

Environmental and Host factors of Diarrhea occurrence in Toddlers of Banyuasin District

Hakim, M. M.¹, Irfannuddin^{1, 2}, Hermansyah^{1,3*} and Novrikasari^{1, 4}

¹*Department of Environmental Science, Graduate Program, Universitas Sriwijaya, Jalan Padang Selasa No. 524, Palembang, 30139, South Sumatera, Indonesia*

²*Department of Physiology, Faculty of Medicine, Universitas Sriwijaya, Ogan Ilir 30662, South Sumatera, Indonesia*

³*Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Sriwijaya, Ogan Ilir 30662, South Sumatera, Indonesia*

⁴*Faculty of Public Health, Universitas Sriwijaya, Ogan Ilir 30662, South Sumatera, Indonesia*

(Received 18 July, 2020; Accepted 2 October, 2020)

ABSTRACT

Inadequate environmental sanitation and the growth phase of toddlers where they are prone to diarrhea, makes diarrhea a cause of high morbidity and mortality in toddlers. The purpose of this study was to determine the description of environmental and host factors on the occurrence of diarrhea in toddlers of two wetland areas that have different characteristics. This study used cross-sectional method and cluster random sampling. Samples were 148 Family Heads from Gasing Village and 148 Family Heads from Tanjung Lago Village. Data Analysis was using univariate and bivariate. The prevalence of toddlers with diarrhea in Tanjung Lago and Gasing villages is not much different at around 21 %. In Tanjung Lago Village, latrine sanitation, sewerage and income factors are significantly related to the occurrence of diarrhea in toddlers. In Gasing Village, the factors of clean water sources, latrine sanitation, latrine quality, knowledge and hand washing with soap are significantly related to the occurrence of diarrhea in toddlers. Sanitary environmental factors and clean water resources management and water were both able to contribute in reducing cases of diarrhea in toddlers.

Key words : *Diarrhea, Water source, Latrine sanitation, Sewerage sanitation*

Introduction

Diarrhea is one of the main causes of death in toddlers. A total of 760 thousand toddlers die from diarrhea each year. Toddlers' mortality rate due to diarrhea is 11% (WHO, 2013). Mentioned 1 in 9 deaths in toddlers caused by diarrhea. Diarrhea is the main cause of death in toddlers in Indonesia (Pusat Data and Informasi Kemenkes, 2011). According to Risesdas 2013, the occurrence of diarrhea in toddlers in Indonesia in 2013 was 6.7% with a prevalence period of 7.0%. According to age characteris-

tics, the occurrence of diarrhea in Indonesia occurs in toddlers (7.0%). Toddlers with the highest occurrence of diarrhea were in the age group of 12 to 23 months (9.7%). In Indonesia children suffer from diarrhea more than 12 times per year and this is the cause of death by 15-34% of all causes of death (Wardhani, 2012). Diarrhea often occur endemic to an area. Diarrhea is a disease that is still a burden, which is a cause of infant mortality in general. In addition, acute diarrhea results in malnutrition and stunted growth (Lorntz *et al.*, 2006).

More than 90% of the causes of acute diarrhea are

infectious agents (Ahlquist and Camilleri, 2005). The cause of infection from diarrheal disease itself includes Rotavirus (40-60%), *Escherichia coli* bacteria (20-30%), *Shigella* sp. (1-2%) and the parasite *Entamoeba histolytica* (<1%) (Widoyono., 2013). Rotavirus transmission is oro-fecal through contact, air and water (Heymann, 2008). The amount of bacterial content in water with diarrhea prevalence shows that there is little difference between children who consume water with *E. coli* <1/100 ml and 2 - 100 *E. coli* / 100 ml, but when compared with children who consume water with *E. coli* levels > 1000/100 ml the difference is more significant (9% versus 15%; $p = 0.002$) (Moe *et al.*, 1991). Diarrhea is a contagious disease, which is influenced by environmental factors, the causative agent of the disease and the host. Diarrhea is one of the public health problems, especially in unhygienic environments or slums (Pahwa, 2010). Clean water facilities can be a medium for transmission of various diseases carried by water if these facilities are not sanitary. Drinking water sources must meet the requirements so that drinking water sources are kept away from pollutant. It is necessary to pay attention to the distance between drinking water sources and latrines, garbage dug pits, wastewater dug pits, and other sources of impurities (Soemirat, 2009).

Some risk factors for the occurrence of diarrhea are age, personal hygiene, stomach acid and other obstacles, namely intestinal motility, enteric micro flora, immunity and intestinal receptors (Lever and Soffer, 2009). Research by Avachat *et al.* (2011) and Amugsi *et al.* (2015) explains that low socioeconomic status, poor sanitation practices, nutritional status and weaning practices significantly influence the prevalence of recurrent diarrhea. One effort to reduce the risk of diarrhea is the procurement and improvement of clean water facilities to avoid contamination of disease-causing agents. In addition, the community must first boil drinking water to kill the disease causing agents contained in the water (Madhi *et al.*, 2016)

In South Sumatra Province, based on the Integrated Health Surveillance (STP) program based on the Puskesmas in 2009, diarrhea was the most common illness among toddlers, amounting to 56.2 %. The data of new cases of hospital-based infectious disease in 2009 showed that diarrhea was in the top three most occurred diseases. Whereas in 2008, the three most inpatient diseases suffered by toddlers were diarrhea, DHF, and clinical abdominal typhus.

South Sumatra Province has a period of diarrhea prevalence of 7.1% for toddlers (Kemenkes, 2014). The occurrence of diarrhea per 1000 population in Gasing Village and Tanjung Lago Village tends to increase. Tanjung Lago Village showed that in 2015 there were 10 events per 1000 inhabitants, in 2016 there were 13 events per 1000 inhabitants and in 2017 there were 15 events of diarrhea per 1000 population, while for Gasing Village there were 125 events per 1000 inhabitants (in 2015), 134 events diarrhea per 1000 inhabitants (in 2016) and 119 per 1000 residents in 2017.

These two villages are wetland areas that have characteristics of tidal swamps, where the amount of water content is always changing due to the influence of tides. The village of Gasing has Tanjung Api Api Port so that it develops as an industrial area that is united with residential areas. Tanjung Lago Village is an agricultural, independently integrated area. The number of people who live in this village is also quite large with activities such as bathing, washing, defecating and others carried out around rivers and swamps. These activities can make the water source polluted and it can be a source of disease, especially diarrhea.

Based on the background above, this study aims to determine the description of environmental and host factors towards the occurrence of diarrhea in toddlers of Gasing Village and Tanjung Lago Village, Banyuasin District.

Materials and Methods

This study uses a cross-sectional design with cluster random sampling technique. This study was conducted in two wetland villages in Banyuasin Regency, namely Gasing Village and Tanjung Lago Village in April-December 2018. The number of samples was calculated using the Lemeshow, Hosmer and Klar (1997) for hypothesis testing of different proportions. Therefore, samples for this study are 148 families from 11 neighborhood units of Gasing Village and 148 families from 15 neighborhood units of Tanjung Lago village. This study illustrates environmental sanitation and host factors related to the occurrence of diarrhea in toddlers. The environmental sanitation factors include laboratory tests of water sources (physical, chemical and microbiological indicators), types of clean water sources, types of drinking water sources, quality of clean water source facilities, water source condi-

tions, latrine sanitation, latrine quality, sanitation of garbage bins and sewerage. While the host characteristic factors include parental income, number of family members, family composition, mother’s education, mother’s occupation, mother’s knowledge related to diarrhea, maternal / toddler personal hygiene, toddler’s gender, toddler’s age, breastfeeding history, toddler’s utensils’ sanitary and toddler’s supplementary food. The research data went through univariate analysis, presented as percentages and bar charts, and went through bivariate analysis as presented in the table .

Results

The occurrence of diarrhea

The results of the analysis showed that the proportion of toddlers who had diarrhea in Tanjung Lago Village reached 20.95 %, with 31 cases of diarrhea out of a total of 148 respondents / toddlers, while 79.1% (117 children) had no diarrhea. The proportion of toddlers with diarrhea in the village Gasing also not much different from Tanjung Lago Village with 21.62 % or 32 cases of diarrhea of the total 148 respondents / toddlers. Toddlers who did not experience diarrhea incidence reached 78.4% with 116 toddlers out of 148 respondents/toddlers.

The following is a bar diagram illustrating the prevalence of diarrhea in toddlers for each village where the study was conducted:

Characteristics of Environmental Factors

The frequency distribution factors of the environment that affect the occurrence of diarrhea in toddlers can be seen on Table 1.

Based on Table 1 above, several characteristics of environmental factors in the respondents from the two majority villages fulfill the requirements, such as physical indicator of water (100%) and microbiology of water (more than 75%). However, several characteristics of environmental factors in the two villages are still largely categorized as not meeting the requirements, such as chemical indicators of water, clean water sources, quality of clean water source facilities, physical condition of water sources, sanitation of rubbish bins and sanitation of the sewerage. Some environmental characteristics such as drinking water sources, latrine sanitation and quality of latrines in Tanjung Lago Village have a percentage that does not meet the requirements that are greater than the percentage of Gasing Villages.

Host Factor Characteristics

The frequency distribution of host factors that affects the occurrence of diarrhea in toddlers can be seen in Table 2.

Based on Table 2 above, the analysis results of host’s characteristic data of respondents showed a lot of difference in pattern between the two villages, only a few characteristics of the host that is similar such as the composition of families at risk (over 64%) and maternal education which were approximately 98% of high school and below. On some host characteristics, Tanjung Lago Village has a higher percentage than Gasing Village such as higher percentage of income above standard, the number of non-risk family members and good toddler personal hygiene. But in some characteristics, Gasing Village has a higher percentage than Tanjung Lago Village such as higher percentage of good knowl-

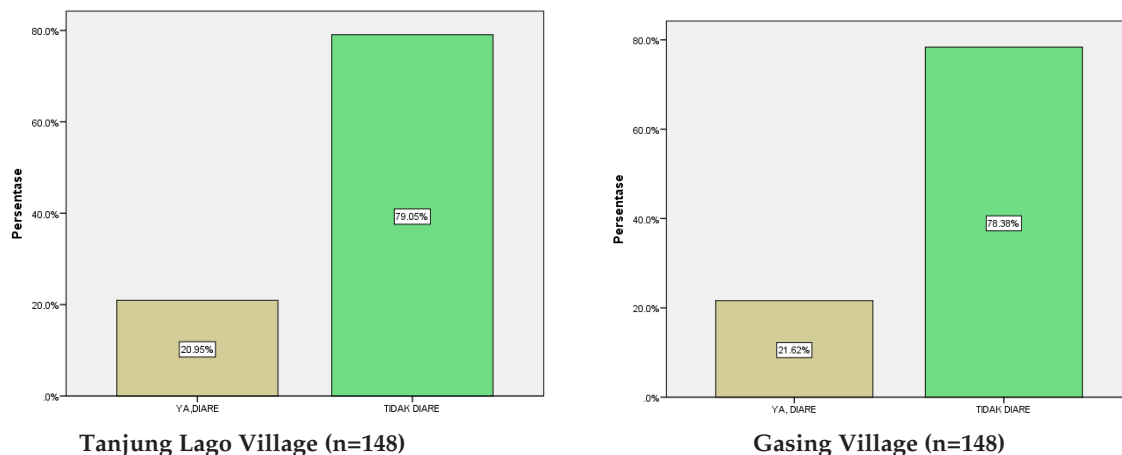


Fig. 1. Prevalence of Diarrhea in Toddlers

Table 1. Frequency Distribution of Characteristics of Respondent Environmental Factors

| Variable | Tanjung Lago Village (n = 148) | | Gasing Village (n = 148) | |
|---|-----------------------------------|------------|-----------------------------|------------|
| | Frequency | Percentage | Frequency | Percentage |
| Physical indicator of water | | | | |
| Inadequate | 0 | 0 | 0 | 0 |
| Qualify | 148 | 100 | 148 | 100 |
| Chemical indicator of water | | | | |
| Inadequate | 107 | 72,3 | 114 | 77 |
| Qualify | 41 | 27,7 | 34 | 23 |
| Microbiological indicator of water | | | | |
| Inadequate | 17 | 11,5 | 37 | 25 |
| Qualify | 131 | 88,5 | 111 | 75 |
| Water sources | | | | |
| Inadequate | 138 | 93,2 | 126 | 85,1 |
| Qualify | 10 | 6,8 | 22 | 14,9 |
| Drinking water source | | | | |
| Inadequate | 104 | 70,3 | 2 | 1,4 |
| Qualify | 44 | 29,7 | 146 | 98,6 |
| Quality of clean water source facilities | | | | |
| Inadequate | 148 | 100 | 137 | 92,6 |
| Qualify | 0 | 0 | 11 | 7,4 |
| Water source conditions | | | | |
| Inadequate | 143 | 96,6 | 147 | 99,3 |
| Qualify | 5 | 3,4 | 1 | 0,7 |
| Toilet sanitation | | | | |
| Inadequate | 104 | 70,3 | 16 | 10,8 |
| Qualify | 44 | 29,7 | 132 | 89,2 |

| Variable | Tanjung Lago Village (n = 148) | | Gasing Village (n = 148) | |
|------------------------------------|-----------------------------------|------------|-----------------------------|------------|
| | Frequency | Percentage | Frequency | Percentage |
| Latrine Quality | | | | |
| Inadequate | 6484 | 43,256,8 | 11137 | 7,492,6 |
| Qualify | | | | |
| Waste bin Sanitary | | | | |
| Inadequate | 1471 | 99,30,7 | 1435 | 96,63,4 |
| Qualify | | | | |
| Waste Water Sewage Sanitary | | | | |
| Inadequate | 13018 | 87,812,2 | 12820 | 86,513,5 |
| Qualify | | | | |

edge, good personal hygiene of the mother, the state of still conducting breastfeeding when toddlers suffering diarrhea and good sanitation of eating utensils.

Risk Factor of Diarrhea for Toddlers in each Village

Risk factors that affect the occurrence of diarrhea in toddlers in each village can be seen on Table 3 below:

Based on bivariate analysis on Table 3, it is found that variables that has correlation with occurrence of diarrhea among toddlers in Tanjung Lago Village

are latrine sanitation, the sewerage and income. Table 3 also shows that variables with correlation to occurrence of diarrhea among toddlers of Gasing Village are water sources, latrine sanitation, latrine quality, knowledge and handwashing with soap.

Discussion

Environmental Factor

Water Factor

Water plays an important role for humans for hy-

Table 2. Host Characteristic Frequency Distribution

| Variable | Tanjung Lago Village (n = 148) | | Gasing Village (n = 148) | |
|--|-----------------------------------|------------|-----------------------------|------------|
| | Frequency | Percentage | Frequency | Percentage |
| Income | | | | |
| Low (below Standard Income) | 70 | 47,3 | 102 | 68,9 |
| Height (\geq Standard Income) | 78 | 52,7 | 46 | 31,1 |
| Number of family members | | | | |
| Risky (more than 4 people) | 63 | 42,6 | 62 | 58,1 |
| No risk (less than 4 people) | 85 | 57,4 | 86 | 41,9 |
| Family composition | | | | |
| Risky (more than 1 Head of Family) | 113 | 76,4 | 96 | 64,9 |
| Not at risk (only 1 Head of Family) | 35 | 23,6 | 52 | 35,1 |
| Education | | | | |
| Low (high school and below) | 146 | 98,6 | 146 | 98,6 |
| College (Higher Education) | 2 | 1,4 | 2 | 1,4 |
| Profession | | | | |
| Does not work | 17 | 11,5 | 12 | 8,1 |
| Work | 131 | 88,5 | 136 | 91,9 |
| Variable | Tanjung Lago Village (n = 148) | | Gasing Village (n = 148) | |
| | Frequency | Percentage | Frequency | Percentage |
| Knowledge | | | | |
| Low | 90 | 60,8 | 58 | 39,2 |
| High | 58 | 39,2 | 90 | 60,8 |
| Mother's Personal Hygiene | | | | |
| Low | 130 | 87,8 | 49 | 33,1 |
| High | 18 | 12,2 | 99 | 66,9 |
| Wash Hands With Soap (CTPS) | | | | |
| Bad | 42 | 28,4 | 17 | 11,5 |
| Well | 106 | 71,6 | 131 | 88,5 |
| Defecation Behavior | | | | |
| Bad | 20 | 13,5 | 1 | 0,7 |
| Well | 128 | 86,5 | 147 | 99,3 |
| Toddler's Sex | | | | |
| Girl | 76 | 51,4 | 62 | 41,9 |
| Male | 72 | 48,6 | 86 | 58,1 |
| Toddler's Age | | | | |
| \leq 2 years | 89 | 60,1 | 84 | 56,8 |
| $>$ 2 years | 59 | 39,9 | 64 | 43,2 |
| Breastfeeding Status When Suffering Diarrhea | | | | |
| No breastfeeding | 139 | 93,9 | 0 | 0 |
| Breastfeeding | 9 | 6,1 | 148 | 100 |
| History of breastfeeding | | | | |
| Less than 2 years | 67 | 45,3 | 18 | 12,2 |
| Exactly 2 years | 62 | 41,9 | 127 | 85,8 |
| $>$ 2 years | 19 | 12,8 | 3 | 2 |
| Toddler's Personal Hygiene | | | | |
| Low | 23 | 15,5 | 96 | 64,9 |
| High | 125 | 84,5 | 52 | 35,1 |
| Sanitary tableware for toddlers | | | | |
| Low | 96 | 64,9 | 69 | 46,6 |
| High | 52 | 35,1 | 79 | 53,4 |
| Toddler's food supplement | | | | |
| Yes | 125 | 84,5 | 144 | 97,3 |
| No | 23 | 15,5 | 4 | 2,7 |

Table 3. Risk Factor of Diarrhea for Toddlers in each Village

| Variables | | Tanjung Lago Village (n=148) | | Gasing Village (n=148) | |
|-------------------------------------|-----------------------------------|---------------------------------|--------------------------|---------------------------|--------------------------|
| | | <i>P-Value</i> | PR CI 95% | <i>P-Value</i> | PR CI 95% |
| Environmental Factor | | | | | |
| Physical indicator | Inadequate | - | - | - | - |
| | Adequate | | | | |
| Chemical indicator | Inadequate | 0,065 | 2,58 (0,965 – 6,936) | 0,380 | 1,611 (0,672 – 3,860) |
| | Adequate | | | | |
| Microbiological indicators | Inadequate | 1* | 0,826 (0,281 – 2,427) | 0,249 | 0,556 (0,231– 1,338) |
| | Adequate | | | | |
| Water sources | Inadequate | 0,122* | - | 0,009* | 0,384 (0,212 – 0,696) |
| | Adequate | | | | |
| Drinking water source | Inadequate | 1 | 1,034 (0,828 – 1,187) | 0,387* | 2,355 (0,569 – 9,749) |
| | Adequate | | | | |
| Quality of Clean Water Resources | Inadequate | - | - | 0,926 | 0,776 (0,281 – 2,147) |
| | Adequate | | | | |
| Water source conditions | Inadequate | 0,281 | 0,507 (0,165 –1,556) | 1* | - |
| | Adequate | | | | |
| Latrine sanitation | Inadequate | 0,037 | 2,856 (1,062 – 7,679) | 0,001* | 3,228 (1,826 – 5,707) |
| | Adequate | | | | |
| Latrine quality | Inadequate | 0,095 | 1,817 (0,963 – 3,429) | 0,002* | 3,487 (1,972 – 6,168) |
| | Adequate | | | | |
| Waste sanitation | Inadequate | 1* | - | 0,585* | - |
| | Adequate | | | | |
| Sewerage Sanitation | Inadequate | 0,014* | - | 0,918* | 0,844 (0,368 – 1,935) |
| | Adequate | | | | |
| HOST FACTORS | | | | | |
| Income | Below standard | 0,05 | 2,026 (1,046 – 3,924) | 0,291 | 1,611 (0,751 – 3,452) |
| | Above standard | | | | |
| Number of family members | More than 4 people | 0,776 | 0,852 (0,447 – 1,624) | 0,240 | 0,630 (0,322-1,235) |
| | Less than 4 people | | | | |
| Family composition | Risky (> 1 head of family) | 0,936 | 0,890 (0,438 –1,810) | 0,345 | 0,696 (0,378 – 1,284) |
| | No risk (1 family head) | | | | |
| Education | Low | 1* | - | 1* | - |
| | High | | | | |
| Profession | Does not work | 0,756* | 1,142 (0,455 – 2,866) | 0,463* | 0,366 (0,055 – 2,449) |
| | Work | | | | |
| Knowledge | Low | 0,788 | 1,172 (0,607 – 2,261) | 0,013 | 0,358 (0,157 – 0,816) |
| | High | | | | |
| Mother's personal hygiene | Low | 0,536* | 1,389 (0,611 – 3,155) | 0,189 | 0,566 (0,263 – 1,216) |
| | High | | | | |
| Wash Hands with Soap | Bad | 0,561 | 0,736 (0,343 – 1,578) | <0,0001* | 4,624 (2,785 – 7,675) |
| | Good | | | | |
| Defecation Behavior | Bad | 0,136 | 1,867 (0,929 – 3,750) | 1* | - |
| | Good | | | | |
| Gender | Female | 1 | 1,011 (0,540 – 1,890) | 1* | 0,949 (0,508 – 1,774) |
| | Male | | | | |
| Toddler's age | ≤ 2 years | 0,953 | 0,918 (0,487 – 1,729) | 0,590 | 1,270 (0,671 – 2,402) |
| | > 2 years | | | | |
| Breastfeeding Status | Not breastfeed during diarrhea | 0,685* | 0,515 (0,079 – 3,356) | - | - |
| | Breastfeeding during diarrhea | | | | |

Table 3. Continued ...

| Variables | | Tanjung Lago Village (n=148) | | Gasing Village (n=148) | |
|----------------------------|-----------------|------------------------------|--------------------------|------------------------|--------------------------|
| | | P-Value | PR CI 95% | P-Value | PR CI 95% |
| History of breastfeeding | <2 years | 0,535 | 0,650 (0,167 – 2,533) | 0,579 | 0,5 (0,038 – 6,547) |
| | Exactly 2 years | 0,621 | 0,707 (0,178 – 2,799) | 0,485 | 2,386 (0,21 – 27,49) |
| | > 2 years | | Reference | | |
| Toddler's Personal Hygiene | Low | 0,265* | 1,585 (0,776 – 3,240) | 0,075 | 0,542 (0,296 – 0,992) |
| Sanitary food equipments | High | | | | |
| | Low | 0,797 | 0,858 (0,453 – 1,625) | 0,333 | 0,687 (0,363 – 1,301) |
| Toddler Supplement | High | | | | |
| | Yes | 0,785* | 1,242 (0,480 – 3,215) | 0,577 | - |
| | No | | | | |

* Alternative test: Fisher Exact Test

giene and sanitation use that is necessary to maintain personal hygiene such as toothbrushing and bathing, also used to wash clothes, eating utensils cleaning, and food processing. On the other hand, if the water does not meet the water quality requirements, it will become the transmission of various diseases infection, one of which is diarrhea. Based on the standard regulation of the Minister of Health of the Republic of Indonesia No. 416 / MENKES / PER / IX / 1990 concerning healthy and clean water quality requirements that contain physical, chemical, bacteriological and radiological requirements.

Water that has good quality with the function of clean water (raw water) as well as drinking water sources includes the importance of meeting physical requirements, such as colorless, not turbid, tasteless, and odorless. In general, these important physical requirements are met as water aesthetics. Laboratory examination results for water sources showed that all water sources in the two villages met the physical requirements in terms of color, odor, turbidity, taste, temperature and total dissolved solids. Non-tasteless water will present all kinds of substances that are harmful to health. Fishy or metallic taste, salty, bitter, and so on. The impact depends also on the emergence of these taste factors. The presence of substances causes changes in water physics and if it is beyond the threshold, it can be dangerous to health.

According to Permenkes RI 416/MENKES/PER / IX / 1990 the pH of the water should be neutral, not alkaline and not acidic, to avoid tissue corrosion and dissolution of heavy metals. Good pH of water

in drinking water is 6.5-9.0. Utilization of water with levels of chemicals that exceed the maximum limit is allowed and toxic chemicals cause materials used by humans and health to be unfavorable. Laboratory results show that around more than 70% of water sources in each village do not meet chemical requirements because the pH of the water is outside the normal pH range for the water source. Water is a very good solvent so that when followed by a non-neutral pH it can dissolve all kinds of chemical elements through it.

The results of the bivariate analysis stated that there was a correlation between the source of water with the occurrence of diarrhea in toddlers in Gasing Village ($p = 0.009$). The results of the study are supported by research conducted by Komarulzaman *et al.* (2017) showing a correlation between the source of clean water used by households and the prevalence of diarrhea. The conclusions from a study conducted by Amaliah (2010) also stated that there was a significant correlation between the use of clean water sources and the occurrence of diarrhea, with the results of the *chi-square* analysis obtained $p = 0.007$. The results of this study are also in line with study by Nurpauji (2016) which shows that there is a significant relationship between the type of clean water source for drinking and the occurrence of diarrhea ($p = 0.003$).

The majority of respondents (70.3%) of Tanjung Lago Village used drinking water sources that did not meet the requirements; meanwhile in Gasing Village only around 1.4% of drinking water sources did not meet the requirements. Around 93.2% of

respondents in Tanjung Lago Village and 85.1% of respondents in Gasing Village used clean water sources that did not meet the requirements. Water sources that are categorized to be meeting the requirements are if they come from PDAMs, dug wells, drilled wells and refill water, while water sources from rivers / lakes / swamps and rain fed do not meet the requirements. The use of refill water as a source of clean / drinking water can be a good choice in efforts to prevent the occurrence of diarrhea in toddlers in wetlands. However, management of refill water consumption must be considered because the health quality of the water is not fully guaranteed.

The people of Tanjung Lago Village and Gasing Village use river water daily to wash and bathe, but for cooking some of them use well water. Some residents who use gallon water directly consume it without boiling it first, because respondents felt that refill drinking water from the gallon water was already clean and proper to drink directly. In fact, the refilled water gallon actually came from river water, and must be boiled first (to 100 °C) before water is consumed.

The field observations in the areas of Tanjung Lago Village and Gasing Village shows that there are three areas located in the river basin, which are the upstream, downstream, and middle stream areas. In the upstream area, the water quality is slightly clearer, contains fewer biological and chemical contents. Downstream areas have the potential to be polluted far more because they have higher biological and chemical contents and with more variations. The middle area which meets other river streams has a larger volume and a very slow flow. It is a flow from the downstream area formed by a muddy delta with a very turbid color so that it contains a lot of dissolved substances. In general, a complete processing is needed for water from this source.

Environmental Sanitation Factor

According to environmental sanitation is one of three underlying factors that affects the occurrence of diarrhea and children's health status that also affects the quality of children's growth. Two other underlying factors are sustenance in the household and weaning method. This is in line with the report released by World Health Organisation (2011) which shows that a bad environmental sanitation could manifest into the occurrence of diarrhea and

other infections in toddlers. This issue is also in line with Bloom's theory where public health status is determined by hereditary factor, healthcare, behaviour and environmental factor.

There are two dominant environmental factors that causes diarrhea; defecation behaviour and clean water facilities. Those factors can interact with human behaviour. If the environment is unhealthy because it is infected with bacteria, combined with unhealthy human behaviour, diarrhea incidence will occur. The research shows that 70,3% respondents from Tanjung Lago Village has inadequate latrine sanitation, while 89,2% respondents from Gasing Village already has adequate latrine sanitation. 43,2% respondents of Tanjung Lago Village has inadequate latrine quality while in contrast, 92,6% Gasing Village respondents already fulfilled ten minimal requirements and criterias for healthy latrine.

The research shows that more than 95% respondents from both Tanjung Lago and Gasing Village have inadequate waste bin sanitation and more than 85% respondents from both villages does not have healthy and sanitary sewerage. Despite the little difference between proportion of waste facilities in Tanjung Lago Village and Gasing Village, the waste bin/ waste facilities and sewerage in Tanjung Lago Village are in worse condition compared to Gasing Village.

Combined analysis result of the research shows that there is a significant correlation between latrine sanitation and latrine quality with the occurrence of diarrhea in toddlers. Separated analysis shows a different pattern where sewerage sanitation and latrine sanitation Tanjung Lago Village has significant correlation with occurrence of diarrhea in toddlers. Meanwhile, latrine sanitation and latrine quality has significant correlation with occurrence of diarrhea in toddlers in Gasing Village.

Demographic and Health Survey Data (1997) shows that children below 5 years old whose family use a bore well has a risk of diarrhea 1,2 times more compared to children whose family use pump well. Research in Karangmangu Village of Rembang District also reported significance between drinking water quality (p-value=0,008) with the occurrence of diarrhea (Wandansari, 2013). In January-December 2012 period in Tubir Village, Manado, there was 74% of 100 respondents who suffered diarrhea. The result of that research also reported that the water source they use the most are tap water (23%), river

water (52%), non-cemented well (3%) and cemented well (22%). Meanwhile, drinking water sources are tap water (21%), well (23%), refilled gallon water (41%) and river water (15%) (Lagarensen, Palandeng and Rombot, 2013).

Indonesia is the second place for the most unsanitary defecation habit in the world in 2014 after India. UNICEF data from the year 2014 shows 24% of Indonesian citizens were still having unsanitary defecation habit or 63 millions of Indonesian people were still defecating into the river (Bappenas, 2011). This behaviour is a direct and indirect factor of drinking water contamination also re-contamination of food sources and drink at home. Unsanitary defecation habit is defined as leaving their feces in the open and in improper location. Whereas healthy lifestyle, hygiene and sanitation can control communicable diseases, water transmission, and also gives significant economical, environmental and social advantages (Depkes, 2008).

Host Factors

Socio-Economic Factors

Around 47.3% of respondents in Tanjung Lago Village have income below the minimum wage, while 68.9% of respondents in the Gasing village have income below the minimum wage. Based on the analysis, significant income is associated with the occurrence of diarrhea in toddlers of Tanjung Lago Village with a p-value of 0.05. Based on research by Ariesta *et al.* (2017), the p-value was 0.006 ($P < 0.05$) which means that there was a statistically significant relationship between socio-economic family and diarrhea occurrence in toddlers of the East Kaduagung Village Work Area of Mandala Health Center. This is not in line with research Maidartati and Dewi Anggraini (2017) shows that there is a significant relationship between parental income factors and the occurrence of diarrhea in toddlers in Babakansari Health Center in Bandung with a p-value (0.038). Economic factors are factors that indirectly cause the occurrence of diarrhea in toddlers. Income is one of the determinants of fulfilling the level of food diversity, families with sufficient income will increase purchasing power of food and food diversity will be fulfilled. In addition, adequate income also affects the ability of families to access health facilities.

Mother Factor

In addition to the extrinsic and intrinsic factors of

toddlers, risk factors for the occurrence of diarrhea are also influenced by the behavioral factors of mothers and or caregivers of toddlers. Because toddlers themselves are very dependent on their caregivers, if their caregivers cannot maintain toddlers' good health, they can not avoid the case of diarrhea in toddlers.

It is known that as many as 60.8% of respondents from Tanjung Lago Village and 39.2% of respondents from Gasing Village have low knowledge on facts related to diarrhea. In addition, around 77% of respondents in Tanjung Lago Village and 45% of Gasing Village respondents did not know the cause of diarrhea. The mother is the main person who is closest to the child, and has the responsibility in caring for her child. For this reason, a mother must have good knowledge to avoid health problems in toddlers, especially diarrhea. Knowledge is the result of the process of learning. These factors occur after a person senses an object, such as seeing, hearing, and feeling. This relates to a mother's knowledge. Clean and healthy lifestyle can be applied by mothers in their domestic environment when the mother has good knowledge and knows the risks if they don't apply it to their family.

Several other studies also support the idea that mother's knowledge is one of the factors that influence the occurrence of diarrhea in toddlers. This is in accordance with research conducted by Hartati and Neurazila (2018) which states that there is a correlation between the level of knowledge and the occurrence of diarrhea in toddlers in the Rejosari Public Health Center Pekanbaru area with a p-value = 0,000 < 0.05. Mothers who have good knowledge understand about clean and healthy living practices and are able to apply it in a family environment. In addition, mothers who have good knowledge understand how diarrhea transmits to toddlers so they can take precautions early. The level of mother's education also influences the knowledge and behavior of mothers regarding the occurrence of diarrhea (Hartati *et al.*, 2018). Education is a cause that can influence a person in understanding and absorbing the knowledge they have received. The higher the education level of the mother, the easier it will be for the mother to understand the message of health information and preventive measures from the disease (Christy, 2014).

Washing hands with soap is very important for mothers to do because hands are the transmitting routes for viruses and bacteria to get into the body.

Diarrhea can occur in toddlers with intermediaries dirty hands when the mother or caregiver preparing their food. Therefore, it is important for mothers to wash their hands using soap either before or after preparing food for toddlers to kill bacteria and germs that cause diarrhea on their hands (Rifai *et al.*, 2016). This is not in accordance with the results of this study where the personal hygiene of respondents in each village is fairly high with a percentage above 65%. This indicates the high occurrence of diarrhea in the two villages could be due to other factors.

Toddler Factor

Based on the results of the study, the characteristics of toddlers in Tanjung Lago Village are 51.4% female and 60.1% aged 2 years or less, while the characteristics of toddlers in Gasing Village are 41.9% female and 56, 8% aged 2 years old or less. The majority of toddlers getting breastfeed when they suffer diarrhea is 93.9% from Tanjung Lago Village and 100% from Gasing Village. Then as for other factors that cause toddlers vulnerable to diarrhea is history of exclusive breastfeeding. This study noted that more than 41% of toddlers in Tanjung Lago Village and 85% of toddlers in Gasing Village was breastfed for 2 years or more. Based on Sukardi's research in 2016, there was a significant correlation between exclusive breastfeeding and the occurrence of diarrhea in toddlers in the work area of Poasia Health Center with a p-value = 0.024.

Toddlers who receive exclusive breastfeeding have protective substances in their digestive tract that are obtained through breast milk such as bifidus factor, cellular immunity, humoral immunity, lactoferrin, and lysozyme. These protective substances work as a protector against parasitic, viral, and bacterial infections. In addition, immunologically breast milk has preventive properties with the presence of antibodies and other substances contained in them. In neonates (newborns), exclusive breastfeeding has 4 times greater protective power from occurrence of diarrhea compared to baby feeding by using formula milk because breast milk is sterile, different from other sources of milk such as formula milk or other liquids that can get contamination from germs and bacteria that have additional ingredients used such as water or equipment used such as flow nipples (Susanti, 2012).

Sanitary cutlery for toddlers used by respondents from Tanjung Lago Village is relatively low at

64.9% of respondents, while from Gasing Village at 53.4% of respondents with high sanitary utensils for toddlers. Around 84.5% of respondents in Tanjung Lago Village and around 97.3% of respondents in Gasing Village chose to buy extra food for toddlers. There are several aspects that are regulated in food handling, namely food ingredients, equipment, water, food handlers, food additives, food handlers and serving facilities.

Occurrence of Diarrhea in Toddlers

Diarrhea in Toddlers

Based on a report from WHO (2017), diarrhea is the main cause of morbidity and mortality in toddlers or children under 5 years (0 - 59 months). Globally, the occurrence of diarrhea in 2015 - 2017 shows an increase in cases. In 2015, diarrhea caused an estimated 499,000 deaths and 688 million illness worldwide which occurred in children aged <5 years. Then in 2017, WHO stated the occurrence of diarrhea reached 1.7 billion with a mortality rate of around 525,000 annually in toddlers.

Indonesia is a developing country in the Southeast Asia region with the highest occurrence of diarrhea. Based on a report from the Ministry of Health of the Republic of Indonesia in 2011, diarrheal disease became an endemic disease and a potential extraordinary event (KLB) which was the main cause of death in toddlers in Indonesia. The largest proportion of diarrhea sufferers in the toddler group is the age group 24-29 months at 12.37%, the age group 12-17 months at 14.43%, the age group 6-11 months that is at 21.65%, whereas in the age group 54 - 59 months, 2.06% is the smallest proportion. Then based on data from the Republic of Indonesia Health Profile (2016), diarrheal diseases also caused outbreaks from 2013 to 2016 accompanied by an increase in Case Fatality Rate (CFR). In 2013, the diarrhea CFR of 1.08% increased in 2014 to 1.14%. The CFR increase during the extraordinary event, in 2015 it reached 2.47% and in 2016 it reached 3.04%. This figure is not in line with the expected target of <1% (Kemenkes, 2017).

The results of the study reported that the occurrence of diarrhea in toddlers reached almost a quarter of the 148 respondents, reaching 20.95% in Tanjung Lago Village and 21.62% in Gasing Village. The figure is quite high because the scope of the study was conducted in only two villages; Gasing Village and Tanjung Lago Village, Banyuasin Re-

gency. Whereas based on the Health Profile of Banyuasin District (2016), the total cases of diarrhea in all ages in Banyuasin Regency in 2016 were 23,394 cases or with an Incidence Rate of 28.4% (for all ages).

Conclusion

The proportion of toddlers with diarrhea in Tanjung Lago and Gasing villages is not much different at around 20%. The factors of latrine sanitation, sewerage sanitation and income are related significantly to the occurrence of diarrhea in toddlers of Tanjung Lago Village. Factors of water sources, latrine sanitation, latrine quality, knowledge and hand washing with soap are significantly related to the occurrence of diarrhea in toddlers of Gasing Village. Sanitary waste bins and sewerage (SPAL) in the two villages are still poor. Improvement of water and environmental sanitation (latrine sanitation, sewerage sanitation, waste bins sanitation, water source and drinking water sanitation) as well as education for mothers (related to personal hygiene, breastfeeding, supplementary food, sanitary utensils and hand washing with soap) can contribute greatly in efforts to reduce the prevalence of diarrhea in Tanjung Lago Village and Gasing Village, Banyuasin District.

Acknowledgements

Authors acknowledge the contribution of Health Department of Banyuasin District, South Sumatra, Indonesia for the supports and cooperation during this study.

References

- Ahlquist, D. and Camilleri, M. 2005. Diarrhea and constipation. *Diarrhea and Constipation*. 207-222. doi: 10.1016/b978-1-4160-4698-1.50049-7.
- Amaliah, S. 2010. Hubungan sanitasi lingkungan dan faktor budaya dengan kejadian diare pada anak balita di Desa Toriyo Kecamatan Bendosari Kabupaten Sukoharjo. *Jurnal Unimus*.
- Amugsi, D. A. 2015. Socio-demographic and environmental determinants of infectious disease morbidity in children under 5 years in Ghana. *Global Health Action*. 8(1). doi: 10.3402/gha.v8.29349.
- Ariesta, R., Ervina, A. and Eida, D. N. 2017. Hubungan sosial ekonomi keluarga and pekerjaan ibu dengan kejadian diare pada balita. *Jurnal Obstretika Scientia*. 4(2) : 472-489.
- Avachat, S. S. 2011. A cross-sectional study of socio-demographic determinants of recurrent diarrhoea among children under five of rural area of western Maharashtra, India. *Australasian Medical Journal*. 4 (2): 72-75. doi: 10.4066/AMJ.2011.524.
- Bappenas, 2011. *Kebijakan Nasional Pembangunan Air Minum and Penyehatan Lingkungan Berbasis Masyarakat*. Jakarta.
- Christy, M. 2014. Faktor yang Berhubungan dengan Kejadian Diare Pada Anak. *Berkala Epidemiologi*. 2(3).
- Depkes, R.I. 2008. *Pedoman Sanitasi Total Berbasis Masyarakat (Pedoman STBM)*. Jakarta. Dinas Kesehatan Provinsi Sumatera Selatan (2009)
- Gurpreet, K. T. 2011. Incidence and Determinants of Acute Diarrhoea in Malaysia: A Population-based Study. *Journal Health Population Nutrition*. 103-112.
- Hartati, S. and Nurazila, N. 2018. Faktor Yang Mempengaruhi Kejadian Diare Pada Balita Di Wilayah Kerja Puskesmas Rejosari Pekanbaru. *Jurnal Endurance*. 3(2) : 400. doi: 10.22216/jen.v3i2.2962.
- Heymann, D. 2008. *Control of Communicable Diseases Manual, 19th Edition*. Washington DC: American Public Health Association. Indonesia, K. K. R. 2014. *Pusat Data and Informasi Kementerian Kesehatan*. Jakarta.
- Kemenkes, R.I. 2014. *Pusat Data and Informasi Kementerian Kesehatan*. Jakarta.
- Kolopaking, M. 2002. Penatalaksanaan Muntah and Diare Akut. Makalah Simposium Penatalaksanaan Kedaruratan di Bidang Ilmu Penyakit Dalam II'. Jakarta, pp. 1-11.
- Komarulzaman, A., Smits, J. and de Jong, E. 2017. Clean water, sanitation and diarrhoea in Indonesia: Effects of household and community factors. *Global Public Health*. 12 (9) : 1141-1155. doi: 10.1080/17441692.2015.1127985.
- Lagarensen, D. E., Palandeng, H. M. and Rombot, D. V. 2013. Gambaran Sumber Air and Kejadian Diare di Kampung Tubir Kecamatan Paal II, Manado Periode Januari â Desember 2012. *Jurnal Kedokteran Komunitas Dan Tropik*. 1(4).
- Lever, D. and Soffer, E. 2009. *Acute Diarrhea*. Philadelphia: Cleveland Clinic Center for Continuing Education.
- Lorntz, B. 2006. Early childhood diarrhea predicts impaired school performance. *Pediatric Infectious Disease Journal*. 25 (6) : 513-520. doi: 10.1097/01.inf.0000219524.64448.90.
- Madhi, S. A. 2016. Effect of human rotavirus vaccine on severe diarrhea in African infants. *Malawi Medical Journal*. 28(3) : 108-114. doi: 10.1056/NEJMoa0904797.
- Maidartati and Dewi Anggraini, R. 2017. Faktor-Faktor yang Berhubungan dengan Kejadian Diare Pada Balita (Study Kasus: Puskesmas Babakansari). *Jurnal Keperawatan BSI*, 5(2).

- Moe, C. L. 1991. Bacterial indicators of risk of diarrhoeal disease from drinking-water in the Philippines. *Bulletin of the World Health Organization*, pp. 305–317.
- Nurpauji, S. V. 2016. Hubungan Jenis Sumber Air, Kualitas Bakteriologis Air, Personal Hygiene Dengan Kejadian Diare Pada Balita Di Wilayah Kerja Puskesmas Lamper Tengah Semarang. *Jurnal Kesehatan Masyarakat (e-Journal)*. 3(1) : 569–578.
- Pahwa, S., Kumar, G. T. and Toteja, G. S. 2010. 'Performance of a community-based health and nutrition-education intervention in the management of diarrhoea in a slum of Delhi, India. *Journal of Health, Population and Nutrition*. 28(6) : 553–559. doi: 10.3329/jhpn.v28i6.6603.
- Pusat Data and Informasi Kemenkes RI. 2011. *Situasi diare di Indonesia, Jurnal Buletin Jendela Data & Informasi Kesehatan*. Jakarta.
- Rifai, R., Wahab, A. and Prabandari, Y. S. 2016. Kebiasaan cuci tangan ibu dan kejadian diare anak/: studi di Kutai Kartanegara. *Berita Kedokteran Masyarakat*, 32(11) : 409–414.
- Soemirat, J. 2009. *Kesehatan Lingkungan*. Yogyakarta: Gajah Mada University Press.
- Suhardiman, 2007. Hubungan Escherichia coli (E.coli) Dalam Air Minum dengan Kejadian Diare Pada Balita di Kota Tangerang, Tesis, Program Pasca Sarjana. Program Studi Ilmu Kesehatan Masyarakat, Fakultas Kesehatan Masyarakat Universitas Indonesia, Depok.
- Susanti, N. 2012. Peran Ibu Menyusui Yang Bekerja Dalam Pemberian Asi Eksklusif Bagi Bayinya. *Egalita*. doi: 10.18860/egalita.v0i0.2122.
- Wandansari, A. P. 2013. 'Kualitas Sumber Air Minum and Pemanfaatan Jamban Keluarga Dengan Kejadian Diare. *KESMAS - Jurnal Kesehatan Masyarakat*. 9(1) : pp. 24–29. doi: 10.15294/kemas.v9i1.2826.
- Wardhani, D. P. K. 2012. 'Faktor-Faktor yang Berhubungan dengan Frekuensi Kejadian Diare pada Bayi Umur 7-12 Bulan di Wilayah Kerja Puskesmas Kedungmundu Kecamatan Tembalang Kota Semarang. *Jurnal Kesehatan Masyarakat*. 1(2) : pp. 945–954.
- WHO. 2013. *Diarrheal Disease*. USA
- WHO. 2017. *Diarrhoeal Disease*. USA.
- Widoyono. 2013. *Penyakit Tropis/: Epidemiologi, Penularan, Pencegahan, and Pengendalian*. Jakarta: Erlangga.
-