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Hygiene and Sanitation of Refill Drinking Water Depots in Relation Escherichia coli: A Quantitative Study

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Clean water is essential for various daily needs such as drinking, cooking, bathing, and washing. Ensuring proper hygiene and sanitation is critical to prevent waterborne diseases, particularly those caused by *Escherichia coli*. This descriptive observational study conducted from March to June 2024. The aim of this research is to worker hygiene practices and sanitation conditions at Refill Drinking Water Depots (RDWDs) as well as their relation to the presence of *E. coli* in the Timika Jaya Health Center area, Mimika Regency. All 20 certified RDWDs in the area were included in this study, involving workers and managers as respondents. Data were collected through sanitation inspections and water sampling for laboratory testing, and analyzed using SPSS to determine frequency distributions and percentages. The majority of respondents were male (87.1%), aged 25–30 years (38.7%), had completed senior high school (54.8%), and worked ≥8 hours per day (100%). In terms of hygiene compliance, only 3.2% of workers met the required standards, while 96.8% did not. All depots (100%) met sanitation standards related to location and equipment. However, 6 depots (30%) were found to be contaminated with *E. coli*. These findings indicate that inadequate personal hygiene among workers is a key risk factor for *E. coli* contamination, despite compliance with infrastructural sanitation standards. Regular monitoring, hygiene training, and enforcement of health regulations are strongly recommended to ensure the safe distribution of drinking water.

Keywords: Eschericia coli, Hygiene, Refill Water, Sanitation, Water Pollution

INTRODUCTION

Water is essential for maintaining various human bodily functions. It supports metabolic reactions, facilitating nutrient transport, and eliminating metabolic waste through urine and sweat (Kondracki & Collins, 2009). In addition, water regulates body temperature through perspiration and supports the function of vital organs that are largely composed of water, such as muscles and kidneys. (Akan, 2020; Cavallo, 2024). Inadequate fluid intake or dehydration may impair kidney function, increase the risk of kidney stones, and reduce the efficiency of the digestive efficiency, as water is critical for both nutrient absorption and waste excretion (Butarbutar, 2024).

Clean water is a fundamental necessity for human life and daily activities such as washing, cooking, bathing, and drinking. However, its availability remains a global issue. According to the United Nations Environment Programme (UNEP), 40% of the 75,151 water bodies assessed in 2020 did not meet clean water standards, significantly impacting public health, especially for nearby communities that rely directly on these sources (Suryani & Kusumayati, 2022). In Indonesia, only 57.8% of drinking water facilities are monitored for water quality, despite safe water being a national development target.

Among various sources of drinking water, Refill Drinking Water Depots (RDWDs)have emerged as a preferred choice in Indonesia due to their affordability and convenience. In densely populated areas with limited access to land, and high risk of groundwater contamination, the consumption of refill water continues to rise. However, despite its widespread use, concerns regarding the safety and regulatory compliance of refill drinking water persist, particularly in relation to hygiene and sanitation standards(Suryani & Kusumayati, 2022).

The quality of refill drinking water is influenced by several interrelated factors, including depot location, water treatment equipment, handling procedures, and personnel hygiene. inadequate hygiene practices by handlers who are directly involved in the production and distribution process are a critical pathway for microbial contamination. Previous studies (Utami et al., 2017), and Dahrini et al., (2021)have underscored the role of poor knowledge, attitudes, and behaviors among workers as key contributors to non-compliance with sanitation protocols at RDWDs. Research also indicates that a significant proportion of RDWDs fail to meet microbiological standards, with approximately 60% found to exceed permissible coliform level (Kasim et al.,

2014). The detection of *Escherichia coli* (E. coli) in these systems is particularly alarming, signalling severe lapses in hygiene and water treatment procedures (Harianja et al., 2022; Zarić et al., 2023).

Beyond human factors, technical shortcomings such as the improper maintenance of filtration and disinfection equipment, and the absence of routine inspections further elevate the risk of contamination (Sunaryo et al., 2022). In many cases, depot environments lack basic cleanliness, and personal hygiene among staff remains inadequate. These deficiencies are often compounded by weak regulatory oversight, as numerous depots continue to operate without consistent monitoring or enforcement from local health authorities (Hasby & Abrianti, 2024).

Escherichia coli (E. coli) and coliform bacteria serve as key microbiological indicators of fecal contamination. In accordance with the Regulation of the Minister of Health of the Republic of Indonesia No. 492/MENKES/PER/IV/2010, drinking water must contain zero detectable coliforms or *E. coli* per 100 mL. Exposure to these bacteria may result in gastrointestinal illnesses such as diarrhea, typhoid, and dysentery. Certain strains of *E.coli* can produce harmful toxins include indole, skatole, and ethionine, which are associated with serious health risks (Alfian et al., 2021). The presence of coliform in refill water has been linked to inadequate filter maintenance, low hygiene awareness among operators, poor environmental conditions, and deficient infrastructure(Putri & Priyono, 2022).

UNICEF stated that diarrhea remains a leading cause of death among children under five, with 9% of cases attributed to unsafe water, poor hygiene, and inadequate sanitation. In Indonesia, the incidence of diarrhea reached 270 cases per 1,000 people in 2019, with a disproportionately high rate of 843 per 1,000 among children under five (Kementerian Kesehatan RI, 2021; Riskesdas NTB, 2018).

At Timika Jaya Health Center (*Puskesmas*), diarrhea was ranked as the seventh most prevalent disease in 2023, with 312 reported cases. A preliminary survey conducted in *Kelurahan Timika Jaya Besar* found that 1,427 out of 1,537 households relied on refill drinking water as their primary water source. A report from Health Laboratory of Mimika Regency revealed that, among 26 active depots in the area, two failed bacteriological testing and one did not meet sanitation standards. Field observations also documented poor hygiene practices among workers, such as neglecting to wash hands and wearing inappropriate clothing during service

In response to these findings, this study titled "Hygiene and Sanitation of Refill Drinking Water Depots in Relation to Escherichia coli: A Quantitative Study". It aims to assess the personal hygiene of workers, evaluate the sanitation conditions of refill drinking water depots, and determine the presence of *E. coli* contamination. The study seeks to identify hygiene-related risk factors and provide evidence-based recommendations to enhance water safety and protect public health in the region.

METHODS

This study employed an observational research design to examine the relationship between personal hygiene, sanitation conditions, and the presence of *Escherichia coli* in Refill Drinking Water Depots (RDWDs) located in the Timika Jaya Health Center area, Mimika Regency, in 2024. Sanitation inspections and structured observations were conducted at each certified depot in Timika Jaya Village between March and June 2024. The study population consisted of all 20 RDWDs registered and certified by the Mimika Regency Health Office. A total sampling method was applied, involving the participation of all depots and their respective workers or managers.

The research instrument consisted of a standardized and structured questionnaire adapted from Okzan et al., (2022), which assessed hygiene and sanitation practices at RDWDs. Water samples were collected directly from the water outlet of each depot using sterile 100 mL bottles. Samples were kept in a cool box at 4°C and transported within six hours to the Environmental Health Laboratory of Mimika Regency for testing.

Microbiological analysis of *E. coli* and total coliforms was conducted using the Multiple Tube Fermentation Technique (MTFT) based on the Most Probable Number (MPN) method, in accordance with the Regulation of the Minister of Health of the Republic of Indonesia No. 492/MENKES/PER/IV/2010. Quality control measures included the use of blank samples, positive and negative controls, and the calibration of equipment prior to each testing session. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS), focusing on univariate analysis to determine frequency distributions and percentages for each variable, with results presented in tabular form.

RESULTS AND DISCUSSION

Respondent Characteristics

The frequency distribution of respondents based on demographic and occupational characteristics, including age, gender, education level, and duration of work.

Table 1

Frequency distribution based on the personnels characteristics of RDWDs in Timika Jaya Health Center Area

Variable	Frequency	Percent
Age		
<25 Year	7	22.6
25-30 Year	12	38.7
31-35 Year	5	16.1
36-40 Year	5	16.1
>40 Year	2	6.5
Gender		
Male	27	87.1
Female	4	12.9

Education		
Elementary School	7	22.6
Junior High School	7	22.6
Senior High School	17	54.8
Duration Of Work		
< 8 Hours	0	0
> 8 Hours	31	100

Based on Table 1 the most respondents (38.7%) were 25–30 years. In terms of gender, the majority of workers are male (87.1%). Regarding education level, more than half of the participants (54.8%) had completed senior high school. All respondents reported working more than eight hours per day, indicating a consistent pattern of extended working hours among depot workers.

Hygiene and Sanitation Conditions of RDWDs' Location in the Timika Jaya Health Center Area

Table 2

Frequency Distribution of Hygiene and Sanitation Conditions of RDWDs' Location in the Timika Jaya Health Center Area

Sanitation	**NC**		**C**	
Description	**F**	**%**	**F**	**%**
Location free from disease transmission and pollution	13	65	7	35
Building is strong, safe, easy to clean, and maintain Floor is water-resistant, smooth, non-slip, crack-free, dust-resistant, easy to clean, and with a gentle slope	0	0	20	100
Walls are water-resistant, smooth, non-slip, crack-free, dust-resistant, easy to clean, and with a bright and clean finish Roof and ceiling must be strong, rodent-proof, easy to clean, dust-resistant, flat-surfaced, brightly colored, and with sufficient height	0	0	20	100
Room layout includes processing, storage, distribution/supply, and customer waiting areas	0	0	20	100
Lighting is adequate for work, non-glare, and evenly distributed	0	0	20	100
Ventilation ensures good air circulation/exchange	1	5	19	95
Humidity supports comfort during work/activities	0	0	20	100
Access to a bathroom and toilet	0	0	20	100
Waste disposal system is functioning and covered	0	0	20	100
Trash bins are covered	4	20	16	80
Handwashing facilities are available with running water and soap	0	0	20	100
Free from rodents, flies, and cockroaches	9	45	11	55
Location free from disease transmission and pollution	19	95	1	5
Building is strong, safe, easy to clean, and maintain	0	0	20	100

Note:
C : Compliant
NC: Non-Compliant

Based on Table 2, the observation results on sanitation and hygiene at indicate that out of 14 sub-variables under the place variable, five were found to be non-compliant with the standards. These include the location not being free from disease transmission and contamination (65%), iinadequate facility layout for processing, storage, distribution, and customer areas (5%), lack of access to bathroom and toilet facilities (20%), absence of covered trash bins (45%), and the unavailability of handwashing facilities (95%). Additionally, 36.4% of the depots were reported to have pests such as rats, flies, and cockroaches. On the other hand, several indicators were fully compliant, including building structure integrity, flooring conditions, facility layout design, wastewater disposal systems, and air humidity, all of which met the required standards at 100%.

Hygiene and Sanitation Conditions of Equipment at RDWDs in the Timika Jaya Health Center Area

Table 3

Frequency Distribution of Hygiene and Sanitation Conditions of Equipment at RDWDs in the Timika Jaya Health Center Area

Sanitation of Equipment	**NC**		**C**	
Description	**F**	**%**	**F**	**%**
Equipment is made from food-grade materials	0	0	20	100
Microfilters and disinfection equipment are not expired and within their usage period	0	0	20	100
Raw water tanks must be covered and protected	0	0	20	100
Bottles/gallons are cleaned before filling	0	0	20	100
Filled bottles/gallons must be given to consumers immediately and not stored at the Drinking Water Depot for more than 24 hours	3	15	17	85
Regular backwashing of macro filters is performed	0	0	20	100
There are more than one microfilter with tiered sizes	0	0	20	100
Sterilization equipment, such as ultraviolet or ozonization equipment or other disinfection tools, are functional and used correctly	0	0	20	100
There is a facility for filling bottles	0	0		100

(gallons) in a closed room			
Clean, new bottle caps are available	0	0	100

Note:
C : Compliant
NC: Non-Compliant

Table 3 shows that the hygiene and sanitation conditions of equipment were generally satisfactory, with full compliance (100%) observed in most indicators. All depots used food-grade materials, ensured that microfilters and disinfection equipment were within their usage period, kept raw water tanks covered, cleaned bottles before filling, conducted regular backwashing of macro filters, utilized tiered microfilters, and operated functional sterilization tools such as ultraviolet or ozonization equipment. Additionally, all depots provided clean bottle caps and had designated enclosed areas for bottle filling. However, 15% of the depots did not comply with the requirement to immediately distribute filled bottles, instead storing them for more than 24 hours, which may pose a potential risk for contamination.

Personnel Hygiene and Sanitation Conditions at RDWDs in the Timika Jaya Health Center Area

Table 4
Frequency Distribution of Personal Hygiene and Sanitation Conditions of RDWDs in the Timika Jaya Health Center Area

Personnel Hygiene	**NC**		**C**	
Description	**F**	**%**	**F**	**%**
Healthy and free from infectious diseases	1	5	30	95
Not a carrier of disease-causing germs	1	5	29	95
Practices hygiene and sanitation every time serving customers	30	96.8	1	3.2
Washes hands with soap and running water every time serving customers	30	96.8	1	3.2
Uses clean and tidy work clothes	2	6.5	29	93.5
Undergoes regular health check-ups at least once a year	31	100	0	0
Operator/responsible person/owner has a certificate and has attended hygiene and sanitation courses for Refill Drinking Water Depots	24	77.4	7	22.6

Note:
C : Compliant
NC: Non Compliant

Based on Table 4, most respondents (95%) were reported to be healthy and free from infectious diseases and not carriers of disease-causing germs. Most workers (96.8%) consistently practiced hygiene and sanitation when serving customers and washed their hands with soap and running water each time. In terms of personal appearance, 93.5% were found to wear clean and tidy work clothes. However, only a small portion of respondents (0%) underwent regular health check-ups at least once a year, indicating a serious gap in preventive health monitoring. Additionally, only 22.6% of operators or responsible personnel had HACCP certificates and had participated in hygiene and sanitation training specifically related to the management of refill drinking water depots, suggesting the need for increased capacity-building efforts to ensure compliance with health standards.

Laboratory Examination Results of RDWDs in the Timika Jaya Health Center Area

Table 5
Laboratory Examination Results of RDWDs in the Timika Jaya Health Center Area

Name	**Presumptive Test**			**Confirmatory Test**		
	10	**1**	**0,1**	**10**	**1**	**0,1**
Depot 1	5	0	0	0	0	0
Depot 2	5	0	0	0	0	0
Depot 3	5	1	1	4	1	1
Depot 4	5	0	0	0	0	0
Depot 5	5	0	0	0	0	0
Depot 6	5	0	0	0	0	0
Depot 7	5	1	1	4	1	1
Depot 8	5	0	0	0	0	0
Depot 9	5	0	0	0	0	0
Depot 10	5	1	1	3	1	1
Depot 11	5	0	0	0	0	0
Depot 12	5	0	0	0	0	0
Depot 13	5	1	1	4	1	1
Depot 14	5	0	0	0	0	0
Depot 15	5	1	1	3	1	1
Depot 16	5	0	0	0	0	0
Depot 17	5	0	0	0	0	0
Depot 18	5	1	1	4	1	1
Depot 19	5	0	0	0	0	0
Depot 20	5	0	0	0	0	0

Table 6
Laboratory Examination of RDWDs in the Timika Jaya Health Center Area

Name	**Index MPN/100ml**	**Max. Limit/100 ml**	**Des.**
Depot 1	0	0	C
Depot 2	0	0	C

Depot 3	4.4	0	NC
Depot 4	0	0	C
Depot 5	0	0	C
Depot 6	0	0	C
Depot 7	3.2	0	NC
Depot 8	0	0	C
Depot 9	0	0	C
Depot 10	3.6	0	NC
Depot 11	0	0	C
Depot 12	0	0	C
Depot 13	2.1	0	NC
Depot 14	0	0	C
Depot 15	4.6	0	NC
Depot 16	0	0	C
Depot 17	0	0	C
Depot 18	3.3	0	NC
Depot 19	0	0	C
Depot 20	0	0	C

Note:
C : Compliant
NC: Non Compliant

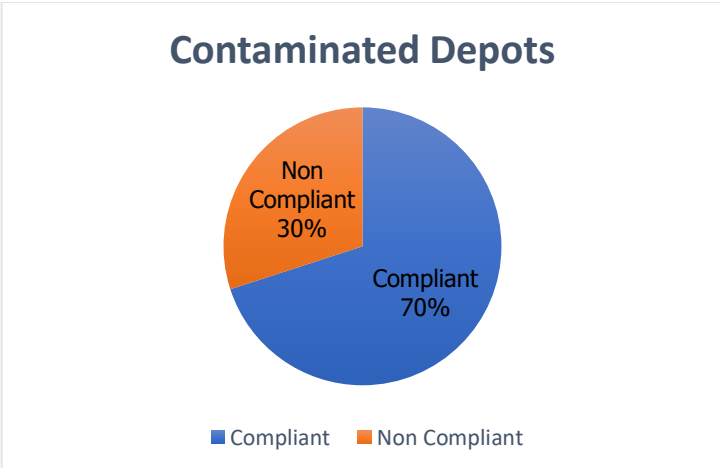

Figure. 1 Graph of Contaminated Depots

The Most Probable Number (MPN) method involves a presumptive test to detect the presence of gram-negative bacteria in water. followed by a confirmatory test specifically identify *E. coli* in the sample. This method uses liquid media in test tubes and interprets results based on the number of positive tubes. A 5-5-5 series of test tubes is used. consisting of five tubes each containing 10 mL. 1 mL. and 0.1 mL of the water sample

The assessment of whether a sample meets or does not meet microbiological standards is based on the Ministry of Health Regulation No. 492/MENKES/PER/IV/2010 concerning drinking water quality requirements. which stipulates that the maximum allowable level of *E. coli* in 100 mL of drinking water is 0 MPN. As shown in Figure 1. 14 Refillable Drinking Water Depots (70%) complied with the standard. while 6 depots (30%) exceeded the permissible limit and were deemed non-compliant.

Table 7
Description of the relationship between worker hygiene and the presence of E. coli bacteria

ID	Depot	Worker Hygiene	Depot Status (*E. coli*)
P1	Depot 1	Good	Not Contaminated
P2	Depot 1	Good	Not Contaminated
P3	Depot 2	Poor	Not Contaminated
P4	Depot 2	Poor	Not Contaminated
P5	Depot 3	Poor	Contaminated
P6	Depot 3	Poor	Contaminated
P7	Depot 3	Poor	Contaminated
P8	Depot 4	Good	Not Contaminated
P9	Depot 4	Poor	Not Contaminated
P10	Depot 5	Poor	Contaminated
P11	Depot 5	Good	Contaminated
P12	Depot 5	Poor	Contaminated
P13	Depot 6	Good	Not Contaminated
P14	Depot 6	Poor	Not Contaminated
P15	Depot 7	Poor	Not Contaminated
P16	Depot 7	Good	Not Contaminated
P17	Depot 8	Poor	Not Contaminated
P18	Depot 9	Poor	Contaminated
P19	Depot 9	Poor	Contaminated
P20	Depot 10	Good	Not Contaminated
P21	Depot 10	Poor	Not Contaminated
P22	Depot 11	Poor	Not Contaminated
P23	Depot 12	Good	Not Contaminated
P24	Depot 13	Poor	Contaminated
P25	Depot 14	Poor	Contaminated
P26	Depot 15	Good	Not Contaminated
P27	Depot 16	Poor	Not Contaminated
P28	Depot 17	Poor	Not Contaminated
P29	Depot 18	Good	Not Contaminated
P30	Depot 19	Poor	Not Contaminated
P31	Depot 20	Poor	Contaminated

Based on the data presented in the table. a notable correlation was observed between inadequate worker hygiene and the presence of *E. coli* contamination in the

refill drinking water depots. Of the 31 workers surveyed. 19 were identified as having poor hygiene practices. Among these. 10 individuals were associated with depots where water samples tested positive for *E. coli*. specifically in Depot 3. Depot 5. Depot 9. Depot 13. Depot 14. and Depot 20. This finding suggests that substandard personal hygiene among workers may serve as a significant risk factor for microbiological contamination in refill water systems. Although not all workers with poor hygiene were from depots with confirmed contamination. the majority of contamination incidents occurred in depots where hygiene practices were generally low. These results underscore the critical need for enhanced hygiene training and routine supervision by depot managers to mitigate contamination risks and protect public health.

Hygiene and Sanitation Conditions of RDWDs Personnels

The hygiene inspection conducted in 2024 at Refill Drinking Water Depots (RDWDs) in Timika Jaya Village revealed a strong correlation between personnel hygiene practices. depot sanitation conditions. and the presence of *E. coli* contamination. Among the 31 RDWDs' personnels assessed within the Timika Jaya Health Center area. 30 participants (96.8%) failed to meet hygiene and sanitation standards. This widespread non-compliance was predominantly observed in depots where water samples tested positive for *E. coli*. indicating that poor hygiene among workers suggesting that inadequate personal hygiene is a significant contributing factor to microbiological contamination. Specifically. 10 out of 19 personnels categorized as having poor hygiene came from depots where *E. coli* was detected. namely Depot 3. 5. 9. 13. 14. and 20.

These findings reinforce Majdi & Hidayat (2023) conclusion that personnel behavior plays a critical role in safeguarding drinking water quality. with poor hygiene practices being closely associated with contamination in the final product. In one notable case. a symptomatic worker continued to handle water without wearing a mask. directly violating health protocols. and potentially serving as a transmission vector for pathogens. Such practices contravene the Ministry of Health Regulation No. 43 of 2014. which mandates that water handlers must be free from communicable diseases and observe strict personal hygiene measures. The lack of adherence to these regulations raises significant public health concerns.

Infrastructural shortcomings in many depots further exacerbate contamination risks. A high proportion of personnels failed to wash their hands before serving customers due to the unavailability of handwashing facilities. Utami et al.. (2017) reported that 83.6% of handlers who failed to wash their hands were associated with poor microbiological water quality. Similarly. Kartika et al.. (2021) found that most handlers in Bengkulu lacked formal hygiene training and failed to follow proper sanitation protocols. These patterns highlight systemic gaps not only in behavior but also in the physical and managerial infrastructure supporting hygiene compliance.

Beyond personnel-related factors. other critical contributors to *E. coli* contamination include raw water quality. environmental conditions. and the performance of filtration and disinfection systems. In Makassar. for example. 39.08% of raw water sources were deemed microbiologically unsafe (Kasim et al.. 2014). largely due to contamination of surface and groundwater in areas with poor sanitation infrastructur(Apriliana et al.. 2014). Furthermore. 68.87% of depot workers in the same study did not meet hygiene requirements. a condition worsened by the absence of sanitation training. Additionally. the failure of filtration and disinfection systems to eliminate pathogens has allowed contamination to persist in the final water product (Pou et al.. 2022). These findings collectively underscore the urgent need for integrated interventions to ensure the microbiological safety of refillable drinking water.

Sanitation Conditions of RDWDs' Location

Observation revealed that only seven RDWDs were located in areas free from contamination and disease transmission. These locations were away from temporary waste disposal sites. thus being safe from environmental pollution. However. thirteen RDWDs were located in areas did not meet sanitation requirements; many were situated along main roads. making them vulnerable to dust and vehicular emissions. Several depots were also located near traditional markets. where high population density and activity levels may compromise environmental hygiene. According to (Hafizah et al.. 2023). most RDWDs in Minas Jaya Village were positioned near high-traffic roads. particularly along the Pekanbaru Duri highway. exposing them to constant air pollution and dust generated by heavy vehicles.

These findings are consistent with Haki (2022) who reported that proximity to pollution sources such as workshops. markets. and drains negatively impacts the bacteriological quality of drinking water. Open trash bins were also identified as a contamination source. as they can attract vectors like flies that pose additional hygiene risks. Despite these concerns. the majority of RDWDs in the study area had structurally sound buildings. Most depots were equipped with plastered and brightly painted walls. rodent-proof roofing. and waterproof tiled floors with adequate slopes for drainage. Proper ventilation and acceptable humidity levels were also observed. supporting hygienic operational conditions. However. one depot lacked a designated consumer waiting area. while four depots (20%) did not have toilet or bathroom facilities. primarily due to limited space.

Waste management practices varied among the depots. Nine depots (45%) still used open trash bins. while 11 depots (55%) had covered bins. which are more appropriate for preventing vector access. A critical concern was the lack of handwashing facilities: 19 depots (95%) did not provide any handwashing station equipped with soap. and only one depot (5%) complied with this hygiene requirement. These deficiencies underscore the urgent need for improving basic hygiene infrastructure.

Supporting this. Selomo et al.. (2018) found that although all nine RDWDs in Campalagian District had toilets and bathrooms. only three (33.33%) had adequate drainage systems. two (22.22%) used covered trash bins. and just one (11.11%) provided a handwashing facility with soap.

Overall. most RDWDs in the Timika Jaya Health Center's area were found to comply with the structural sanitation requirements as outlined in Ministry of Health Regulation No. 43 of 2014. In order to ensure compliance with sanitation standards. routine inspections by local health centers and public health departments are essential. Ongoing evaluations can help detect risks early. guide targeted interventions. and support depot operators in maintaining clean. safe. and compliant environments. Strengthening supervisory frameworks will be critical in preventing drinking water contamination and protecting community health.

Sanitation Conditions of RDWD's Equipment

Observations conducted at 20 RDWDs within the Timika Jaya Health Center area revealed that all depots use food-grade materials. such as stainless steel. maintain covered raw water tanks protected from direct sunlight. and employed functional sterilization systems including multi-stage filters with varying pore sizes. Each depot rinsed and cleaned bottles prior to refilling and provide new. hygienic bottle caps.

However. a critical non-compliance issue was identified in 3 depots (15%). where filled bottles were stored for over 24 hours before distribution. This practice violates Regulation of the Minister of Health No. 43 of 2014. which stipulates that refilled bottles be delivered directly to consumers to prevent microbial growth. Even depots that meet infrastructure requirements may still be susceptible to *E. coli* contamination due to poor maintenance routines or inadequate hygiene among personnel.

These findings are corroborated by prior research. Nuryani (2018) found that most depots complied with sanitation standards. such as cleaning bottles prior to refilling. using multi-tiered microfilters. providing rinsing facilities. filling bottles in closed rooms. and supplying clean. new caps. Some depots used expired filters. failed to backwash macro filters. or operated UV/ozonation equipment improperly. Putri & Priyono (2022). Pou et al.. (2022) and Harianja et al.. (2022) confirmed that poor maintenance. expired treatment systems. and a lack of operator training are major contributors to *E. coli* contamination. Depots that lacked hygiene certification or failed to meet raw water source standards exhibited higher contamination risks (Utami et al.. 2017).

Therefore. ensuring water safety requires more than compliance with structural or technical standards. Regular maintenance. strict quality control procedures. and hygiene training for depot personnel are essential to minimize the risk of microbial contamination. Kasim et al.. (2014) found that 68.87% of RDWD employees failed to meet personal hygiene standards. which corresponded with higher contamination rates. Harianja et al.. (2022) also demonstrated a significant association between poor equipment maintenance and the presence of E. coli (p = 0.007). As emphasized by Rahayu and Herniwanti (2022). an integrated approach involving infrastructure quality. routine evaluation. worker hygiene. and supervision is critical to preventing contamination and ensuring safe drinking water for the community.

Laboratory Results of RDWDs

Laboratory analysis using the Most Probable Number (MPN) method revealed that 14 out of 20 RDWDs in the Timika Jaya Health Center area (70%) complied with the national drinking water quality standard for Escherichia coli (0 MPN/100 ml). while 6 depots (30%) failed to meet this requirement. The presence of *E. coli* is linked to poor hygiene. sanitation. and handling practices.

Previous studies have linked E. coli contamination to several factors. including improper handwashing. inappropriate water storage. the use of untreated surface water. and ineffective treatment systems (Neyole. 2020; Odonkor & Mahami. 2020; Wispriyono et al.. 2021;Shrestha et al.. 2024)In this study. 30 out of 31 handlers failed to meet hygiene standards outlined in Ministry of Health Regulation No. 43 of 2014. further supporting the association between poor hygiene and microbial contamination.

Contamination with E. coli not only signals the presence of fecal matter but also highlights environmental and behavioral risk factors such as open defecation. biofilm formation in distribution systems. proximity to livestock areas. and unsafe agricultural practices (Orhan et al.. 2019;Gemeda et al.. 2022; Gwimbi et al.. 2019; Kabiru & Kabiru. 2022; Rath. 2021) These findings emphasize the need for comprehensive interventions targeting both environmental sanitation and behavioral change among workers.

Further observations of sanitation conditions at the 20 RDWDs in the Timika Jaya area indicated that several key aspects did not fully comply with regulatory standards. These include depot locations near sources of contamination. absence of proper toilet and bathroom facilities. lack of closed waste bins. and insufficient sanitation infrastructure such as handwashing stations with clean running water and soap. Non-adherence to these standards may significantly increase the risk of microbial contamination and jeopardize public health.

CONCLUSIONS

Based on the 2024 study of Refill Drinking Water Depots (RDWDs) in the Timika Jaya Health Center area and in reference to the Indonesian Ministry of Health Regulation No. 43 of 2014 concerning hygiene and sanitation standards for RDWDs. it can be concluded that most depot buildings and equipment complied with the required sanitation standards. particularly in terms of location and supporting infrastructure. However. a significant proportion of depot workers failed to meet personal hygiene standards. including aspects such as personal cleanliness. use of personal protective equipment. and hygienic practices during the water refilling process. Notably. approximately 30% of the

depots were found to be contaminated with *Escherichia coli*. with inadequate worker hygiene identified as a primary contributing factor. despite otherwise sufficient sanitation infrastructure.

These findings suggest that technical compliance alone is insufficient to ensure the microbiological safety of refillable drinking water. Human factors play a crucial role in preventing contamination. To improve the safety and quality of RDWDs. it is recommended that regular hygiene and sanitation training be provided to all depot personnel. including correct procedures for equipment maintenance and bottle cleaning. Furthermore. routine inspections by local health authorities are essential to monitor compliance with hygiene protocols. Implementing periodic recertification programs for depot owners and operators is also advised to ensure their ongoing competence and adherence to health standards. Collectively. these measures are expected to reduce contamination risks. improve water quality. and enhance the protection of public health.

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