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High Incidence of Contact Dermatitis in Communal Rainwater Harvesting Users in a Rural Area of Sampang, Madura, East Java, Indonesia

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ABSTRACT: Marparan village in Sampang, Indonesia uses a communal rainwater harvesting system (RWHS) for collecting water during the dry season. This study aimed to assess the quality of the water in the communal rainwater catchment pond (CRHP) and investigate the occurrence of contact dermatitis among the community members. The research followed an observational approach with a cross-sectional design, involving 50 individuals randomly selected from the user community of the CRHP for sanitation hygiene purposes. Water samples were collected from the CRHP and analyzed for physical characteristics, pH level, and surfactant content. The results revealed that the water in the communal rainwater storage pond did not meet the quality standards established by the Ministry of Health Indonesia. Additionally, a significant association was found between age and the occurrence of contact dermatitis. However, no significant relationships were observed between variables such as activity type, exposure frequency, and the incidence of contact dermatitis. Moreover, no relationships were identified between activity type, exposure frequency, duration of exposure, and the occurrence of contact dermatitis. It was observed that respondents did not rinse with clean water after using the communal rainwater storage pond for bathing or washing clothes. Therefore, it is recommended that individuals rinse with clean water after engaging in activities involving the use of the rainwater storage pond to minimize the risk of contact dermatitis.

KEYWORDS: Contact dermatitis; water quality; communal rainwater catchment; sanitation hygiene

1. Introduction

The global water crisis is expected to worsen if urgent action is not taken to make sustainable improvements. Water is an essential component of daily human life, and it is crucial to raise awareness about the use of clean water. Proper administration of water management policies should also be implemented [1]. Drinking polluted water has led to an increase in the incidence of waterborne diseases, such as diarrhea and vomiting. Without proper treatment, these diseases can be fatal. Ensuring the safety of drinking water quality is a significant

challenge for public health, as water contamination with pathogenic microorganisms poses an increasingly serious threat to human health [2]. According to Dammeh from the United Nations Environment Programme (UNEP) within Shafira (2011), approximately 10 million people worldwide are struggling to access clean water supplies. This clean water crisis will spread to several developing countries. If not managed properly and effectively, many people will be affected by the lack of clean water. One alternative solution to address this issue is water conservation. When rain comes, it often overwhelms the collection systems with a sudden burst of water. Key strategies for addressing this issue include erosion control, ponding and storage, managed aquifer recharge, wetland restoration, and the promotion of viable ecosystems managed for water conservation, among others. Through research, pilot programs, and effective monitoring, practical and affordable rainwater harvesting systems can be developed, which can be incrementally upgraded to serve households and institutions such as schools and healthcare facilities. It is essential to recognize rain as the invaluable resource that it is [3]. Minister of Health Policy No. 32, 2017 states that water utilization is intended for sanitation and hygiene needs, public baths, solus per aqua, and swimming pools. The quality of water used for sanitation and hygiene purposes differs from the quality required for drinking water [4].

The village of Marparan is located in the Sampang District, Sampang, Indonesia. It consists of two hamlets: Marparan and Soro'an. Clean water scarcity is one of the problems faced by this village, particularly during the dry season. In order to meet sanitation and hygiene needs, the village relies on communal rainwater harvesting system (RWHS). Soro'an hamlet has several communal rainwater catchments to assist its residents during the dry season. However, the water from these catchments is not allowed to be used outside the catchment area. RWHS in West Soro'an hamlet lack inlet and outlet channels, which means that all community activities, such as washing clothes, bathing, and washing feet, must be carried out within the pond. The absence of inlet and outlet pipes has the potential to affect water quality and may also impact skin health, such as causing contact dermatitis. Based on the village health house report 2017, in August, villagers experienced skin diseases such as itching and allergies. This particular disease ranked second among 12 reported cases. Village midwives, during interviews, attributed this phenomenon to the use of RWHS for activities like washing clothes and bathing. Information gathered also indicated that skin diseases caused by seafood allergies were minimal because the villagers primarily consumed food from rivers and ponds. During preliminary studies, the majority of participants complained of various skin issues, including heat, itching, and spots. Out of the eight individuals interviewed, six stated that the occurrence of these diseases could be attributed to factors such as seafood allergies, high temperatures, and bathing and washing clothes in the RWHS. Similar skin health problems were also observed among individuals in close proximity. Based on these issues, the aim of this research was to establish a correlation between water quality and the incidence of contact dermatitis among the community in West Soro'an hamlet, Sreseh District, Sampang. The study analyzed water quality parameters such as turbidity, temperature, color, pH, and detergent levels, comparing them with the standards outlined in Health Minister Policy No. 32 of 2017. Additionally, the research considered individual characteristics (age and gender), socioeconomic conditions (education level, occupation, and

family income), and exposure factors (type of activity, frequency, and habit of rinsing with water).

2. Materials and Methods

2.1. Experimental design.

The type of research conducted in this study is observational, using a cross-sectional approach. The research took place in West Soro'an hamlet, Marparan Village, Sreseh District, Sampang Regency, Indonesia. Two types of samples were collected for this study: community samples and water samples. The community sample consisted of 50 individuals, selected through a simple random sampling technique. Water samples were collected from a communal rainwater catchment pool, which was not permitted for general use in West Soro'an hamlet. Water sampling took place on Wednesdays at two different points, labeled as Point 1 and Point 2, during two designated times: 03:32 AM (before use) and 15:55 PM (after use). Point 1 was identified as the primary location for bathing and washing clothes, while Point 2 represented a similar location but with less frequent usage. For each collection time and point, water samples were obtained from both the surface and bottom layers, with a total volume of 1.5 liters per collection. These samples were mixed in a container according to the guidelines outlined in SNI 698957 of 2008, which provides the recommended method for sampling surface water.

2.2. Tools and materials.

In this study, various tools and materials were used, including water sampling bottles, ropes, jerry cans, sample carrier bottles, stationery, label paper, and water funnels. The process of collecting water samples involved several steps. Firstly, the water sampling bottles were prepared by attaching ropes and creating a hole in the mineral water cap. The specific sampling points were then determined to facilitate the collection process in the field. To ensure the cleanliness of the samples, the sampling bottles, jerry cans, and sample carrier bottles were thoroughly rinsed multiple times with the water to be collected. Next, the sampling bottles were inserted into the water at the desired points and depths, and subsequently lifted out. In order to mix the surface water with the water collected at specific depths, the samples were poured from the sampling bottles into the jerry cans using water funnels. The water samples, with a volume of 1.5 liters, were then transferred from the jerry cans into the sample carrier bottles using the water funnels. To keep track of the samples, important information such as sampling time, sampling point, sampling location, sampler's name, and the parameters to be analyzed were recorded and labeled. Lastly, these steps were repeated to ensure that samples were collected from all designated points and at different collection times. The procedures adhered to the guidelines outlined in reference [5].

2.3. Equipment/analysis.

This study utilizes both primary and secondary data. There are four primary data collection techniques employed, namely observation, interviews, laboratory tests, and field tests.

Observation was conducted by a licensed doctor to gather data on the incidence of contact dermatitis. Interviews were conducted by researchers to examine socioeconomic conditions (such as education level, job types, and family income) and exposure factors (such as types of activities, frequency of exposure, duration of exposure, and washing habits) among the respondents. Laboratory tests were performed to assess water quality parameters, including turbidity, color, and detergent levels. Field tests were conducted to measure water temperature and pH. Secondary data were obtained from the village health house to analyze the trend of contact dermatitis/skin diseases in Marparan Village, and from the village profile to gain an overview of the village itself. The physical and chemical quality of water exceeding the maximum specified limits can have negative impacts on one's health. Contact dermatitis is one of the health issues associated with such deteriorations [6].

2.4. Statistical analysis.

The data analysis technique employed in this study involves analytical analysis assisted by computer equipment. Descriptive analysis is utilized to describe and present data on various aspects including water quality parameters (such as turbidity, color, temperature, pH, and detergent levels), socioeconomic conditions (such as education level, job types, and family income), and exposure factors (such as types of activities, frequency of exposure, and duration of exposure) among the respondents. For further analysis, the chi-square test is used to examine the relationship between exposure variables and the incidence of contact dermatitis. This statistical method helps to determine if there is a significant association between these variables. It is worth noting that this research has undergone ethical review and has obtained approval from the ethics committee of the Faculty of Public Health, Airlangga University, Surabaya.

3. Results and Discussion

West Soroa'an Hamlet is part of Marparan Village, Sreseh District, Sampang Regency. According to the monograph data of Marparan Village, it is stated that the village land was divided into four categories: backyard plantations, yards, rice fields, and ponds. The area designated for backyard plantations covered 60,000 hectares, the yard area is 140,000 hectares, the rice fields covered 3,280,000 hectares, and the pond area spanned 4,910,000 hectares. The profile of Marparan Village in 2017 recorded a total of 243 families in Soro'an Hamlet [7]. Due to its geographical location surrounded by rivers, accessing this village through land routes was not possible. This created various limitations, one of which was the availability of clean water. In West Soro'an Hamlet, there were two communal RWHS. One of the catchments allowed the use of its water outside the immediate area, while the other catchment, used for bathing and washing clothes, prohibited the use of its water beyond the communal rainwater catchment. This restriction stemmed from the fear of water scarcity during the dry season. Water, although a mild irritant, has the potential to irritate the skin if exposed for prolonged periods. According to Table 1, it was evident that the water quality did not meet the requirements of Permenkes 32 of 2017 in terms of turbidity, detergent content, and pH, but only at one specific time and point. This discrepancy could be attributed to the

frequent bathing and clothes washing activities performed by the community, exceeding three times a day. Water quality has emerged as a significant global concern in recent years. It stands apart from other environmental components as it is irreplaceable. The water cycle plays a fundamental role in the dynamics of life and the economy. However, water resources are limited and vulnerable to various negative human-induced impacts. Only 2.5% of our planet's water resources consist of fresh water. Water is an indispensable resource for all living organisms and holds vital value. Life itself cannot exist without water. The availability of sufficient and high-quality water is essential for freshwater ecosystems, food security, sustainable development, and ultimately, the future of humanity. Pollution of limited freshwater resources further strains their availability. It takes eight liters of clean water to treat one liter of wastewater [8].

Table 1. Result of RWHS quality measurement.

Parameter	Point 1		Point 2	
	03.32 AM	15.55 PM	03.32 AM	15.55 PM
Turbidity	x	x	x	X
Temperature	√	√	√	√
Color	√	√	√	√
pH	√	x	√	√
Detergent	x	x	x	x

Source: Sucofindo lab and field tests.

One of the causes of discoloration in the communal RWHS water was the continuous use of detergents by the community. Detergent, which is a mixture of various substances used for washing clothes, typically consists of three components. These include builders (phosphate compounds) comprising 70-80% of the detergent, surfactants (the main detergent ingredients) making up 20-30%, and additives (such as bleach and fragrance) accounting for 2-8%. The production of detergent products, such as laundry detergents, household cleaners, and fabric softeners, has garnered increasing attention from the consumer-oriented chemical industry. Surfactants play a crucial role as the primary ingredient in detergents [9]. Based on the conducted research, the residents of West Soro'an hamlet carried out their daily activities using water from the contaminated communal RWHS containing detergent. This further contributes to the incidence of contact dermatitis among the people of West Soro'an Hamlet. Contact with polluted water serves as a medium for disease transmission, and repeated exposure can lead to irritation and dryness. Water pollution arises due to the growing population's activities and the need to provide them with goods and services that rely on water as a vital resource [10]. Women were the gender group that most frequently bathed and washed clothes in the communal RWHS. According to observations and diagnostic findings by the doctor, 76% of the respondents tested positive for contact dermatitis (Table 2). Contact dermatitis manifests as inflamed, itchy, and red rashes on the skin resulting from contact with specific substances or materials.

Table 2. Diagnose result by doctor.

Contact Dermatitis	Frequency (people)	Percentage (%)
Yes	38	76
No	12	24
Frequency	50	100

The respondents experienced various complaints, including itching, redness, and spots. These complaints manifested less than one week after their activities in the communal RWHS. The contamination of the water in the communal rainwater catchment is one of the factors contributing to the occurrence of contact dermatitis among the respondents. Additionally, it is known that fungi and viruses can also cause infections in the human body. Bacteria, fungi, and viruses closely interact with the host's defenses and thrive in order to surpass them [12]. Air pollution, particularly due to industrialization and wildfires, may also contribute to the development and exacerbation of dermatitis [11]. The communal RWHS water becomes polluted due to bathing and washing activities conducted by the residents of West Soro'an Hamlet. It is worth noting that there are four stages in the natural history of a disease, one of which is the stage of susceptibility. At this stage, exposure between the host, agent, and environment has occurred, even though the disease has not yet manifested. This implies the presence of risk factors [13].

Based on the interview results aimed at determining the social characteristics of individual respondents, it was found that 64% of them had an education level of less than nine years, which is the compulsory education duration according to government regulation number 47 of 2008 [14]. This regulation reflects the government's efforts to enhance public education and ensure the acquisition of quality education, enabling individuals to develop their potential and become independent members of society. Education plays a significant role in shaping people's behavior [15]. Moreover, education influences individuals' knowledge, including in terms of health. Regarding occupation, respondents have various job types, including teacher, construction worker, entrepreneur, farmer, housewife, and civil servant (PNS). Among them, 72% work as farmers, an occupation that increases the incidence of contact dermatitis. Research by Suryani et al. in 2017 indicated that rice farmers experienced a 61.2% higher incidence compared to salt farmers. This finding is supported by the monograph data from Marparan Village, which states that rice fields occupy a significant portion of the village's land area (3,280,000 hectares). The income level of the respondents' families is relatively low, with 96% admitting to earning less than the district minimum wage (UMK) in Sampang. According to East Java Governor Regulation number 75 of 2017, the UMK in Sampang is Rp. 1,632,201.84 [16]. The average income of the 50 respondents is Rp. 412,288.00, indicating that their income is nearly one-fourth of Sampang's UMK. Some respondents even stated that their income is zero, as they rely on bartering rice for side dishes. Instead of solely selling or exchanging rice for money, they exchange it bit by bit for essential items.

Based on the results of the interviews conducted to determine the exposure experienced by the respondents, it was found that there were three types of activities carried out in the communal RWHS: bathing, washing clothes, and bathing animals. In general, the respondents engaged in bathing activities in the communal RWHS. Only 12% of the respondents solely bathed in the communal rainwater catchment, while 64% engaged in both bathing and washing clothes. Additionally, 2% of the respondents bathed and bathed animals, and 10% of the respondents performed all three activities. Statistical tests (Table 3) yielded a p-value of 0.141, indicating no significant relationship between the type of activity and the

incidence of contact dermatitis experienced by the people of West Soro'an Hamlet. This can be attributed to the fact that 64% of the respondents engaged in bathing and washing clothes. It is speculated that detergent exposure is the causative agent of irritant contact dermatitis (DKI) [17]. This phenomenon can occur because the type of activity can affect the quality of the communal rainwater catchment, resulting in water contamination. Detergent is one of the contaminants used by the residents of West Soro'an Hamlet to wash clothes in the pool. Water-borne transmission is stated as one of the modes of disease transmission, which occurs through contact with polluted water [11].

Tabel 3. Relationship between activities types and contact dermatitis.

Activities Types	Contact Dermatitis		Total
	Yes	No	
Bathing	10 (90,9%)	2 (9,1%)	12 (100%)
Bathing and Washing Clothes	25 (75,8%)	7 (24,2%)	32 (100%)
Bathing dan Bathing Animals	0 (0%)	1 (100%)	1 (100%)
Bathing, Washing Closthes, dan Bathing Animals	3 (60%)	2 (40%)	5 (100%)
Total	38 (76%)	12 (24%)	50 (100%)
p = 0,141			

In this study, 72% of the respondents stated that they were actively using the communal rainwater catchment ponds more than 3 times a day. The statistical tests conducted (Table 4) yielded a p-value of 1.000, indicating that there is no significant relationship between the frequency of exposure and the incidence of contact dermatitis. This finding is different from other studies that have shown a relationship between personal hygiene and the incidence of dermatitis [18].

Table 4. Relationship between exposure frequency and contact dermatitis.

Exposure Frequency	Contact Dermatitis		Total
	Yes	No	
1x a day	1 (100%)	0 (0%)	1 (100%)
2x a day	1 (100%)	0 (0%)	1 (100%)
3x a day	9 (75%)	3 25%)	12 (100%)
> 3x a day	27 (75%)	9 (25%)	36 (100%)
Total	38 (76%)	12 (24%)	50 (100%)
p = 1,000			

In a previous study, it was mentioned that there was a relationship between the frequency of exposure and the incidence of occupational contact dermatitis [18]. This phenomenon can occur because the frequency of exposure in that study was higher than the frequency of exposure in the current research. Occupational history is considered one of the factors that can contribute to the development of dermatitis, particularly if there is direct contact in the current work being performed [18]. According to the responses of the participants, 72% of them reported engaging in activities in the communal rainwater catchment pool for more than 30 minutes per day. Prolonged contact time with damaged skin cells can increase the likelihood of contact dermatitis [19]. Contact dermatitis is a common inflammatory skin disorder that affects millions of Americans and is a primary reason for numerous clinic visits to internists each year. The statistical tests conducted (Table 5) yielded

a p-value of 1.000, indicating that there is no significant relationship between the duration of exposure and the incidence of contact dermatitis. This finding may be attributed to the overall contact with contaminated water. However, a previous study reported a relationship between the duration of exposure and the incidence of contact dermatitis, with a higher prevalence among individuals exposed for ≥ 5 hours per day [20]. Moreover, the use of detergents during clothes washing can increase the risk of contact dermatitis. Many consumer products and topical medications today contain allergens that can cause a skin reaction known as allergic contact dermatitis [21].

Table 5. Relationship between exposure duration and contact dermatitis.

Exposure Duration	Contact Dermatitis		Total
	Yes	No	
< 10 minutes	0 (0%)	0 (0%)	0 (0%)
10-20 minutes	1 (100%)	0 (0%)	1 (100%)
21 – 30 minutes	9 (75%)	3 (25%)	12 (100%)
> 30 minutes	28 (75,7%)	9 (24,3%)	36 (100%)
Totals	38 (76%)	12 (24%)	50 (100%)
p = 1,000			

In the study, it was found that 85% of respondents who experienced contact dermatitis through their activities in the communal rainwater were aged between 26 and 45 years. The statistical tests conducted (Table 6) yielded a p-value of 0.036, indicating a significant relationship between age and the incidence of contact dermatitis.

Tabel 6. Relationship between age and contact dermatitis.

Age	Contact Dermatitis		Total
	Yes	No	
12 – 25	0 (0%)	0 (0%)	0 (0%)
26 – 45	29 (85,3%)	5 (14,7%)	34 (100%)
46 – 65	6 (50%)	6 (50%)	12 (100%)
> 65	3 (75%)	1 (25%)	4 (100%)
Totals	38 (76%)	12 (24%)	50 (100%)
p = 0,036			

Overall, the interviewed respondents acknowledged that they did not rinse with water after their activities in the communal RWHS. This practice is not followed by the people of West Soro'an Hamlet, which increases the risk of contracting the disease as the disease chain remains unbroken. Studies have indicated a relationship between age, gender, personal hygiene, use of personal protective equipment (PPE), contact time, contact frequency, and the incidence of contact dermatitis symptoms [22, 23].

4. Conclusions

The quality of water in the communal RWHS in West Soro'an Hamlet is unsuitable for personal hygiene due to bathing and washing clothes activities taking place in the communal rainwater catchment. There is no relationship between the type of activities, frequency of exposure, and duration of exposure with the incidence of contact dermatitis. This is because the entire community is actively using the communal rainwater catchment pool and not rinsing with water afterwards. It is advised that the community should rinse with clean water after their activities in the communal RWHS. Characteristics of the respondents show that

42% are aged between 26-45 years and 62% are females. The social conditions of the respondents are categorized into three aspects: education level, type of work, and family income. The incidence of contact dermatitis among the people of Dusun Soro'an in West District Sreseh Sampang Regency is 76%. There is a significant relationship between age and the incidence of contact dermatitis, with a p-value of 0.036, while no relationship is found between gender and contact dermatitis. Additionally, there is no relationship between the variables of activity type, frequency of exposure, and duration of exposure with the incidence of contact dermatitis. It is recommended that individuals rinse with clean water after their activities in the rainwater storage pond. Planning a village development program to establish individual rainwater collection systems for households that do not have them is also advised. Further research should be conducted to investigate irritant contact dermatitis or allergies caused by communal rainwater collection.

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Competing interest

There is no competing interest.

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