linked to hunger (Kristiani & Mahmudiono, 2020). Zinc is essential in enzymatic processes, gene expression, and cell membrane stabilization. A lack of zinc can impair growth, weaken immune function, cause taste dysfunction, and cause loss of appetite (Noftalina et al., 2019). Given the vital role of zinc as a micronutrient that supports growth, zinc deficiency in the body can impact various human organ systems, affect organ function, and cause multiple biochemical changes that result in general metabolic disorders.

Zinc deficiency is when the body or soil lacks zinc, an essential micronutrient for human health and plant growth. Zinc deficiency can cause various health problems, including growth disorders, immune system issues, and complications during pregnancy. Zinc deficiency is a global issue that affects approximately 1.1 billion people worldwide and can lead to various diseases and increase the risk of death, especially among children and pregnant women (Khan et al., 2022). Several studies have linked zinc deficiency with growth problems and stunting (Kristiani & Mahmudiono, 2020). Research conducted in the Tarai region of Nepal shows that zinc deficiency impacts children's stunting (Bevis et al., 2023).

Several studies have mentioned that a reliable and accurate method to assess zinc status is to use serum plasma zinc levels, followed by zinc levels in hair, and 24-hour urinary zinc excretion as potential biomarkers (Kristiani & Mahmudiono, 2020). The amount of zinc present in hair follicles throughout a prior period is reflected in the zinc content of hair (Jaryum et al., 2018). This is consistent with previous research using this method to assess zinc status in children aged 6-9, indicating that hair zinc concentration remains constant and shows zinc accumulation over 2-3 months (Kristiani & Mahmudiono, 2020). Hair zinc analysis more accurately represents chronic past zinc levels, making it suitable for measuring zinc levels in stunting, a long-term malnutrition condition.

Research on hair zinc levels, feeding patterns, and infectious diseases has not yet been explored. It is possible to utilize hair sampling as a marker to evaluate the nutritional health of toddlers between the ages of 24 and 59 months because it is a reasonably short, non-invasive, and simple procedure. Drawing on the description above, the researchers hope to design a study that examines the correlation between hair zinc levels, dietary habits, and infectious diseases, and the prevalence of stunting in children in North Jakarta between the ages of 24-59 months. The results of this study will likely assist in addressing nutritional problems and lowering the stunting rate, enabling more suitable intervention approaches.

RESEARCH METHOD

This research uses a case-control methodology and is an observational analytical study. Comparing the case and control groups is how a case-control study is carried out. This study starts by classifying individuals with the condition (cases) and those who do not have the disease (controls). Next, it looks backward to see if risk factors connected to stunting development are present or absent.

North Jakarta was the location of this study's conduct. With a rate of 19.8%, North Jakarta has the highest rate in the DKI Jakarta Province, according to data from the Indonesian Health Survey (SKI) in 2023 (Kementerian et al. Indonesia, 2023). North Jakarta is an integrated industrial area producing various goods with national and foreign investment companies. This area was chosen as the research site because it is a locus of stunting and is located near industrial areas (Badan et al., 2023). Data was

collected for approximately one month, in March 2024, after obtaining ethical approval and research permits.

Children who matched the inclusion criteria and were stunted and between the ages of 24 and 59 months served as the study's subjects. On the other hand, the control subjects were stunt-free, 24-59-month-old children who satisfied the control requirements. The Lameshow formula was used to calculate the study's sample size. Using this formula, calculations yielded a P1 value of 0.49 and a P2 value of 0.14 by modifying the findings of earlier studies (Rani et al., 2017). Overall, there were 41 responders in both the case and control groups. An extra 10% of subjects were included to account for potential dropouts, making each group consisting of 45 respondents with a 1:1 case-control ratio, for a total of 90 respondents in this study. Based on the child's age and gender, subjects in the case and control groups were matched.

This study employed both bivariate and multivariate data analysis. Bivariate analysis aims to study the link between independent (free) and dependent (bound) variables. The incidence of stunting is the dependent variable in this study, while the independent factors are hair zinc levels, dietary habits, and infectious illnesses. The chi-square test, with a 95% confidence interval (CI) and a significance level of $p<0.05$, is the statistical test employed. If the p-value is less than 0.05, the hypothesis is accepted. In the meantime, multivariate analysis is utilized to investigate the link between several independent variables and one dependent variable to ascertain which independent variable has the most significant impact on the dependent variable. The multivariate analysis used is multiple logistic regression to analyze the causes of a particular case, stunting.

RESULT AND DISCUSSION

The Relationship Between Hair Zinc Levels and the Incidence of Stunting

Table 1. The Relationship Between Hair Zinc Levels and the Incidence of Stunting

Variables	Stunting		Normal		Total		Value
	n	%	n	%	n	%	P
Hair Zinc Levels							
Low	21	87.5	3	12.5	24	100	0.000
Adequate	20	34.5	38	65.5	58	100	

The chi-square test findings are displayed in Table 1 and show a p-value < 0.05, which suggests a significant correlation between hair zinc levels and the occurrence of stunting in children in the Cilincing district of North Jakarta between the ages of 24-59 months. A p-value of 0.000 provides more evidence in favor of this. The study's findings show that 87.5% of kids with inadequate zinc levels in their hair are stunted.

In the selected study area, hair samples of approximately 0.5–1 gram were taken from the occipital region of the head or the hair closest to the scalp. The hair sampling

process in this study began with sterilizing the instruments before use, and this was repeated with each new respondent. The required hair section was cut using stainless steel scissors, placed in a plastic bag, and stored at room temperature before being sent to the laboratory. A common challenge encountered during sample collection was the limited amount of hair, especially in stunted children, which often required researchers to return to respondents for additional sampling later.

Hair zinc concentration is a suggested indicator for long-term zinc status because the amount of zinc in the hair shaft corresponds to the amount of zinc that hair follicles had access to during the previous time. The scientific literature frequently notes the strong correlation between hair zinc levels and functional outcomes of zinc status, including appetite, taste sensitivity, linear growth impairment, weight gain, and dietary zinc index. Hair zinc readings in babies and young children of less than 70 μg/g (1.07 μmol/g) in spring or summer and less than 110 μg/g (1.68 μmol/g) in winter have been connected to clinical indications of zinc insufficiency (Gibson, 2024).

Studies on animals and experiments involving human intervention have successfully shown that zinc deficiency can impede growth processes. A recent pooled study analyzed the outcomes of over thirty community intervention trials conducted globally to determine the effect of zinc supplementation on total growth response. Zinc supplementation did not affect the weight-for-height index (W/H), according to the meta-analysis results, which instead highlighted zinc's function in linear growth. As a result, one of the best anthropometric indicators for tracking the possibility of zinc deficiency is the stunting rate (H/A) (Gibson, 2024).

There are benefits and drawbacks to using hair zinc levels as a gauge of zinc status. Zinc levels in hair are more stable than in serum and are not impacted by dietary patterns, extended fasting, daily fluctuations, or acute illnesses. Compared to blood collection, hair sampling is less intrusive and frequently more acceptable in groups where blood collection may not be culturally acceptable, particularly in youngsters.

The Relationship between Feeding Practices and the Incidence of Stunting

Table 2. The Relationship between Feeding Practices and the Incidence of Stunting

Variable	Stunting		Normal		Total		Value
	n	%	n	%	n	%	P
Feeding Practices							
Inappropriate	28	75,7	9	24,3	37	100	0,000[a]
Appropriate	13	28,9	32	71,1	45	100	

With a p-value of 0.000 ($p < 0.05$), Table 2 demonstrates a strong correlation between feeding habits and the frequency of stunting in toddlers in the Cilincing subdistrict of North Jakarta. The Child Eating Questionnaire (CFQ) evaluates eating

patterns, such as meal frequency, type, and quantity. In this study, 75.7% of improper feeding practices were observed in mothers with stunted toddlers.

The data from this study indicates that children with improper feeding practices tend to have less varied diets, repetitive food choices, unbalanced meal quantities and frequencies, and no established meal schedule. Most mothers in the area are homemakers, yet many still feed their children only when they request food, resulting in irregular and unscheduled meal times.

Additionally, the lack of food variety is a concern, as some children prefer only certain foods, and many parents do not introduce a wide range of foods during the initial complementary feeding stage (MPASI). Most toddlers in this study preferred snacks such as ice cream, chips, traditional snacks, and donuts over main meals. Consequently, when it is time for their main meals, they often feel full and are unwilling to eat. Over the years, improper feeding practices have led to unbalanced nutrition and impacted the toddlers' health.

Past research conducted in Tanjungpinang has demonstrated a strong link between toddler stunting and feeding practices. Another study conducted in Bandung showed that toddler stunting incidence was significantly correlated with feeding habits. Adequate feeding techniques benefit the amount, kind, and quality of nutrients consumed, affecting toddlers' nutritional status.

The Relationship between Infection History and the Incidence of Stunting

Table 3. The Relationship between Infection History and the Incidence of Stunting

Variable	Stunting		Normal		Total		Value
	n	%	n	%	n	%	p
History of Infection							
Infection Present	29	49,2	30	50,8	59	100	0,806
No Infection	12	52,2	11	47,8	23	100	

Table 3 demonstrates no statistically significant correlation ($p > 0.05$) between the incidence of stunting among toddlers in the Puskesmas Cilincing service region and infectious illnesses. This result is consistent with studies in Bantul Regency, which revealed no evidence of a link between infectious illnesses and child stunting. Similarly, a study conducted in Bangladesh found no evidence of a link between the prevalence of child stunting and infectious infections.

However, infectious diseases can lead to reduced nutritional status, causing decreased appetite and impaired absorption in the digestive tract. Consequently, frequent infectious diseases can result in suboptimal growth, posing a risk of stunting. Essential findings from other research have demonstrated the connection between the prevalence of stunting and a history of infectious infections.

The fact that this study only looked at infections that occurred within the previous month could be why no discernible link was found between infectious disorders and stunting. Some toddlers may have experienced infections that affected their growth and development in previous periods. Easy access to healthcare facilities may also be an alternative for quick intervention in case of infections in children, preventing growth impairment. Despite the relatively high incidence of infectious diseases in this study, one factor that can lessen the severity of infectious diseases in toddlers and lower their risk of malnutrition, including stunting, is the ease of access to healthcare facilities.

The Relationship between Confounding Variables and the Incidence of Stunting

Table 4. The Relationship between Confounding Variables and the Incidence of Stunting

Variable	Stunting		Normal		Total		Value
	n	%	n	%	n	%	P
Toddler Age (months)							
24-36	12	40,0	18	60,0	30	100	0,259[a]
37-48	15	62,5	9	37,5	24	100	
49-59	14	50,0	14	50,0	28	100	
Gender							
Male	21	52,5	19	47,5	40	100	0,659[a]
Female	20	47,6	22	52,4	42	100	
Mother's Education Level							
Low	21	56,8	16	43,2	37	100	0,267[a]
High	20	44,4	25	55,6	45	100	
Family Income							
Low	16	57,1	12	42,9	28	100	0,241[a]
Middle	16	55,2	13	44,8	29	100	
High	9	36,0	16	64,0	25	100	
History of Breastfeeding							
Non-exclusive	24	66,7	12	33,3	36	100	0,008[a]
Exclusive	17	37,0	29	63,0	46	100	
Environmental Sanitation							
Poor	2	50,0	2	50,0	4	100	1,000[b]
Good	39	50,0	39	50,0	78	100	

With a value of 0.267 (p = 0.05), Table 4 demonstrates no significant correlation between the mother's educational attainment and the frequency of stunting in toddlers

in the Cilincing District. This result aligns with earlier studies in Sukamulya Village, which demonstrated no meaningful relationship between the incidence of stunting and the mother's educational attainment.

Their education might influence the way someone takes in and interprets information. Educating people about community health is one strategy to increase public awareness. The average degree of education held by the mothers in this survey was higher than that of junior high school. Health education provided by health cadres and professionals can include counseling using leaflets and visual videos so that mothers can make informed decisions to improve their toddlers' nutritional intake and health.

The family income variable, with a value of 0.241 ($p > 0.05$), does not significantly correlate with the frequency of stunting in the Cilincing District. This result is consistent with earlier studies carried out in Pidie Regency, which found no link between household income and the prevalence of stunting. Another study that corroborated this result was conducted in Aceh and found no connection between socioeconomic position and the prevalence of toddler stunting.

Toddlers' nutritional condition is not directly impacted by income, but it can impact how food is distributed because parental income can be used to pay for necessary food purchases. In this study, the majority of families were in the middle-income category. Interviews showed that many families did not prioritize buying balanced food ingredients even when they had enough money. This study illustrates that income does not always correlate with nutritional adequacy. This is because nutritional knowledge plays a more crucial role than income; if income is low but the mother has good nutritional knowledge, she is more likely to purchase food ingredients that meet nutritional needs and provide them to the child.

Table 4 presents the analysis results. The p-value of 0.008 indicates a significant correlation between the frequency of stunting in children aged 24-59 months in the Cilincing Health Center operating area and the history of exclusive breastfeeding. Conversations with participants disclosed that infants who were not exclusively breastfed did not receive it because the mother's breast milk did not flow, causing the mother to give formula and carry on nursing after her milk production began. Some parents still believe that every time a baby cries, it is due to hunger and will give food such as porridge, plain water, and other items to children under six months.

With a p-value of 1.000 ($p > 0.05$), the Environmental Sanitation analysis results do not indicate a significant correlation with the frequency of stunting in the Cilincing District. Environmental sanitation is a branch of environmental health that focuses on achieving a certain level of health for residents. It includes having access to clean water sources, using potable water that complies with regulations, maintaining healthy family restrooms, managing household waste, and having standards-compliant wastewater disposal facilities.

In the Cilincing District study, most communities use clean water sources such as PAM/piped water. The water source in the area is considered safe because it is accessible and delivered to homes. The physical quality of the water is good,

characterized by being colorless, clear, and odorless. The use of drinking water is assessed based on the source and through interviews with respondents to gather information on how they process and store the drinking water they consume.

Qonita et al.'s research in Palem Village indicates no meaningful correlation between the nutritional health of children under two years old and clean water sources. Water is an essential component of life, especially health. Water can also be used as a means of subsistence and growth in various contexts, including daily living, trade, cattle, and agriculture. Thus, water source conditions and sanitation impact food security and health, which are crucial in combating hunger and malnutrition. One of the indirect causes of nutritional issues in children at risk of malnutrition and stunting is the use of water from inappropriate sources. Participants in this study were families with young children who drank reusable water that complied with health regulations. However, on average, they do not boil the water before consumption or store it in closed containers.

The Relationship between Dietary Intake and Stunting

Table 5. The Relationship between Dietary Intake and Stunting

Variable	Stunting		Normal		Total		Value
	n	%	n	%	n	%	P
Energy Intake							
Insufficient	28	63,6	16	36,4	44	100	0,008
Sufficient	13	34,2	25	65,8	38	100	
Protein Intake							
Insufficient	30	76,9	9	23,1	39	100	0,000
Sufficient	11	25,6	32	74,7	43	100	
Zinc Intake							
Insufficient	31	72,1	12	27,9	43	100	0,000
Sufficient	10	25,6	29	74,4	39	100	
Diet Pattern 1							
Low	17	63,0	10	37,0	27	100	0,163
Medium	14	50,0	14	50,0	28	100	
High	10	37,0	17	63,0	27	100	
Diet Pattern 2							
Low	9	33,3	18	66,7	27	100	0,070
Medium	18	64,3	10	35,7	28	100	
High	14	51,9	13	48,1	27	100	

With a p-value of 0.008 (p<0.05), Table 5 demonstrates a strong correlation between energy intake and stunting in children in the Cilincing sub-district of North Jakarta, aged 24-59 months. In this study, the energy intake of stunted children was 63.6% lower than that of normal children.

Stunted children's low-calorie intake can be attributed to various causes, such as low energy density, poor appetite, low frequency and quantity of feedings, and concomitant viral disorders. One of the reasons for nutritional issues can be an energy imbalance brought on by an inadequate energy intake. Stunting is a condition that occurs over a long period. Studies have shown that the causes of stunting include prolonged energy and protein deficiency. Low energy consumption in children affects brain development and delays growth and cognitive development. Energy intake is obtained from foods rich in macronutrients: carbohydrates, proteins, and fats. Energy supports metabolic processes, growth, and physical activity.

With a p-value of 0.000 (p<0.05), Table 5 demonstrates a significant correlation between protein intake and stunting in children in the Cilincing sub-district of North Jakarta, aged 24-59 months. 76.9% of the stunted children in this study consumed less protein than the average children. Furthermore, the table shows a strong correlation (p-value of 0.000; p<0.05) between zinc consumption and stunting in children in the Cilincing sub-district of North Jakarta, aged 24-59 months. 72.1% of the children in this study who consumed inadequate amounts of zinc were stunted. This could be the result of not eating enough foods high in zinc. Poultry, cereals, nuts, shellfish, and dairy products are high in zinc (Purwandini & Atmaka, 2023).

Multivariate Logistic Regression Analysis

Table 6. Multivariate Logistic Regression Analysis

Variable	Model 1[a]			Model 2[b]		
	OR	**95% CI**	**P**	**OR**	**95% CI**	**P**
Hair Zinc Levels						
Low	1	1		1	1	
Adequate	15.916	3.640 – 69.594	0.000	30.373	3.395 – 271.706	0.002
Feeding Patterns						
Inappropriate	1	1		1	1	
Appropriate	9.360	2.873 – 30.497	0.000	9.373	1.858 – 47.279	0.007
History of Infectious Diseases						
With infection	1	1		1	1	
Without infection	0.853	0.308 – 4.458	0.815	0.692	0.134 – 3.565	0.660

The multivariate analysis in this study used multiple logistic regression tests with a risk factor model due to the presence of confounding variables. Variables in the multivariate test must have a p-value of less than 0.25. The analysis in this study looked at the link between the dependent variable and several independent variables. Tests of logistic regression were employed in the analysis. The final model corrected for confounding variables (child age, gender, educational attainment, family income, dietary intake, history of exclusive breastfeeding, and environmental sanitation) and produced adjusted odds ratios to show the impact of independent variables (hair zinc levels, feeding patterns, and history of infectious diseases) on the dependent variable (stunting).

With p-values of 0.002 and 0.007, respectively, Table 6 demonstrates that the variables of children's dietary habits and hair zinc levels were substantially correlated with stunting. An analysis of hair zinc levels without controlling for confounding variables revealed an OR value of 15.916, indicating a 15-fold increased risk of stunting in patients with low hair zinc levels compared to those with greater levels. After correcting confounding variables, the OR for hair zinc levels was found to be 30.373, meaning individuals with low levels were thirty times more likely to suffer from stunting. Because the amount of zinc in hair strands reflects the amount of zinc available in hair follicles over a previous period, zinc concentration in hair is a valuable tool for evaluating long-term zinc status. This study on hair zinc levels proves that zinc deficiency can hinder growth.

A strong correlation was found between the occurrence of stunting and children's feeding patterns. An OR value of 9.360 was observed in the findings examined without confounding variable adjustment, while 9.373 was found in the results tested with confounding variable adjustment. This indicates that the likelihood of stunting was nine times higher in those with inappropriate feeding patterns than in those with appropriate feeding patterns. Improper feeding patterns, such as irregular amounts, types, and timing of meals, can negatively impact children's health by affecting their food intake's adequacy, quality, and quantity, potentially influencing their nutritional status.

CONCLUSION

According to the data shown above, in the Cilincing District, North Jakarta City, and DKI Jakarta Province, there is a correlation between the incidence of stunting and hair zinc levels. Additionally, there is a connection between the prevalence of stunting and feeding habits in DKI Jakarta Province's Cilincing District and North Jakarta City. Nonetheless, in Cilincing District, North Jakarta City, DKI Jakarta Province, there is no correlation between the prevalence of stunting and the history of infectious diseases. In the meantime, in Cilincing District, North Jakarta City, DKI Jakarta Province, there is a confounding variable association between the incidence of stunting and (energy intake, protein, and zinc, and exclusive breastfeeding). However, there is no correlation between the frequency of stunting in Cilincing District, North Jakarta City, DKI Jakarta

Province, and confounding variables such as income, environmental cleanliness, mother education, gender, and child age. The results of the multivariate logistic regression analysis indicate that children's dietary habits and hair zinc levels are the main factors determining the occurrence of stunting.

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