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Literature Review: Factors Affecting the Microbiological Quality of Drinking Water at Drinking Water Depots

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Keyword: Drinking Water Depot; Escherichia Coli; Coliform; Sanitary Hygiene; Microbiological Quality;

Abstract
Introduction: *Refillable Drinking Water Depots (DAM) are one of the main alternatives in meeting people's drinking water needs because they are easily accessible and relatively affordable. However, several studies show that the microbiological quality of drinking water in DAM is still a problem, especially related to the presence of Escherichia coli bacteria and total coliform which has the potential to cause waterborne diseases such as diarrhea.* ***Objective:*** *This literature review aims to identify and analyze the factors that affect the quality of drinking water microbiology in DAM based on research in 2022–2025, article search via Google Scholar.* ***Method:*** *The method used was a literature review of five studies with a cross-sectional design that examined the variables of sanitation hygiene, equipment maintenance, processing process, personal hygiene operator, sanitation of the place, raw water source, and water storage time.* ***Result and Discussion:*** *The results of the study showed that the most consistent factors related to the quality of microbiology were equipment sanitation, operator/handler hygiene, and drinking water maintenance and treatment process. Meanwhile, some studies have found that raw water sources and storage times do not necessarily show a significant relationship.* ***Conclusion:*** *These findings confirm that aspects of hygiene, sanitation, and operational management of DAM have an important role in preventing bacteriological contamination. Therefore, routine supervision, coaching, and increased compliance with sanitation hygiene standards are needed to ensure the safety of refillable drinking water for the community.*

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Introduction

Access to safe drinking water is an internationally recognized human right (Ekowati & Lusno, 2025). In Indonesia, physical, chemical, microbiological requirements (E. coli and total coliform 0/100 ml), and radioactivity are determined through the Minister of Health Regulation No. 2 of 2023 (WHO, 2022), in line with the SDGs Goal 6 target. In practice, people rely heavily on refillable Drinking Water Depots (DAM) because they are easily accessible and affordable (Rizki, Ulfa, & Riyadi, 2025); (Karjono & Sintari, 2023); (Purba, Handini, & Sirait, 2023). The number of DAM that continues to increase (Wulandari & Pristiyaningrum, 2025); (Yushananta, Markus, & Barus, 2022) making the quality of microbiology and the application of hygiene-sanitation in this facility crucial.

Fulfilling the community's safe drinking water needs, many currently use refillable Drinking Water Depots (DAM) because they are considered more accessible, practical, and have a relatively affordable price than branded bottled drinking water. The existence of DAM spread to the residential level makes it easier for people to get drinking water without the need to do their own processing process at home. Several recent studies show that economic factors, ease of access, and perception of practicality are the main reasons why people choose refillable water as a source of daily drinking water.

In addition, the increasing number of DAM in various regions shows the high dependence of the community on this service in meeting the needs of drinking water suitable for consumption (Wulandari & Pristiyaningrum, 2025); (Yushananta et al., 2022). The role of DAM in providing safe drinking water is very strategic, so monitoring the quality of microbiology and the implementation of good sanitation hygiene are important aspects to ensure the safety of water consumed by the community.

Various 2020–2024 studies reported E. coli/coliform contamination in DAM which correlated with an increase in the incidence of diarrhea, especially in vulnerable groups (Kadir, Dangnga, & Madjid, 2021); (Anggraeni, Karuniawati, & Mulyono, 2025). Determining factors include operator hygiene, equipment sanitation, raw water quality, and frequency of filter and UV lamp changes (Puspitasari & Rahman, 2020); (Suryani & Kusumayati, 2022). The WHO affirms that E. coli should not be detected in 100 ml of water samples (WHO, 2022), while the WHO/UNICEF 2023 report shows that millions of people are still consuming unsafe water (WHO, 2023), (UNICEF, 2023). Systematic reviews in developing countries also highlight weak surveillance, inconsistencies in SOPs, and lack of training as key determinants of microbiological contamination in small-scale water providers (Elsa, Ningsih, & Badrah, 2025)

Despite many studies, the findings are still scattered and have not been integrated, even though the 2020–2025 period is important due to the update of national regulations (Permenkes 2023) and the wider adoption of UV filtration and sterilization technology in DAM. Therefore, this literature review aims to identify and analyze factors that affect the microbiological quality of drinking water in the DAM in the 2020–2025 range, so that it can be the basis for improving hygiene-sanitation policies and practices in the field.

Method

This research is a research using a literature review method with a search through Google Scholar. The inclusion criteria include literature published in the 2020–2025 range. Exclusion criteria include duplicate articles and articles that do not match the research keywords. The keywords used in the search for the article were "factors, influences, microbacteriological quality, Escherichia coli, coliform, drinking water

depots" and 131 articles were searched. Based on the search results, 5 literature were obtained that met the inclusion and exclusion criteria.

Results and Discussion

1. Result

The results of the literature search were obtained 5 literatures that will be discussed in this article

Table 1
Article Review

Author	Title	Methods and Samples	Variables Studied	Conclusion
Nizam, Santi, & Andria, (2023)	Analisi Faktor yang Berhubungan dengan Kualitas Bakteriologis Escherichia coli pada Air Minum Isi Ulang di Gampong Rukoh Kecamatan Syiah Kuala Kota Banda Aceh Tahun 2022	Cross sectional 9 DAM	- Equipment maintenance - Refillable drinking water management process - Hygiene of the handler - Bacteria Escherichia coli	- There is a relationship between the maintenance of equipment and the bacteriological quality of scherichia - There is a relationship between the process of managing refillable drinking water and the bacteriological quality *of Escherichia* - There is a relationship between the hygiene of the handlers and the bacteriological qualities *of Escherichia*
Karjono, M et al. (2022)	Hygiene Sanitasi Sangat Penting untuk Mempertahankan Kualitas Air Minum Depo Isi Ualng di Kabupaten Lombok Timur	Cross sectional 50 DAM	- Sanitation hygiene (place, equipment used, handlers, raw water source) - Length of water storage in gallons - Coliform bacteria	- There is a significant relationship between sanitary hygiene and drinking water quality - There was no significant relationship between the length of water storage in gallons and the quality of the depot's drinking water
Butarbutar, Tuda, Lasut, Manampiring, & Surya, (2023)	Analisis Faktor Risiko Kualitas Bakteriologi Air Minum Isi Ulang di Kecamatan Mapanget	Cross sectional 30 Consumers, 6 DAM	- Sanitation facilities - Customer service facilities - Refillable drinking water treatment facilities - Raw water - Personal hygiene - Coliform bacteria	- Raw water, sanitary hygiene facilities and personal hygiene greatly affect the bacteriological quality of refillable drinking water

Elsa et al., (2025)	Hygiene Sanitation and the Presence of Escherichia Coli Bacteria at Drinking Water Depots (DAM)	Cross sectional 5 DAM	- Hygiene of handlers/ operators - Sanitation of the premises - Equipment Sanitation - Raw water source - Bacteria Escherichia coli	- There was no significant association between the handler hihiene and the presence of *E. coli bacteria* in the refillable drinking water depot - There is a significant relationship between the sanitary conditions of the place and the presence of *E. coli bacteria* in the refillable drinking water depot - There is a significant relationship between the sanitary conditions of DAM equipment and the bacteriological presence *of E. coli* - There was no significant relationship between raw water sources and bacteriological presence *of E. coli*
Wulandari & Pristiyaningrum (2025)	Analisi Cemaran Mikroba E. coli dan Total Koliform pada Depot Air Minum Isi Ulamh: Studi Kasus di Pulo Gadung, Jakarta Timur	Cross sectional 61 DAM	- Equipment sanitation - Hygiene operator - Storage time - Sanitation of the premises - Raw water source	- Equipment sanitation is the most dominant factor related to microbial contamination in refillable drinking water. - Operator hygiene is significantly related to microbial contamination in refillable drinking water - Water storage time of more than 24 hours has also been shown to be significantly associated with an increased risk of microbial contamination - Place sanitation did not show a significant association with the presence of microbial contamination in refillable drinking water - Raw water sources did not show a significant association with the presence of microbial contamination in refillable drinking water

Based on the findings in table 1, it is known that the bacteriological quality of drinking water at the drinking water depot is evidenced by the results of laboratory examinations, and the factors that affect it based on observations while in the field. The factors that affect the microbiological quality of drinking water at the drinking water depot are as follows:

Table 2
Factors Affecting the Microbiological Quality of Drinking Water at Drinking Water Depots

Researcher	Influencing Factors								
	Equipment Sanitation	**Sanitation of the Place**	**Sanitation Facilities**	**Processing Process**	**Hygiene Digester**	**Storage Length of Water in Gallons**	**Raw Water Source**	**Bacteria Escherichia coli**	**Coliform Bacteria**
Nizam, Fahrul, et al. (20220)	✓	-	-	✓	✓	-	-	Positive	Not checked
Karjono, M et al. (2022)	✓	-	-	-	✓	-	✓	Not checked	Positive
Butarbutar, Augustinus R, et al. (2023)	-	-	✓	-	✓	-	✓	Not checked	Positive
Peronika Deliana Elsa, et al (2025)	✓	✓	-	-	-	-	-	Positive	Not checked
Wulandari, Puri et al. (2025)	✓	-	-	-	✓	✓	-	Positive	Positive

Description: (✓)= Affect, (-) = Not Affect

Table 2 illustrates that out of 5 articles, 80% of the sanitary factors of the equipment and hygene of the handlers affect the quality of microbiology, 40% of the raw source factors affect the quality of microbiology, 20% of the factors of sanitary hygiene facilities, the process of managing refillable drinking water, and sanitation of the place affect the quality of microbiology. Meanwhile, when viewed based on each microbiological parameter, namely the parameters of Escherichia coli and coliform, it is known that what affects the quality of microbiology with the parameters of Escherichia coli as much as 100% is influenced by sanitation factors, 67% of sanitary hygiene factors, 33% of drinking water management process factors, the duration of storage of water in gallons and sanitation of the place, while the facilities of sanitary hygiene do not affect the quality of microbiology.

The quality of microbiology is based on coliform parameters, so 100% of the raw water source factor and the sanitary hygiene factor greatly affect the quality of microbiome, 50% of the equipment factor and sanitary hygiene, while the sanitary factors of the place, the drinking water management process and the storage time of water in gallons do not affect the microbiological quality of drinking water at the drinking water depot. However, these factors can affect the microbiological quality of drinking water at drinking water depots.

2. Discussion

Based on the analysis of the article above, it shows that the quality of microbiology is influenced by several factors, including:

1) **Equipment Sanitation Factors:** Multivariate analysis shows that equipment sanitation is the most dominant factor against microbial contamination in refillable drinking water. Depots with unqualified sanitation are more than 30 times more at risk of contamination than depots that meet standards. Equipment that is not properly cleaned and maintained can be a breeding ground for biofilm and coliform bacteria, including *E. coli*. The risk is increasing due to the use of microfilters that do not meet standards, the operation of UV lamps that are not optimal, and the gallon washers that are dirty or unsuitable for use. This condition has the potential to reduce the quality and safety of the drinking water produced
2) **Sanitation Factors of the Place:** Place sanitation does not show a significant relationship with microbial contamination in refillable drinking water, so it is not a major factor compared to equipment hygiene and operator hygiene. However, the cleanliness of the depot environment remains important as a comprehensive preventive measure. Several studies show that there are still depots that do not meet the sanitary standards of the place, such as the unavailability of latrines, closed garbage cans, handwashing facilities, and adequate waste disposal. The location of depots in densely populated areas, roadsides, and shops also has the potential to increase exposure to dust and pollutants that can carry microorganisms. These inadequate environmental conditions have the potential to affect water quality, so the implementation of sanitation standards is still needed to maintain drinking water safety
3) **Factors of Hygiene and Sanitation Facilities:** The results of the study showed that there was a relationship between sanitary hygiene and depot drinking water quality, where the implementation of better sanitation hygiene tended to be followed by better water quality as well. Most depots have met the sanitary hygiene requirements related to the condition of the premises, equipment, handlers, and raw water sources, but there are still almost half that do not meet the standards, potentially affecting the quality of the water produced
4) **Processing Process Factors:** Some depots are known to have not met the requirements in the process of managing refillable drinking water, while others have met the standards. The results of statistical analysis showed that there was a relationship between the refillable drinking water management process and the bacteriological quality *of Escherichia coli*, so that an unqualified management process has the potential to increase the risk of microbiological contamination
5) **Hygiene Factors of Handlers:** Research shows that operator hygiene is significantly related to microbial contamination in refillable drinking water, where depots with operators who have poor hygiene are at a much higher risk of contamination than those who maintain good personal hygiene. Personal hygiene is essential because operators can be a source of the transfer of microorganisms to water or equipment, especially if they do not wash their hands, do not use protective equipment, or do not have adequate sanitation facilities available. On the other hand, there are studies that cannot continue

the relationship analysis because the hygiene data of handlers is homogeneous. However, the results of the questionnaire showed that most depots still had unqualified handler hygiene practices, reflecting the low implementation of hygiene standards in the field

6) **Factor of Long Water Storage in Gallons:** Research shows that water storage of more than one day is associated with an increased risk of microbial contamination. Depots that store water for too long tend to be more at risk of contamination than those that distribute it immediately. This can be caused by unhygienic containers, not tightly closed, exposure to unclean environments, and uncontrolled storage temperatures that support bacterial growth. In fact, some studies report that the number of *Escherichia coli* and total coliforms increases after water is stored for a certain period of time. However, another study found that the length of water storage in gallons was not necessarily associated with a decline in drinking water quality. It is also mentioned that storage for several hours can actually help settle large particles such as sand, mud, and large microorganisms. This suggests that the effect of storage time on water quality can vary depending on the conditions and storage methods
7) **Raw Water Source Factors:** The results showed that the source of raw water did not have a meaningful relationship with the presence of microbial contamination in refillable drinking water. These findings show that although raw water quality is important, the factors of the treatment, handling, and filling processes at the depot have more influence on the microbiological safety of drinking water. In general, water coming from mountains tends to have lower levels of contamination because it comes from a natural environment far from human activities. This is in line with the results of laboratory tests at several depots which showed that the raw water was not detected to contain *Escherichia coli bacteria*, so that the initial quality of the water was classified as good before going through the treatment process

Conclusion

Overall, the results of the study show that the microbiological quality of refillable drinking water is influenced by various factors, but the most dominant factor comes from the internal aspects of depot management. Operator hygiene has been shown to have a very important role in determining the presence or absence of microbial contamination. Operators who do not implement good personal hygiene practices, such as not washing hands, not using protective equipment, and working without the support of adequate sanitation facilities, are at high risk of becoming a source of contamination. This emphasizes that the behavior and discipline of operators are key components in maintaining the safety of drinking water. In addition, the cleanliness of equipment and water management processes, including the stages of treatment, storage, and refilling, also contribute to the final quality of drinking water. Processes that do not meet standards have the potential to increase the risk of growth and transfer of microorganisms. The length of water storage in some findings was associated with an increase in the number of bacteria, especially if the conditions of the container and the storage environment were unhygienic. However, there were differences in results between studies, suggesting that the effect of storage length was largely dependent on the way and conditions of storage itself.

On the other hand, the environmental sanitation factors of the depot and the source of raw water do not always show a direct relationship with microbiological contamination. Some laboratory test results even show that the raw water has met the standards and has not been detected to contain indicator bacteria such as *Escherichia coli*. This indicates that the initial quality of the water is relatively good, so potential contamination is more likely to occur during the treatment and distribution process at the depot. Thus, it can be concluded that efforts to improve the quality of refillable drinking water should be focused on strengthening the implementation of hygiene and sanitation in depot operations, especially in the aspects of operator hygiene, equipment, and supervision of the processing and refilling process. Coaching, routine supervision, and the provision of adequate sanitation facilities are strategic steps to minimize the risk of contamination and ensure the safety of drinking water for the community.

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