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FREQUENCY OF SEAFOOD CONSUMPTION AND LEAD (Pb) EXPOSURE TO STUNTING IN CHILDREN 24-59 MONTHS AGE IN CILINCING DISTRICT, DKI JAKARTA

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ABSTRACT

Background*: Pollution in Jakarta Bay is already very worrying both physical, chemical, and biological pollution. In addition to pollution that causes an increase in biological/chemical oxygen demand (BOD/COD) and a decrease in dissolved oxygen (DO), there is also chemical pollution in these waters that is quite dangerous, namely heavy metals. Lead exposure is associated with a variety of neurodevelopmental deficits in children. Children who experience food contamination and are exposed to environmental contaminants, such as metals may be particularly susceptible to neurodevelopmental delays or disorders caused by problems in brain development and other negative health impacts.*
Objectives*: This study aims to analyze the relationship between the frequency of seafood consumption and heavy metal exposure on the incidence of stunting in children aged 24-59 months in Cilincing District, DKI Jakarta.*
Methods*: The method used is a retrospective study with a sample of 60 children who meet the inclusion criteria.*
Results*: The results showed a significant association between the frequency of seafood consumption and the incidence of stunting, with a p-value of 0,001. Children who frequently consume lead-contaminated seafood have a higher risk of stunting compared to children who rarely consume seafood. In addition, urinary lead levels were also associated with stunting with a p-value of 0,005. Children with urine lead levels above the median value were more likely to be stunted.*
Conclusion*: The conclusion of this study is that the low frequency of consumption of lead-contaminated seafood and high levels of lead in children's urine contribute to the incidence of stunting in children in the study area.*

Keywords *: lead (pb) exposure; seafood consumption; stunting*

INTRODUCTION

The 1000 HPK period can also be called the golden period, namely during the fetal period starting from the beginning of pregnancy until the child is two years old. At this time, fulfilling nutritional intake is essential because at this age there is a development and growth occurred rapidly (Guardone et al., 2020). Malnutrition during this period lead to malnutrition which risks permanent disruption to children's development and growth, one of which is stunting (Govzman et al., 2021).

Stunting is a chronic condition that describes growth retardation caused by prolonged malnutrition. According to WHO, the standard for stunting growth in children is based on the body length index for age (PB/U) or height for age (TB/U) with a limit (z-score) below -2 SD. Developmental delays in childhood are a risk factor for increased mortality, impaired cognitive abilities and motor development, and physical imbalance. Growth retardation in early childhood requires special attention because it can hinder the child's physical and mental development (Hu & Chan, 2021). The deformity is associated with an increased risk of morbidity and mortality, and slowed growth in motor and mental capacities. Short stature is associated with an increased risk of obesity because even short people have a low ideal body weight. A weight gain of several kilograms can cause a person's body mass index to rise above the normal limit. Long-term overweight and obesity increase the risk of degenerative diseases (Soviyati et al., 2021).

Height is a type of anthropometric examination and shows a person's nutritional status. The presence of stunting indicates poor nutritional status (malnutrition) over a long period of time (chronic). The problem of malnutrition in Indonesia is a health problem that the government has not been able to fully overcome (Han et al., 2022). This can be seen from survey data such as the 2023

Indonesian Health Survey (SKI) which states that the prevalence of stunting in Indonesia is 15.8%, the 2018 Basic Health Research (RISKESDAS) 19.3%, 2013 (19.2%) and 2007 (18%).

From the results of the Indonesian Nutritional Status Study (SSGI) carried out in 2022, the prevalence of stunting in Indonesia is 21.6%, while in DKI Jakarta Province it is 14.8%. This figure has decreased significantly compared to the prevalence of stunting in DKI Jakarta Province in 2021, i.e 16.8%. Percentage of Thousand Islands City (20.5%), North Jakarta City (18.5%), West Jakarta City (15.2%), East Jakarta City (14.4%), Central Jakarta City (14.0%), South Jakarta City (11.9%).

Factors that contribute to a child's growth are the health status and nutritional intake of the mother during pregnancy, the practice of feeding children, socio-cultural infectious diseases and the condition of the living environment (Murali et al., 2021). Undernutrition and inadequate nutrients intake of pregnant woman will increase the risk of developmental disorders in the fetus, low birth weight, impaired growth so that children are at risk of stunting and are susceptible to disease (Elfrida E, 2015). The causative factor for infectious diseases is poor environmental hygiene and sanitation practices, so there is a risk of transmitting them to people living in that environment. Poor environmental hygiene and sanitation can cause inflammatory disorders of the small intestine which reduces the absorption of nutrients and increases the ability to which is usually also called environmental enteropatly (EE) where there is a change in energy that should be used for growth but is ultimately used to fight infection in the body (Mia et al., 2021). Children who those who have poor sanitation have a 4.6 times higher risk of stunting compared to those who have clean and proper sanitation (Ralston et al., 2024).

Environmental sanitation factors show a correlation with the incidence of stunting in Indonesia. Children from households with unhealthy latrines and untreated drinking water are also at higher risk. Heavy metals are one of the substances that can cause pollution in drinking water. We often hear that pollution in Jakarta Bay is very serious. worrying about both physical, chemical and biological pollution. The high level of water pollution in the Ciliwung River which empties into Jakarta Bay is caused by domestic waste pollution which causes high concentrations of BOD, aminias, phosphates, detergents and coli bacteria. In addition to the pollution which causes the increase the need for biological/chemical oxygen (BOD/COD) and the decline in dissolved oxygen (DO), in these waters there is also quite dangerous chemical pollution, namely heavy metals. However, there is further study of the contribution of toxic environmental exposures including lead. Lead exposure is associated with a variety of neurodevelopmental deficits in children. Children who experience food contamination and are exposed to environmental contaminants, such as metals may be particularly susceptible to neurodevelopmental delays or disorders caused by problems in brain development and other negative health impacts. One common indicator of a nutritional deficit is stunted growth, which occurs when a child's height (or length) for a given age is below the 5th percentile (Beal et al., 2018).

Many studies have demonstrated an inverse correlation between blood lead concentrations and children's height (Anticona & San Sebastian, 2014; Gleason et al., 2016; Raihan et al., 2018), postulating that lead causes decreased gonadotropin secretion, and abnormalities in the growth hormone axis may contribute to adverse neurodevelopment. Children with compromised nutritional status may absorb more metals into their bodies compared with children with adequate nutritional intake, leading to greater reductions in neurodevelopment. Additionally, lead and malnutrition affect neuronal metabolism (Butts et al., 2020). The combination can cause a greater reduction in neurological development. Indicators of exposure to heavy metals are not only measured by measuring Pb in blood, but biomarkers in children as indicators of metal exposure can use urine biomonitoring because they have a strong relationship with blood levels which is the route final elimination (Kim et al., 2020; Klotz & Göen, 2017; Yabe et al., 2018).

This research was conducted in the North Jakarta City area, one of the cities in the DKI Jakarta Province. The city of North Jakarta consists of 6 districts with 31 sub-districts. Cilincing District is one of the districts located in North Jakarta City. Apart from that, Cilincing District is the sub-district with the largest number of sub-districts in North Jakarta, namely 7 sub-districts. Based on the 2022 Central Statistics Agency, Cilincing District has a population of 453,027 people consisting of 229,062 men and 223,965 women. In this sub-district there is an industrial bonded area with various companies, both national and foreign investment companies. Which is a coastal area of the DKI Jakarta Province with many various types of industry. By-products produced from industrial processes include liquid waste. This liquid waste is generally produced from the textile, paint, plastic, paper, food, chemical, oil and metal coating industrial activities (Liu et al., 2020). The presence of these metal ions in waters is persistent, toxic to living organisms and the environment, and cannot be decomposed. Naturally

(Partelow et al., 2023). This dangerous substance enters fresh water resources through careless disposal of waste, which contains lead ions and comes from mining, nuclear power plants, chemical industries, and factories that produce plastic, paint, and batteries.

Biomagnification of lead (Pb) begins when water flows contaminated with the heavy metal lead originating from human activities enter coastal and marine ecosystems (Rattikansukha et al., 2021). Some dissolve in water, some settle to the seabed and concentrate in sediment, and others enter the in the tissues of marine organisms (including phytoplankton, fish, shrimp, shellfish, squid, seaweed and others). Then, pollutants that enter the water are absorbed directly by phytoplankton. Then the phytoplankton are eaten by zooplankton. The concentration of pollutants in zooplankton bodies is higher than in phytoplankton bodies because zooplankton prey on as many phytoplankton as possible. Phytoplankton and zooplankton are then eaten by planktivorous fish (plankton eaters) as a second level trophic (Bechard & Lang, 2023). Shellfish also contain high levels of heavy metals because they eat by filtering the water that enters their gills all the time and the phytoplankton is also swallowed. If these pollutants are in the body tissues of marine organisms in high concentrations, then they are used as food ingredients and will be dangerous for human health (Rolfe et al., 2022).

The respondent in this study were children aged 24-59 months, which is an age vulnerable to exposure to heavy metals such as Pb. Apart from that, children aged 24-59 months are still growing and are at risk of experiencing health problems if they do not receive good parenting. The stunting rate in the North Jakarta City area is 18.5%, so it is necessary to carry out retrospective research to find out whether lead exposure in children is a risk factor for stunting in children aged 24-59 months in this area. This study aims to analyze the relationship between frequency of seafood consumption, environmental sanitation and metal exposure in influencing the incidence of stunting in children aged 24-59 months in Cilincing District.

METHODS

This research uses an analytic study with a case control research design. This research design is a study that compares case groups (mothers who have children with stunted nutritional status) and control groups (mothers who have children with non-stunted nutritional status) aged 24-59 months. Consecutive sampling was used as a sampling technique. The allocation of samples was achieved through the proportional allocation method, a technique that allocates samples proportionally to the size of each stratum.

Anthropometric data was obtained by measuring the height or length of the child by the researcher using a stadiometer. Seafood consumption frequency data was measured by directly asking the toddler's mother or caregiver by asking the child's eating habits for the last 2 weeks. Specific seafood asked were green mussels, tofu mussels, blood mussels, king crab, mantis shrimp or ronggeng shrimp, jerbung shrimp, black pomfret, mackerel, petek fish, squid, and cuttlefish. Urine samples were collected in the morning after the toddlers woke up from sleep as much as 200 ml. Sterile urine collection bags were attached using adhesive after cleaning the area around the child's vital organs to reduce the risk of bacterial contamination of the skin. Analysis of urine samples using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) was conducted by analysts at Saraswanti Indo Genetech Laboratory. Environmental sanitation data were obtained from researcher observations and interviews through a questionnaire consisting of 17 questions measured by assessing clean water source facilities, drinking water use, family latrine facilities, management of toddler diapers, sewerage (SPAL) and household waste management facilities, scores ≥75% are considered good and scores <75% are considered poor.

The study was conducted in March-April 2024. The DKI Jakarta Provincial Health Office, the North Jakarta City Health Office and the Cilincing District Health Center approved the study protocol and was granted ethical clearance by the Health Research Ethics Commission (KEPK) Faculty of Medicine Universitas Sebelas Maret, bearing the reference number: 56/UN27.06.11/KEP/EC/2024. Bivariate analysis using the SPSS Statistics version 27 program to analyze the relationship between the frequency of seafood consumption and heavy metal exposure on the incidence of stunting in children aged 24-59 months in Cilincing District.

RESULT

Description of Research Subject Characteristics

Of the total respondents of 64 children aged 24-59 months registered for the screening phase of the study, only 60 children aged 24-59 months were able to participate in the study until the end.

Table 1. Distribution of Subjects Based on Characteristics

Variable	Stunting	Normal
	Mean ± SD	
Children		
Age (months)	43,30 ± 9,61	42,80 ± 10,26
Height (cm)	88,58 ± 5,70	96,95 ± 6,53
Weight (kg)	11,64 ± 2,86	14,02 ± 2,97
Z-score (SD)	-2,76 ± 0,56	-0,65 ± 0,91
Mother		
Age (years)	33,53 ± 8,44	34,23 ± 8,37

In the table above, it can be seen that all the characteristics show that children under five with stunting have a lower average value compared to children under five with normal nutritional status. The results showed the distribution of subject characteristics based on stunting and normal conditions which can be seen in Table 1, it can be seen that all characteristics show stunted toddlers have lower mean values compared to toddlers with normal nutritional status. The average age of children in the stunting group was 43 months old, while in the normal group the average was 42 months. In terms of height, children with stunting had an average height of 88,58 cm while normal children had a higher average height of 96,95 cm. The stunted children had an average weight of 11,64 kg compared to 14,02 kg in the normal group. The TB/U Z-score index also showed significant differences, with the stunted group having an average Z-score of -2,76 SD while the normal group was -0,65 SD. Maternal age also showed no significant difference, with a mean of 33,53 years for mothers of stunted children and 34,23 years for mothers of normal children. Overall, the data showed significant differences in anthropometric characteristics between stunted and normal children.

Variable	Stunting			Normal			P Value
	Value	n	%	Value	n	%	
Childrens Urine Lead Levels (mg/dL)	0,16 (0,09-0,99)			0,12 (0,03-0,20)			0,000
< Median (0,1843)		16	53,3		26	86,7	0,005
≥ Median (0,1843)		14	46,7		4	13,3	
Frequency of Seafood Consumption (gram/day)	19,09±4,69*			14,68±2,59*			0,000
Rarely (<mean 16,89)		9	30		23	76,7	0,001
Frequently (≥mean 16,89)		21	70		7	23,3	
Environmental Sanitation	35,00 (27,00-39,00)			36,00 (27,00-39,00)			0,450
Not enough		2	6,7		1	3,3	0,554
Good		28	93,3		29	96,7	

Urine lead levels in the stunting case group tended to be higher than urine lead levels in the control (normal) group. The average urinary lead level in the case group (stunting) was 0,16 mg/dL. A significant relationship was found between the frequency of seafood consumption and the incidence of stunting in the Cilincing District area as shown by the p value = 0,000. The results of the association test between children's urine lead levels and the incidence of stunting from 30 children who were stunted, 16 children (53,3%) had urine lead levels lower than the median (0,1843 mg/dL), while 14 children (46,7%) had lead levels higher or equal to the median. In contrast, in the normal children group, 26 children (86.7%) had lead levels lower than the median, while only 4 children (13,3%) had lead levels higher than the median. The results of the analysis showed a significant association between urinary lead levels and the incidence of stunting, with a p value = 0,005 which means that the higher

the urinary lead level, the more likely the child is to be stunted.

Among children who rarely ate seafood, 9 children (30%) were stunted, while 23 children (76,7%) were in the normal category. In contrast, among children who frequently consumed seafood, 21 children (70%) were stunted, while only 7 children (23,3%) had normal nutritional status. There is a significant relationship between the frequency of seafood consumption and the incidence of stunting in the Cilincing District area as indicated by a p value = 0,001. From the several types of seafood mentioned by respondents, it can be concluded that the types of fish that are most popular with the people in this research are mackerel, shrimp and squid.

The results of the assessment of environmental sanitation in the stunting group, the average environmental sanitation value was 35,00 with a range of values between 27,00 and 39,00. Most of the 28 respondents or 93,3% of the environmental sanitation conditions were in the good category, while only 2 respondents or 6,7% were in the poor sanitation category. In the normal children group, the average environmental sanitation score increased slightly to 36,00 with a fixed range of values between 27.00 and 39,00. In this group 29 respondents or 96,7% fell into the good category, while only 1 respondent or 3,3% had poor sanitation. There is no relationship between environmental sanitation and the incidence of stunting in the Cilincing District area as indicated by a p value = 0,554.

DISCUSSIONS

The relationship between lead in the urine of stunted toddlers in Cilincing District is in line with research conducted by Kim, Jin Hee, et al with results showing that the lead and mercury content of urine in toddlers was exposed to above human biomonitoring standards I and II, without looking at the levels in other biological samples like blood. Exposure to lead in urine can be an indicator that other body tissues or organs have been exposed to lead. Lead in urine is the result of body excretion due to lead exposure. Exposure to lead accumulates in bone tissue, kidneys and other body organs. Exposure to lead in influencing stunting in toddlers aged 2 years in Bangladesh shows an increase in blood lead levels as a predictor of stunting and underweight in toddlers but not wasting. Eating seafood that contains lead heavy metals is harmful to health whether the lead heavy metal content exceeds the threshold or not. This is because lead heavy metals have accumulative properties in the body, so that gradually if the body receives continuous exposure the body will not be able to tolerate the toxins from lead heavy metals and will cause chronic poisoning. The body that is exposed to lead heavy metals will partly be disposed of by the body through the urine or urine as much as 70-80% and 15% through feces. The rest will not be excreted and will accumulate in the liver, kidneys, fat tissue, nails and hair (Amaliah et al., 2022; Apriyanti, 2018). Health effects caused by lead heavy metals include interference with the body's metabolism, neurological system disorders (coma and convulsions), kidney disorders, reproductive system, and memory loss (Suryo et al., 2021). In another study, the effects of lead can cause a decrease in IQ in children where the relationship between blood lead concentration and cognitive scores at the age of 2-3 years with an increase of 1µg/dL of lead concentration in cord blood in children with stunting decreased cognitive scores by 2,1 units (Gleason et al., 2020).

This study revealed a significant association between the frequency of seafood consumption, lead exposure, and the incidence of stunting in children in Cilincing, DKI Jakarta. This finding is in line with previous studies showing the impact of nutrition and environmental exposure on child growth. Seafood consumption has long been known to have health benefits, especially because of its omega-3 fatty acid content which is essential for brain development and body growth in children A study by (Wiwith Eskha Ardhanariswari et al., 2021) showed that adequate fish consumption during childhood is associated with improved cognitive and optimal physical growth. The benefits of seafood consumption can be reduced if the fish is contaminated with heavy metals such as lead and mercury. A study by (Belayneh et al., 2021) showed that children with high blood lead levels were at greater risk of cognitive deficits and developmental disorders. Lead can damage the central nervous system and inhibit the secretion of growth hormones, which ultimately interferes with the physical growth of children. Furthermore, research by interventions that include improving sanitation and hygiene can significantly reduce the prevalence of stunting. They emphasized the importance of access to clean water and adequate sanitation facilities in efforts to prevent stunting. Overall, the findings of the study in Cilincing support existing theories regarding the importance of good nutritional intake and a healthy environment for child growth. Adequate seafood consumption can provide essential nutrients for child growth, but needs to be balanced with control of heavy metal contamination to avoid negative impacts on child health.

Thus, interventions that focus on increasing the frequency of safe seafood consumption and improving the quality of environmental sanitation can be effective strategies in reducing the incidence of stunting in children, especially in areas with high levels of pollution such as Cilincing. This study makes an important contribution to our understanding of the factors that influence stunting and emphasizes the need for a holistic approach to addressing children's nutrition and health issues.

CONCLUSION

From the results of the study it can be concluded that there is a significant relationship between the frequency of seafood consumption and the incidence of stunting. Children who frequently consume lead-contaminated seafood have a higher risk of stunting compared to children who rarely consume seafood. In addition, urine lead levels were also associated with stunting. Children with urine lead levels above the median value were more likely to be stunted.

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