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Food profile, environmental factors, stunting, and risk of autism among children on Citarum watershed: a preliminary study

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Abstract

Purpose: The Citarum River, Indonesia, is one of the most polluted rivers in the world. Despite this, it is still used for community purposes. This preliminary study aims to determine the initial profile and magnitude of the problem in the health ecosystem along Citarum River, which focuses on stunting and the risk of autism associated with food consumption and environmental factors. **Methods:** Our random sample included children aged <5 years from their households in the Andir and Gajahmekar villages, from September 2018 to September 2019. We interviewed guardians on food consumption and the Modified Checklist for Autism in Toddlers - Revised (**M-CHAT-R)** questionnaire. The height measurement was interpreted with HAZ WHO-curve. The relationship between variables was analyzed through Chi-square. **Results:** This study showed that the proportion of stunting and risk of autism was 46.2% and 68%, respectively. Children who consume cow's milk and do not consume tomatoes are more at risk of developing autism. Moreover, subjects that consume chicken and fish from the Citarum riverbank have a higher risk of stunting and autism. **Conclusions:** Based on this preliminary study, the proportion of stunting and autism in children on the Citarum watershed is higher than the national average. The animal husbandry service authority must consider efforts to maximize this riverside habitat to provide livestock as a source of protein for communities around the river.

Keywords: food consumption; environmental factors; stunting; risk of autism; M-CHAT-R

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INTRODUCTION

Citarum River flows along West Java and serves as a source of livelihood for residents in its vicinity and 48.27 million people in West Java region [1]. Ironically, since early 2000s, the river has been the most polluted river [2,3]. The surrounding community uses the river as their primary source of life.

Child health problems are often forgotten, especially in developing countries. There are two critical points in children's growth and development. The current COVID-19 pandemic has become a major focus on health issues. According to WHO, 22% of the world's children are stunted [3]. While in Indonesia, the prevalence of stunting is at 30-35% [4]. The prevalence of autism in Indonesia was 20% in 2020 [5]. These have a significant impact on the life and culture of the peoplebank. Aspe peoplects of child development are a crucial factor that must be considered and aspects of productive age health and other public health indicators. Autism Spectrum Disorder (ASD) is a complex developmental problem that involves barriers to social interaction, non-verbal communication, and repetitive behavior. Individuals with autism may be at increased risk of depression and other psychiatric illnesses. The definitive cause of autism is not known, but autism is caused by many factors, one of which is the influence of the environment and parenting patterns. Therefore, early detection of autism must be carried out routinely in children under three years old based on the American Academy of Pediatrics. The screening method that is easy to use is the M-CHAT R questionnaire. In developing countries, autism is often forgotten, coupled with various social, economic, food, and other environmental problems [5].

The initial profile of food consumption patterns, environmental factors, and the magnitude of growth and development disorders (stunting and risk of autism) in Indonesia is still unknown, especially in areas with high pollution levels like the Citarum riverbanks. In addition, this preliminary study is expected to provide information related to the issues to be considered for handling the health of children's growth and development in the future.

METHODS

Ninety-three children who met the eligibility criteria were enrolled in this study. The sample size calculation used the proportion difference between two groups of cross-sectional studies formula. This cross-sectional study examined the association between food consumption and environmental factors with the risk of autism in children on Citarum watershed, conducted from September 2018 until September 2019. Participants were recruited from children 1- 5 years of age, from parents who had lived in the region for more than five years. The participants must be registered on civil records at the local administrative office and provide written consent from their parents. Children with incomplete data and those who were unreachable at the time of data collection were excluded from the study. Duration of residency > 5 years it is expected that the study sample is permanent residents in the area so that food consumption profiles and environmental factors can be adjusted. In addition, this study provide new insights regarding the reciprocity of maternal health and child development problems. Exclusion criteria in this study were non-permanent residents and children with congenital abnormalities.

Sample selection used a random sampling households with children aged 1-5 years who stayed there >5 years. The villages of Andir and Gajahmekar were chosen because they represent upstream and downstream locations of the river (Figure 1). These villages also actively take part in Puskesmas activities that assist in the data collection process. Next, the household selection is made from each neighborhoods (rukun warga) in Andir and Gajahmekar, from the total of 23 RW each. All households meet the inclusion criteria if they will participate in the study.

Food consumption patterns are defined as food that comes from livestock, fisheries, and plantations along the Citarum watershed, which children consume. Data were obtained from an interview with the child guardians. The subject be categorized according of food consump history. A The “yes” refer to a the child had a food consumption history, whereas the “no” group indicated otherwise. We also asked about the frequency of consumption and portion estimation using the standard model of related foods per portion per week. Subdistrict location was defined as the place of stay under the villages and districts of Bandung Regency, West Java Province, Indonesia. House distance from riverbank was defined as the shortest path calculated from subjects’ homes to nearest Citarum river bank. This study used a global positioning system to locate each point and calculate the distance between the two. The children were classified into those staying less than and more than 80 meters from the riverbank. Children aged 16-30 months will undergo an examination of the Modified Checklist for Autism in Toddlers Revised (M-CHAT-R) Indonesian version, validated and routinely used in

clinical settings. The subjects would be considered at-risk of autism if screening results showed medium or high risk. Parents filled out the questionnaire under the researcher's supervision on site. The researcher would answer any question on-site to ensure clarity when answering the questionnaire.

Statistical analysis used IBM SPSS (Version 23). Quantitative data were presented as mean, and counting data were presented as proportion. The comparisons of counting data were evaluated using Chi-square and Fisher test. The strength of association uses a prevalence ratio with a 95% confidence interval.

RESULTS

Table 1 shows the basic characteristics of this study population. The mean age of the subjects was 25.6 months old (skewness 0.05). Most of the participants were female (60.2%).

Table 1. Subjects characteristic

Characteristic	Total	%
Mean age in months	25.6	
Mean meters from riverbank	127	
Gender		
Male	37	39.8
Female	56	60.2
Autism		
Low risk	34	68.0
Moderate-high risk	16	32.0
Stunting		
Normal	13	43.6
Stunted or severely stunted		53.7
Chicken consumption		
Yes	80	87.1
No	12	12.9
Fish consumption		
Yes	43	86.0
No	7	14.0
Exclusive breast milk		
Yes	54	58.1
No	39	41.9
Dairy product consumption		
Yes	11	11.8
No	82	88.2
Broccoli consumption		
Yes	46	49.5
No	47	50.5
Tomato consumption		
Yes	60	64.5
No	33	35.5
Distance from riverbank		
≤ 80m	34	68.0
> 80m	16	32.0
Village		
Andir (upstream)	67	72.0
Gajahmekar (downstream)	26	28.0

This study shows a prevalence of stunting of 53.7% and a moderate-high risk of autism 68%. Most of our participants had a history of regular consumption of chicken (87.1%), fish (86%), tomatoes (64.5%), and exclusive breastmilk (58.1%). On the other hand, most of them had no history of dairy products (88.2%) and broccoli (50.5%) consumption. Our subjects mostly lived in the Andir village (72%), and their home was located less than 80 meters from the riverbank (68%).

Table 2 shows that the prevalence of stunting was 53.7%. Subjects with stunting are chicken consumption (87.8%), fish consumption (76.7%), not getting exclusive breastfeeding (62.0%), not being given dairy products (86.0%), not consuming broccoli (54.0%), not consuming tomatoes (70.0%), house distance >80m (62.0%) and located in Andir (70.0%).

As for the risk of autism in 50 children aged 16-30 years in this study, the M-CHAT R found a moderate-high risk of 68.0%. In Table 2. Subjects with moderate-high risk of autism consumed chicken (87.5%), fish consumption (79.4%), exclusive breastfeeding (62.5%), did not consume dairy products (87.5%), did not consume broccoli (62.5%), not consuming tomatoes (56.2%), distance 80 m (56.2%), and in Andir (68.8%).

The results indicated that a 73.5% children consuming tomatoes had an insignificant risk of autism. The prevalence ratio of subjects at moderate-high risk of autism to the history of consumption of tomatoes, fish and dairy products with a frequency of >2 servings/week, 0.43 (0.19-0.97); 6.00 (0.39-19.25) and 2.44 (1.16 - 5.14) respectively with a significance value of <0.05. The rest variables did not have any significant association with autism risk.

DISCUSSIONS

This preliminary study shows stunting prevalence was 53.7%, and autism was 68.0%. It should be emphasized that the food consumption pattern is food that comes from livestock or farming along the Citarum banks. Most communities along the river use river water and catchment areas as a source of life, ranging from farming, livestock, and water to sanitation needs [2]. So it is crucial to know the food ingredients that need attention in the future.

Table 2. Bivariate analysis for stunting and risk of autism

	Stunting (%)		P	PR	Risk of autism (%)		P	PR
	Yes	No		(95% CI)	Mod-high	Low		(95% CI)
Chicken consumption								
>2 portions/week	87.8	86.0	0.808*	1.08	87.5	82.4	0.495+	1.33
≤2 portions/ week	12.2	14.0		(0.59- 1.99)	12.5	17.6		(0.37- 4.77)
Consumption of fish								
>2 portions/week	88.0	76.7	0.152*	1.46	100.0	79.4	0.054*	6.00
≤2 portions/ week	12.0	23.3		(0.92-2.31)	0	20.6		(0.39-19.25)
Exclusive breast milk								
>2 portions/week	38.0	27.9	0.303*	1.29	62.5	58.8	0.529*	1.11
≤2 portions/ week	62.0	72.1		(0.78 - 2.15)	37.5	41.2		(0.48 - 2.57)
Dairy consumption products								
>2 portions/week	14.0	9.3	0.481+	1.21	12.5	5.9	0.018+	2.44
≤2 portions/ week	86.0	90.7		(0.58 - 2.95)	87.5	94.1		(1.16 - 5.14)
Consumption of broccoli								
>2 portions/week	46.0	53.5	0.609*	0.85	37.5	52.9	0.238*	0.65
≤2 portions/ week	54.0	46.5		(0.55 - 1.32)	62.5	47.1		(0.28 - 1.51)
Consumption of tomatoes								
>2 portions/week	30.0	41.9	0.330*	0.78	43.8	73.5	0.041*	0.43
≤2 portions/ week	70.0	58.1		(0.51 - 1.02)	56.2	26.5		(0.19 - 0.97)
Distance from the riverbank								
≤ 80m	38.0	30.2	0.384*	1.21	56.2	73.5	0.184*	0.61
> 80m	62.0	69.8		(0.74 – 1.98)	43.8	26.5		(0.27 - 1.16)
Subdistrict								
Andir (upstream)	70.0	74.4	0.636*	1.13	68.8	73.5	0.487*	1,18
Gajahmekar (downstream)	30.0	25.9		(0.67 - 1.89)	31.2	26.5		(0.69 – 1.69)

The risk of stunting and autism was the same in children who consumed chicken and fish, which was inversely proportional to the consumption of tomatoes and broccoli. At the same time, profile differences can be seen from tomatoes and broccoli consumption, where the risk of stunting and moderate-high risk of autism is low in the group of subjects who consume these two vegetables. Subject groups with a history of exclusive breastfeeding and dairy products have a lower prevalence of stunting and moderate-high autism risk.

The geographical profile shows no significant relationship between the risk of stunting and autism with the distance from the house to the river bank. Andir of upstream area has a greater risk of stunting and autism than Gajahmekar but it cannot be generalized due to the imbalance in the number of samples between the two sub-district.

The risk of growth disturbance on Citarum

Stunting is a significant indicator of children's growth and development. Malnutrition is a well-known risk in stunting, appearing as severe chronic malnutrition early in children's growth and development. In children, stunting can be calculated by comparing height with age. Stunting may cause both short- and long-term negative impacts, including poor cognitive performance, lack of productivity, increased risk of metabolic diseases such as obesity, and even a low-income rate when reaching adulthood. In 2013, the global prevalence of stunting had reached 161 million children. This figure was based on height to age ratios lower than standard deviation scores of 2 in the WHO curve length for age. Data show that between 9.3% and 24% of children suffer from stunting, of whom the majority live in developing countries [3].

The Health Ministry data showed that the prevalence of stunting in Indonesia between 2005 and 2017 had reached 36.4% [1,4]. In our study, the prevalence of stunting in children was 76.1%, or double the national figure. Children with stunting may not achieve their highest potential when reaching adulthood. They may also experience decreased immunity, lower cognitive capabilities, and an increased risk of non-communicable diseases in later life. Increasing nutritional levels, using clean water and sanitation, adequate socioeconomic conditions, and good quality education are key to overcoming stunting [6]. On average, the age of the child subjects in this study was 26 months (with a range between 11 and 44 months). We found no significant statistical relationship between stunting and children aged <24 months and >24 months. Most subjects in our study had stunting and were recommended for treatment [6,7].

Previous studies have shown a significant relationship between stunting and parental gender preference, maternal education levels, and economic

conditions [6,8]. The preference for boys may lead to a higher incidence of girls with stunting. Another study shows that maternal age significantly correlates with poor nutritional status in girls. Hence, studies exploring the relationship between gender and stunting need to be accompanied by data regarding maternal education, maternal age, socioeconomic conditions, and analysis regarding the culture of parental preferences in the area [9].

The results of data analysis have shown that the intake of six types of food, which include fish (p=0.521), chicken meat (p=0.471), exclusive breastfeeding (p=0.231), cow's milk (p=0.698), broccoli (p=0.180), and tomatoes (p=0.412) have no significant effect on stunting. The subjects' diversity and proportion of food consumed did not influence the results. In addition, food insecurity is a significant factor causing stunting. Food insecurity is when people cannot access nutritious food safely or in adequate amounts, both physical and economic terms. Studies on food insecurity conclude that food insecurity produces maternal oxytocin, stimulating a child's brain development [14-16]. In this study, we found a significant statistical relationship between the consumption of dairy products and the risk of autism, with a prevalence ratio of 2.44. This study does not separate children with cow's milk from breastfeeding, so the direct relationship between dairy product consumption and the risk of autism cannot be conducted. Most of Andri and Gajahmekar's silk/dairy products supplies come from local dairy corporations and farms around the riverbanks. A source of feed from the riverbank needs to be a concern for the continuity of the food health chain, starting from livestock for consumption.

The study of the relationship between sex and the risk of autism was not statistically significant (p=0.649); however, male toddlers had a higher percentage of autism risk when compared to female toddlers (16.2% versus 12.5%, respectively). Although this is not yet completely understood, some suggest a female protective effect (PFE), resulting in a lower risk of developing ASD than males. Our cross-sectional study cannot explain the relationship between independent and dependent variables because of the limited time and resources. Therefore, a larger sample size and sufficient duration of follow-up are needed to determine the relationship between food consumption and environmental factors on child development disorders.

However, our study has provided descriptive data in the population that should raise awareness regarding the impact of the river on the people living around it. Health problems, especially children's growth and development, in this case, stunting and autism, need a comprehensive approach from a medical point of view and require penta-helix involvement from government bodies, educational institutions, NGOs, and the community. By solving the problem of child growth and development, to build a better generation for its future. Further research with an extended follow-up period need to understand better the impact of Citarum river pollution on people's health in its vicinity.

CONCLUSION

Our findings show the need for integrated interventions to reduce stunting and autism risk in Indonesia, especially in polluted environments like Citarum. Further epidemiological studies should assess pollutant levels in a water body, agricultural/livestock products, and the population and their relationship to community health aspects along the Citarum River. Interventions should not only focus on medical aspects but also environmental aspects. Use a multi-sectoral approach, including government, to address multiple determinants from industry, community, and individual levels.

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DISCLOSURE

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AUTHOR'S CONTRIBUTION

S.R. and R.A.W conceived of the presented idea. S.R. developed the theory and performed the computations. A.C.A. and W.A. verified the analytical methods. A.C.A. and W.A. encouraged S.R. to investigate health problems in the Citarum watershed and supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

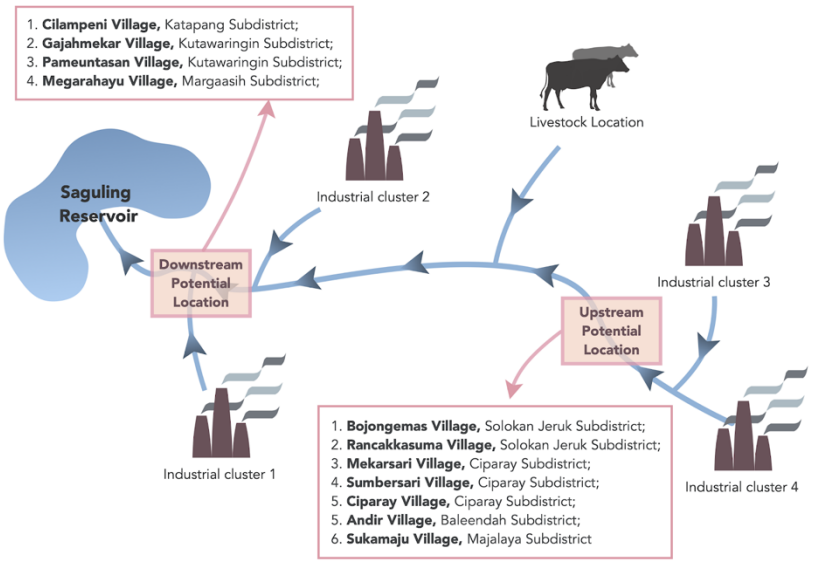

Figure 1. Potential Locations in the Upstream and Downstream of Citarum River

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