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Spatial analysis of environmental sanitation and stunting incidents

Risnawati Tanjung[1], Dini Lestrina[2], Jernita Sinaga[1]
[1]Department of Environmental Health, Politeknik Kesehatan Kementerian Kesehatan Medan, Medan, Indonesia
[2]Department of Nutrition, Politeknik Kesehatan Kementerian Kesehatan Medan, Medan, Indonesia

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ABSTRACT

Environmental factors such as sanitation and hygiene, drinking water sources, quality of drinking water, and ownership of latrines are indirect factors causing stunting. This study aims to analyze the distribution of stunting and environmental sanitation factors that cause stunting in Dairi District, North Sumatra, Indonesia. The case-control design was carried out with 172 toddlers. The distribution pattern of stunting and the association of patient characteristics and environmental risk factors was carried out using the Geographic Information System. Data on healthy clean-living behavior was collected using a questionnaire, and microbiological laboratory tests measured water quality. The spatial analysis uses an average nearest-neighbor overlay. The association of characteristics and risk factors with the incidence of stunting was analyzed using chi-square and logistic regression. The average nearest neighbor analysis shows that the nearest neighbor index is 0.19 (<1) (Z score -16.72, p-value 0.01). Regression analysis GeoDa software (p-value 0.76). There is a relationship between clean water quality and healthy clean-living behavior (p-value <0.05) with stunting. Family toilets and garbage disposal facilities (p-value> 0.05) are unrelated to stunting. The pattern of distribution of cases tended to be in clusters, and no relationship was found between population density and the incidence of stunting. The findings of this study provide a new understanding that health promotion to prevent stunting does not only focus on fulfilling nutrition but also on healthy clean-living behavior and water quality.

Corresponding Author:

Risnawati Tanjung
Department of Environmental Health, Politeknik Kesehatan Kementerian Kesehatan Medan
Kapt. Selamat Ketaren street, Padang MAS, Kabanjahe, Karo, North Sumatera-22112, Indonesia
Email: risnawatitanjung75@gmail.com

1. INTRODUCTION

Stunting is one of the targets of the sustainable development goals (SDGs), which is included in the second sustainable development goal, namely eliminating hunger and all forms of malnutrition by 2030 and achieving food security. The target is to reduce the stunting rate by 40% by 2025. In 2017, more than half of the stunted toddlers in the world came from Asia (55%), while more than a third (39%) lived in Africa. Of the 83.6 million stunted children under five in Asia, the highest proportion came from South Asia (58.7%) and the most minor proportion was from Central Asia (0.9%). Data on the prevalence of stunting under five was collected by the World Health Organization (WHO). Indonesia is the third country with the highest prevalence in the Southeast Asia/Southeast Asia Regional [1]. Stunting is a failure of the child's physical and brain growth due to nutritional deficiencies or insufficient intake of nutritious food for a long time, as well as environmental conditions so that children have shorter bodies than normal children of their age and are

followed by a decrease in intellectual abilities. Multi-dimensional factors cause stunting and are not only caused by KEP factors experienced by pregnant women and malnutrition experienced by children under five. There is also still a lack of household/family access to nutritious food, clean water, and sanitation [2]. The condition of the physical environment and sanitation around the house significantly affects the health of the house's occupants, including the nutritional status of children under five.

Environmental factors as a determining factor for stunting do not stand alone; other factors jointly affect stunting, for example, infectious diseases and parenting styles [1]. One of the indirect factors causing stunting is water, sanitation and hygiene (WASH), which consists of sources of drinking water, physical quality of drinking water, ownership of latrines and hygiene, namely the habit of washing hands [3], [4] .Stunting that cannot be treated in the long term will impact motor and verbal development, increase in degenerative diseases, morbidity and mortality. The effect of stunting on children's cognitive development and learning achievement can reduce work productivity so that, in the end, it can hamper economic growth and increase poverty in a country [4]

Efforts to overcome stunting must be carried out by the factors that cause this condition. Indonesia has scattered regions and its own characteristics. The difference in these characteristics causes variations in handling called spatial effects. This modeling is to see what factors influence the prevalence of short and very short toddlers in a particular area according to the conditions of that area [5]. Therefore, it is necessary to have stunting prevention based on the results of mapping the problem, such as in research on mother empowerment, where a high prevalence of stunting was found in coastal areas, so one of the countermeasures is carried out by training mothers who have stunted toddlers to increase their intake of substances. Nutrition by increasing the consumption of marine fish [6].

Based on data from a study on the nutritional status of toddlers in Indonesia in 2019, the prevalence of stunting in North Sumatra Province is 30.11%, while Dairi Regency is 39.7% and is a priority locus for reducing stunting in North Sumatra. In general, the Dairi Regency is a potential agricultural area that is quite extensive, and the yield is substantial so the livelihoods of the population are primarily rice, secondary crops and annual crops/materials for export trade, including food crops such as rice, corn, sweet potatoes, sweet potatoes. Trees, peanuts, soybeans and green beans; Vegetables such as chilies, potatoes, tomatoes, beans, eggplant, spinach and other vegetables are magnificent in Dairi District. Meanwhile, the shallot and garlic plants in the Sumbul District are in Silalahi II's village and Paropo's village, which are located on the outskirts of Lake Toba. Export trade crops such as coffee, coconut, frankincense, cloves, tobacco, ginger, candlenut, cinnamon, and patchouli. Annual plants are very well cultivated and have a large enough yield to affect the economy of the people of Dairi District. An additional livelihood is also obtained from forest products such as carpentry, resin, and rattan. However, a small portion of the population also raises poultry and inland fisheries with traditional maintenance procedures, so it is only an additional income where the amount needs to meet national standards [7].

Based on data from the Dairi District Health Service, stunting sufferers are spread throughout the subdistrict, namely in 18 subdistricts the highest distribution is in the Sumbul subdistrict and the lowest is in the Silima Pungga-punga subdistrict, so it is known that the distribution of cases in each area is uneven. The distribution of cases of stunting in toddlers and their risk factors can be mapped using a geographical information system (GIS). The need for mapping cases of stunted toddlers in Dairi Regency is to determine the distribution of cases of stunting toddlers and the relationship between stunting incidents and stunting risk factors based on space, region, and time. Depicting stunting using GIS can be useful for knowing the distribution pattern of stunting incidents, the relationship between stunting incidents and stunting risk factors in an area, areas that can be used as a locus for handling stunting and important locations for providing public health facilities such as community health centers that are adequate and can be reached by the community as a place to obtain treatment or preventive measures related to stunting conditions so that it can be used as a recommendation for determining appropriate policies in handling cases of stunted toddlers [8].

A GIS is a computer-based information system, designed to work using data that has spatial information (spatially referenced). Geographic information systems can capture, check, integrate, manipulate, analyze and display data spatially refers to the conditions of the earth. Geographic Information Systems are also defined as information systems used to enter, store, recall, process, analyze and produce geographically referenced data or geospatial data, to support decision making in planning and managing land use, natural resources, environment, transportation, city facilities and other public services. Spatial analysis is a technique used to explore data from a spatial perspective. In processing GIS data, spatial analysis can be used to provide solutions to spatial problems. Average nearest neighbor analysis method to determine the distribution pattern, the indicator used is the nearest neighbor index number by taking into account the average distance from each Stunting coordinate point [9].

Dairi District is a district with high cases of stunting, which is a problem that must be handled as best as possible. The availability of sufficient food indicates that it is necessary to address stunting holistically by considering environmental sanitation factors. This research is essential to carry out to analyze

the distribution of identification of sufferers' locations to individual location addresses to obtain information about the distribution of cases in each region using the GIS and analyze the determinants of stunting in terms of sanitation factors. Risk is a situation that is uncertain and contains an element of danger, outcome, or consequence that could occur as a result of the ongoing process or future events. Research to determine the risk of stunting from environmental sanitation (quality of clean water, toilet facilities, waste disposal facilities, clean and healthy living behavior) [10], [11].

2. METHOD

The type of research used is observational research with a case-control design. The research location was in Dairi District from January to October 2022. The ratio used for cases: control was 1:1 (86 stunted toddlers: 86 control toddlers). The cases in this study were all toddlers suffering from stunting in Dairi district, taken proportionally from 15 sub-districts. The inclusion criteria were stunted toddlers who did not regularly have their weight checked at the Posyandu and based on the researchers' anthropometric measurements were stunted. Controls are toddlers who do not suffer from stunting, taken proportionally from 15 sub-districts. The inclusion criteria were toddlers who were not stunted and who routinely had their weight measured at the Posyandu and based on anthropometric measurements, the researchers did not experience stunting. Data collection for the distribution of stunting toddlers using global positioning system (GPS) to get GIS data. GPS type Garmin Etrex 10, map source, Quantum GIS, and Google Earth to collect coordinates of stunting toddler homes in Dairi Regency. For sanitation data in clean and healthy living behavior with a questionnaire instrument made by researchers first conducted validity and reliability tests with a Cronbach alpha value of 0.789. The 10-item questionnaire contains the behavior of washing hands with soap after defecating cleanly, before processing and serving food, the cleanliness of children and the behavior of cooking drinking water before consumption. Data was collected through direct interviews and observation sheets as supporting instruments.

Laboratory tests are carried out to assess the quality of drinking water by checking for Escherichia coli bacteria. The sampling procedure was carried out microbiologically. First of all, we sterilized the sample bottles using an autoclave. The sterilized sample bottle is put into a sample flask and taken to the field for sampling. The tools used in the field are sample bottles, Bunsen lamps, labels, and bottle wrapping paper. Then we determine sampling points in the house, including clean water and drinking water facilities. Once the sampling point is determined, we carry out sampling. To take samples, we first sterilize the faucet if the clean water source faucet is made of iron with a Bunsen lamp. If the faucet is made from a plastic water hose, then sterilize it with alcohol. After sterilizing, we turn on the tap for 2-3 minutes then turn it off. We took a sample bottle and re-sterilized the mouth of the bottle using a Bunsen lamp. After sterilization, we turned on the tap to take a clean water sample of 2/3 of the bottle. After the bottle was filled, we sterilized the mouth of the bottle again with a Bunsen lamp, then closed the bottle and wrapped it in brown wrapping paper. We then make a sample label by writing the name of the sample, day, date, and time of collection, source of collection, and name of the sample taker. Samples that have been labeled are placed in a sample box to be sent to the laboratory of the Center for Disease Control and Environmental Health Techniques (BTKLPP) in Medan and the Environmental Health Laboratory in Kabanjahe. This water microbiological examination is carried out within a maximum of 24 hours.

2.1. Data analysis

Data analysis was carried out by analyzing the average nearest neighbor, used to look at the distribution pattern of stunting events in Dairi District conditional regression logistic with a confidence level of 95% (α=5%). The association of characteristics and risk factors with the incidence of stunting was analyzed bivariate, using Chi-square. Data are presented in a frequency distribution table.

2.2. Ethics declaration

Informed consent is conveyed to prospective informants and respondents. The researcher explains the aims and objectives of the research. The researcher guarantees the confidentiality of all information provided and is only used for research purposes. Prospective respondents who are willing to sign the consent form and prospective respondents who are not willing, researchers do not come and respect the rights of prospective respondents. Prior to conducting the study, the researcher had obtained ethical approval from the Health Polytechnic Ethics Commission of Poltekkes Kemenkes Medan number: 1639/KEPK/POLTEKKES KEMENKES MEDAN 2023.

3. RESULT AND DISCUSSION

3.1. Spatial analysis

A geographic information system is a type of epidemiological visualization used to show an overview in the form of a map about the distribution of a condition based on the regional analysis. GIS can help those who need to see patterns of distribution of stunting events and their relation to stunting risk factors through a regional perspective. Dairi Regency is one of the districts with a relatively high stunting rate. The distribution of stunting in Dairi Regency can be seen in Figure 1.

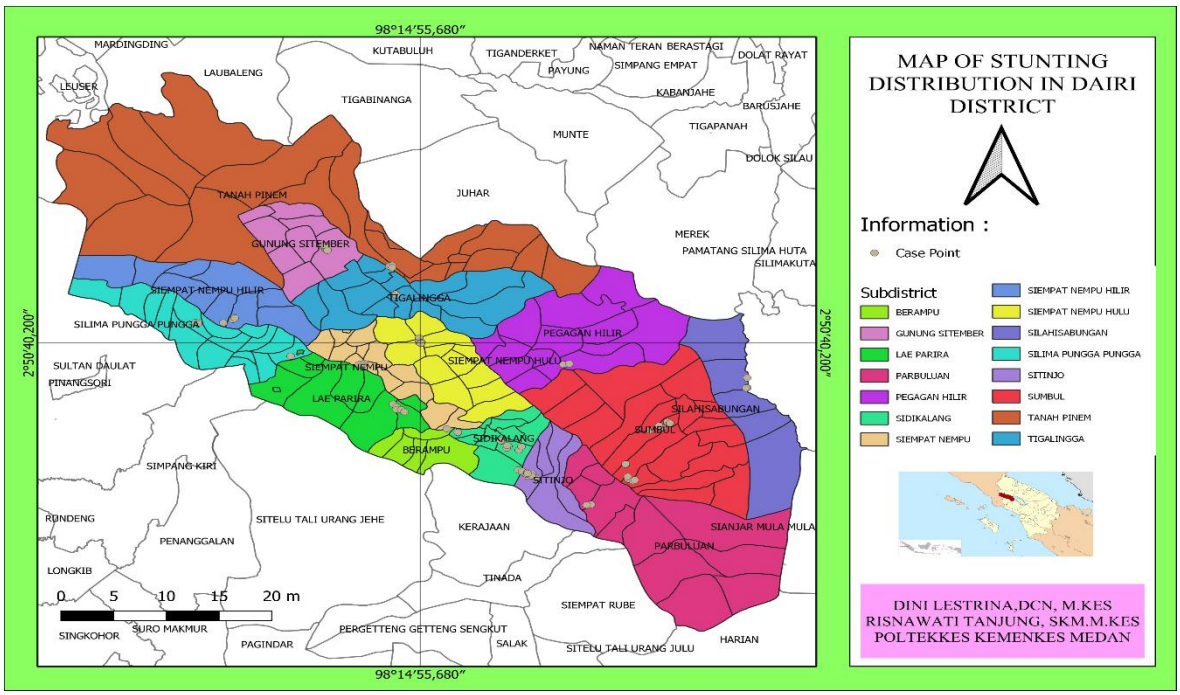

Figure 1. Distribution of stunting in Dairi Regency in 2022

Figure 1 shows the distribution of coordinate points for stunting sufferers. These coordinate points are numbered according to the number of stunting cases in the sample (n=86). Distribution of Stunting Stunting in Dairi District is spread across all sub-districts. Based on the results of the research conducted, the most stunting was in the Sumbul District, with a total of 20 stunts consisting of 10 stunts in the work area of the Sumbul Health Center and 10 stunts in the work area of the Pegagan Julu II Health Center. Meanwhile, the Berampu sub-district has the lowest stunting with 1 stunt. Based on the average nearest neighbor analysis, the stunting distribution pattern tends to cluster with the nearest neighbor index number of 0.19 (<1) with a Z score =-16.72 and a p-value of 0.01. The results of the analysis using Satscan show that there are 9 clusters. The numbers in Figure 2 show the distribution of coordinate points for stunting sufferers. These coordinate points are numbered according to the number of stunting cases in the sample (n=86) spread across the area, as shown in Figure 2.

Figure 2 above shows the results of the analysis using Satscan, there are 9 clusters, namely: the first cluster contains 38 cases with a radius 19.90 km, which means that there is a grouping of stunting (clusters) that is most at risk, having a risk level of 3.50 times being affected by stunting for sufferers who are inside the cluster are compared with sufferers who are outside the cluster with a cluster radius of 19.90 km. The second cluster contained 18 Stunting, p–value <0.0001; RR: 4.02; radius: 9.34 km, which means there is a Stunting grouping (cluster) that is most at risk, having a risk level of 4.02 times being affected by stunting for sufferers who are inside the cluster compared to sufferers who are outside the cluster with a cluster radius of 9.34 km. The third cluster contained 5 Stunting, p–value <0.0001; RR: 7.92; radius: 0.50 km, which means there is a Stunting grouping (cluster) that is most at risk, having a risk level of 7.92 times being affected by stunting for sufferers who are inside the cluster compared to sufferers who are outside the cluster with a cluster radius of 0.50 km. The fourth cluster contained 3 Stunting, p–value <0.0001; RR: 18.86; radius: 1.16 km, which means there is a Stunting grouping (cluster) that is most at risk, having a risk level of 18.86 times being affected by stunting for sufferers who are inside the cluster compared to sufferers who are outside the

cluster with a cluster radius of 1.16 km. The fifth cluster contained 3 Stunting, p–value <0.0001; RR: 4.69; radius: 0.39km, which means there is a Stunting grouping (cluster) that is most at risk, having a risk level of 4.69 times being affected by stunting for sufferers who are inside the cluster compared to sufferers who are outside the cluster with a cluster radius of 0.39 km. The sixth cluster contained 5 Stunting, p–value <0.0001; RR: 2.11; radius: 1.21 km, which means that there is a grouping of stunting (cluster) that is most at risk, having a risk level of 2.11 times being affected by stunting for sufferers who are inside the cluster compared to sufferers who are outside the cluster with a cluster radius of 1.21 km. The seventh cluster contained 9 Stunting, p–value <0.0001; RR: 1.83; radius: 0.69 km, which means that there is a Stunting grouping (cluster) that is most at risk, having a risk level of 1.83 times being affected by stunting for sufferers who are inside the cluster compared to sufferers who are outside the cluster with a cluster radius of 0.69 km. The eighth cluster contained 2 Stunting, p–value =0.00011; RR: 2.2; radius: 0.19 km, which means there is a Stunting grouping (cluster) that is most at risk, having a risk level of 2.2 times being affected by stunting for sufferers who are inside the cluster compared to sufferers who are outside the cluster with a cluster radius of 0.19 km. Meanwhile, in the ninth cluster, there were 5 Stunting, p–value =0.0026; RR: 1.82; radius: 1.39 km, which means there is a Stunting grouping (cluster) that is most at risk, having a risk level of 1.82 times being affected by stunting for sufferers who are inside the cluster compared to sufferers who are outside the cluster with a cluster radius of 1.39 km. Based on the regression analysis results with GeoDa software, there was no relationship between population density and stunting in District Dairy (p-value: 0.76).

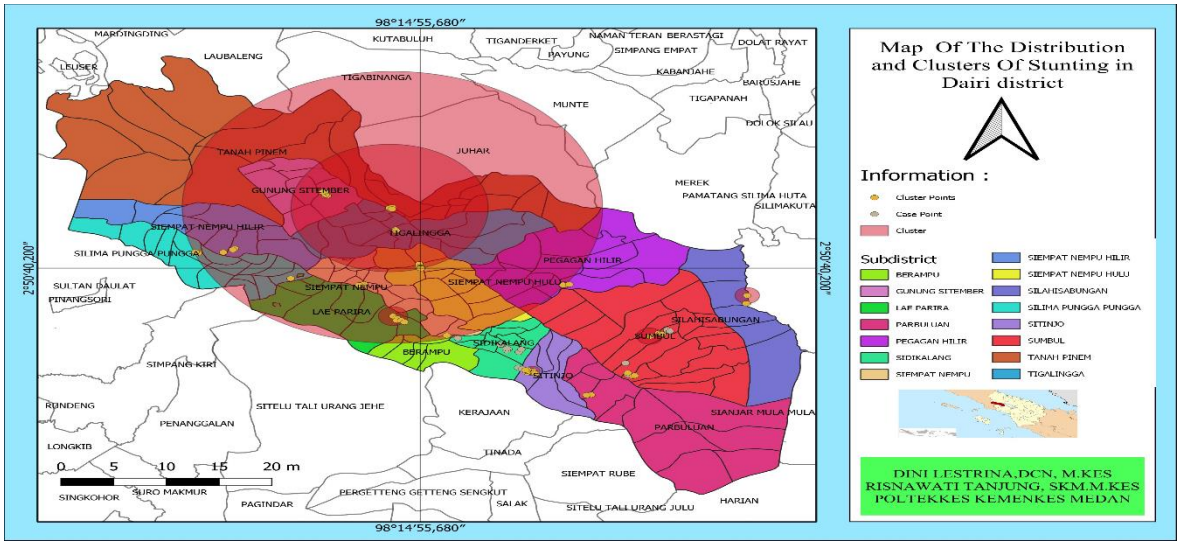

Figure 2. Nearest neighbor analysis and distribution of stunting in Dairi Regency in 2022

Figure 3 shows that the distribution of stunting cases is predominantly in the very high and high populations. Children who live in urban areas have a lower risk of experiencing stunting than children who live in rural areas. The prevalence of stunting is increasing in densely populated and rural areas with the Moran I index value being positive 0.71 (p=0.0001) for the incidence of stunting in densely populated areas, 0.6 (p=0.0002) in rural areas and 0.45 (p=0.0001) in highland areas.

Children who live in urban areas have a lower risk of experiencing stunting than children who live in rural areas. The prevalence of stunting is increasing in densely populated and rural areas, with a positive Moran I index value of 0.71 (p=0,0001) for stunting in densely populated areas, 0.6 (p=0.0002) in rural areas and 0.45 (p=0.0001) in the highlands [12].

3.2. Stunting risk factors

Stunting can occur due to direct or indirect factors. Direct stunting factors and indirect factors can occur from various aspects. One of the indirect factors causing stunting is sanitation. Risk is a situation that is uncertain and contains an element of danger, outcome, or consequence that could occur as a result of the ongoing process or future events. Research to determine the risk of stunting from environmental sanitation (quality of clean water, toilet facilities, waste disposal facilities, clean and healthy living behavior). The sanitation factors can be seen in the Table 1.

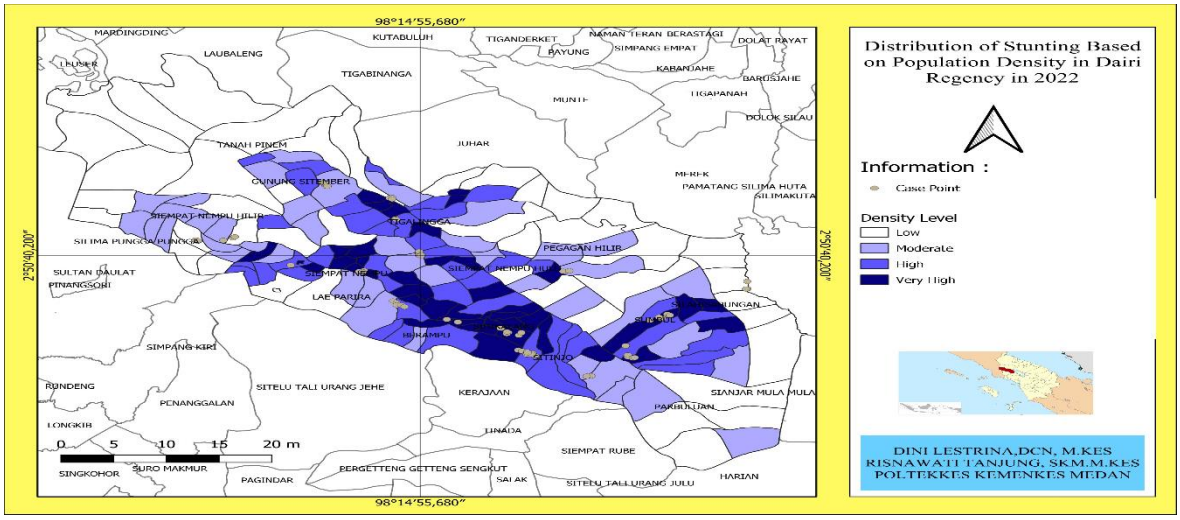

Figure 3. Stunting distribution map based on population density in Dairi District in 2022

Table 1. Relationship between clean water quality, clean and healthy lifestyle, latrine facilities and garbage disposal facility with stunting incidents

Variable	Stunting		Not Stunting		Total		OR	p-value
	n	%	n	%	n	%		
a. Clean water quality							20.8	0.001
There is *E. coli*	37	43.0	3	3.4	40	23.3		
No *E. coli*	49	57.0	83	96.5	132	76.7		
b. Clean and healthy living behavior							2.27	0.01
Good	28	32.6	45	52.3	73	42.4		
Not good	58	67.4	41	47.7	99	57.6		
c. Family latrines							0.89	0.86
Qualify	61	70.9	59	68.6	120	69.8		
Does not meet the	25	29.1	27	31.4	52	30.2		
d. Garbage disposal facilities								
Qualify	48	55.8	51	59.3	99	57.6	1.15	0.75
Does not meet the	38	44.2	35	40.7	73	42.4		
Amount	86	100	86	100	172	100		

Table 1 shows that the dominant difference was in the stunting group, where 37 (43%) had clean water containing *E. coli* compared to the non-stunted group, which only had 3 (3.5%). For the clean and healthy behavior variable, the Stunting group has a dominant clean and healthy behavior that is not good, namely 58 people (67.4%), compared to the Not Stunting group, which has good clean and healthy behavior (52.3%). For the variable family latrine facilities between the Stunting and Not Stunting groups, there is little difference in having family latrine facilities that meet the requirements, namely 61 people 70.9% and 59 people (68.6%). Likewise, with waste disposal facilities, namely in the Stunting group, 48 (55.5%) and in the Not Stunting group, as many as 51 (59.3%). The statistical test was continued with the chi test for the quality of clean water containing e coli, which had a significant relationship, namely a p-value of 0.00 with OR=20.8, which means that respondents whose clean water contained *E. coli* have a possibility of stunting 20.8 times compared to water that does not contain *E. coli.*

The clean and healthy behavior variable also has a significant relationship with a p-value of 0.01 and OR=2.27, meaning families with clean and healthy behavior are less likely to stunt 2.27 times compared to those with good clean and healthy behavior. Based on this Chi-square test for the variable family latrines and garbage disposal facilities, there is no significant relationship with the incidence of stunting with a p-value>0.05, 0.86 and 0.75. However, it has a risk of stunting for the variable family latrine facilities of 0.89 times and garbage disposal facilities 1.15 times.

3.3. The relationship between water quality and stunting

Clean water must be addressed because it is used for daily activities, from bathing and washing toilets (MCK) to clean water. Lack of access to clean water is like a child getting nutritious food with dirty cutlery, so there is no absorption of nutrients in digestion. The Relationship between consumption of dirty water and stunting lies in the number of microorganisms (such as pathogens and E. coli bacteria) in dirty

water, which, if consumed, can disrupt the systems in the human body [13], [14]. Some diseases that lurk in dirty water are diarrhea and intestinal worms. For example, Children who have difficulty accessing clean water may experience repeated diarrhea. In fact, during diarrhea, a lot of fluid and micronutrients (important nutrients) are wasted from the child's body; zinc is one of them [15]. When the body is deficient in zinc, the intestines that are disrupted during diarrhea cannot be regenerated. Based on research, zinc deficiency in childhood can cause stunting and delay sexual function maturity. Lack of access to clean water also makes children vulnerable to worm infections. At first, worms entering the body will absorb nutrients in the child's body, then decrease their appetite. If it continues, this condition will cause the child to experience malnutrition and cause the child's growth to slow down. This causes a person to experience stunting due to worm infection [16], [17]. Stunting itself is a condition of failure to thrive in children (body and brain growth) due to long-term malnutrition. This disorder is characterized by a child's height being stunted or much shorter than their peers.

Our findings in this study showed that the dominant difference was in the case group; there were 37 (43%) whose clean water quality contained e coli compared to the control group, which only had 3 (3.5%). For the small group, there were 49 (57%) whose clean water quality contained *E. coli.* Multivariate analysis using logistic regression found that water quality (*E. coli*) was a higher risk factor for stunting in Dairi Regency, with Exp B 22.5 (p-value 0.000). From observations or observations made by researchers in the field, this pollution occurs due to cross-contamination between water and containers or cutlery used in households. This happens because, in general, the location of clean water sources, storage of food equipment or dish racks is close to the toilet. The position of the water closet (WC) is parallel to the tub or water reservoir used for drinking water, washing food items, bathing water and water for washing hands when defecating. Personal hygiene is generally lacking, and our research also proves that there is a relationship between clean and healthy behavior and stunting.

Our findings are very important for making stunting prevention and control policies related to good nutrition in the first 1,000 days of life and ensuring adequate clean water needs. Many studies have proven that E.coli contamination can cause diarrhea in children, and the incidence of diarrhea in children is a risk factor for stunting in children [14], [18]–[26]

3.4. Relationship between clean and healthy behavior and Stunting

Theory and several studies have proven that the high incidence of stunting in toddlers is associated with inadequate hygiene and healthy living behavior. Our findings in this study also strengthen the theory and results of other studies, namely, a significant relationship exists between stunting and clean and healthy living behavior [2]. This study showed that the dominant clean and healthy living behavior was at a disadvantage in the case group, namely as many as 58 people (67.4%) compared to the control group, which had good clean and healthy living behavior (52.3%). The high prevalence of stunting caused by multi-factors requires efforts to prevent and control through approaches from various disciplines because prevention and control of stunting are not enough to improve nutrition interventions. There are other factors, namely lifestyle, sanitation and environmental hygiene. The factor of low sanitation and environmental hygiene is one of the indicators of clean and healthy behavior [27]. Clean and healthy living behavior is a preventive behavior by individuals or families from various diseases. Therefore, clean and healthy living behavior practices in daily life are still needed because behavioral factors contribute 30-35% to health status. Clean and healthy living behavior in the household empowers household members to know, want and be able to practice clean and healthy living behaviors and play an active role in the health movement in the community.

The worse the clean and healthy lifestyle, the more likely a person is to get sick and have the potential to experience stunting. Clean and healthy living behavior is a set of behaviors that are practiced based on awareness as learning outcomes, which enable a family, group or community to help themselves (independently) in the health sector and play an active role in realizing public health. Thus, clean and healthy living behavior includes hundreds and maybe even thousands of behaviors that must be practiced in order to achieve the highest degree of public health. Behaviors contributing to stunting are the habit of washing hands with soap before eating and drinking water that is boiled until it boils [1], [15], [28]–[30].

Alternatives must be made to reduce the high number of stunting incidents through household arrangements. Namely, clean and healthy living behavior coaching is carried out in an integrated manner. Empowerment in the household order is carried out for individuals, families and community groups. The process begins with empowering community groups through community organizing to form or revitalize Village/Kelurahan Forums [31]. With community organizing, individual and family empowerment can be weighed and received by village/sub-district officials, community leaders and community members appointed cadres. Individual empowerment is carried out on various occasions, especially when individuals from the community visit and take advantage of community-based health efforts (UKBM) such as Posyandu, Poskesdes and others, through the provision of information and consultation. Meanwhile, cadres carry out family

empowerment through home visits and family consultations. Also, through guidance or assistance when the family needs it (for example, when building latrines, making a family medicine garden and so on [32]

3.5. Relationship between latrines and stunting

Ownership of latrines that do not meet standards will trigger infectious diseases due to poor hygiene and sanitation, which can inhibit the absorption of nutrients in the digestive tract, affecting the growth of toddlers. This is also related to the Decree of the Minister of Health of the Republic of Indonesia No.852/MENKES/SK/IX/2008 regarding healthy latrines, namely adequate fecal disposal facilities to break the chain of disease transmission. An unhealthy latrine is a latrine that does not meet the criteria for protecting latrine users, with a gooseneck construction or a hole without a gooseneck and is closed, the latrine floor is not slippery. It has a channel for disposal, and has a bottom structure consisting of a septic tank or cubluk for waste disposal. Unsanitary latrines will show unfavorable conditions for the family. This can be a medium for transferring germs from feces as a center of infection to new hosts through various intermediary media, including water, hands, insects, soil, food and vegetables. Sanitary disposal of feces and liquid waste will break the chain of disease transmission and is a sanitation barrier for disease germs to move from feces to potential hosts.

This study's results align with research [33], namely that the quality of unsanitary latrines has no simultaneous and significant effect on stunting in toddlers with a path coefficient/beta value of 0.172 (β=0.172). However, it has an indirect effect with a path coefficient/beta value of 0.556 (β=0.556)[34]. Environmental sanitation is a health effort carried out by maintaining and protecting the subject's environment's cleanliness. Poor sanitation can be a source of disease, thereby increasing morbidity and mortality. Healthy latrines are one indicator of environmental sanitation. Latrine is a fecal disposal facility, so using unsanitary latrines, such as clean water, can pollute the environment, so it becomes a source of infection [2], [35]. The environment in which children are raised is also an important factor, one of which is using healthy latrines. There is no relationship between latrine ownership and the incidence of stunting because all toddlers with healthy latrines do not experience stunting. However, it can be a risk factor that causes stunting in toddlers in this study.

3.6. Relationship of garbage disposal with stunting

The findings of our study show that 46.1% of households in the waste management category do not meet the requirements, so basic sanitation facilities in the waste management category have no significant relationship to stunting [3], [31]. Other studies suggest that the chi-square test results show a p-value of 0.955, which means there is no significant relationship between waste management and stunting [3]. Securing household waste is carrying out waste processing activities in households by prioritizing the principles of reducing, reusing and recycling. The purpose of securing household waste is to prevent this waste from becoming a breeding ground for bacteria/parasites and disease vectors. Safe waste storage is the collection, transportation, processing, recycling or disposal of waste material in a way that endangers public health and the environment [36]. Waste processing facilities are said to have no relationship to the incidence of stunting in this study because the majority of respondents, both those who are stunted and those who are not stunted, manage household waste properly so that there are no negative impacts arising from stunting waste management in toddlers.

4. CONCLUSION

Spatial analysis shows that the pattern of distribution of cases tends to be in groups but regression analysis with GeoDa software found no relationship between population density and stunting. The statistical test results show that stunting in toddlers is significantly related to clean water quality and clean and healthy living behavior (p-value <0.05). This study did not analyze infectious diseases caused by clean water containing *E. coli*. Further research is needed to prove the relationship between the e coli factor and infectious diseases that cause stunting. The findings of this study have implications for the development of science, especially public health science, namely providing a new understanding of the prevention and control of stunting by paying attention to the structure of the house, which causes the possibility of *E. coli* cross-contamination.

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BIOGRAPHIES OF AUTHORS

Risnawati Tanjung is a lecturer at the Department of Environmental Health, Politeknik Kesehatan Kementerian Kesehatan Medan, Indonesia. Her research interests are public health and research in the field of sanitation which includes spatial analysis and environmental-based determinants of disease occurrence such as tuberculosis, stunting, respiratory infection, and dengue hemorrhagic fever. She can be contacted via email: risnawatitanjung75@gmail.com.

Dini Lesterina is a lecture at Department of Nutrition, Politeknik Kesehatan Kementerian Kesehatan Medan, Indonesia. Her research interests are public health and Nutrition. She can be contacted via email: dinilestrina@gmail.com.

Jernita Sinaga is a lecture at Department of Environmental Health, Politeknik Kesehatan Kementerian Kesehatan Medan, Indonesia. Her research interests are public health and Research in the field of sanitation which includes spatial analysis and environmental-based determinants of disease occurrence such as tuberculosis, stunting, respiratory infection, and dengue hemorrhagic fever. She can be contacted via email: jernitasinaga@gmail.com.