International Journal of Health Literacy and Science 3 (2) (2025)
International Journal of Health Literacy and Science
https://ihelis.com

Household Drinking Water Quality Surveillance (KAMRT) for Public and Environmental Health Improvement

Herniwanti[1*],Oktavia Dewi[2], Novita Rani[3], Rafni Nasyabila[4], Mitra[5]

[1,2,3,4,5]Master of Public Health Sciences, Hang Tuah University Pekanbaru

Article Info

Article History

Submitted: October 15, 2025

Revised: December 2, 2025

Accepted: December 31, 2025

Keywords:
E. coli; environmental health;Household water quality; STBM; KAMRT

Abstract

Access to safe drinking water is a key target under SDG 6.1; yet household-level risks remain under-monitored in Indonesia. This study aimed to assess household drinking-water quality in the Rumbai Bukit PHC area as part of the implementation of STBM pillar 3 by the Household Drinking Water Quality Surveillance (KAMRT). A cross-sectional surveillance (July–Sept 2024) tested 24 household water samples from wells, PDAM, and refill depots for physical (colour, turbidity, odour, TDS), chemical (pH, Fe, Mn), and microbiological (E. coli) parameters. Laboratory examination showed that 22 samples (91.7%) were positive for E. coli, with the highest contamination detected in dug-well (100%) and refill-depot water (87.5%), while only one PDAM sample was positive. In addition, three parameters, pH (33.3%), Fe (25%), and Mn (20.8%), failed to meet the national standards set in the Ministry of Health Regulation No. 2/2023. No samples failed for colour, odour, turbidity, or TDS. Most household water was unsafe microbiologically. Strengthened internal/external monitoring, public education on safe storage/treatment, and multi-sector collaboration using community-based technologies are required to secure sustainable safe water access.

Correspondence Address:
Master of Public Health Sciences, Hang Tuah University Pekanbaru
Mustafa Sari Street, No.5, Pekanbaru City, Riau, 28281, Indonesia
E-mail: herniwanti@htp.ac.id

pISSN 2964-2035
eISSN 3025-9258

Introduction

Access to safe drinking water is essential for preventing waterborne diseases and remains a key component of SDG 6.1. Although global progress has been made, more than 2 billion people still lack safely managed drinking water services (WHO & UNICEF, 2022). In low- and middle-income countries, microbial contamination is frequently reported even from improved water sources due to infrastructure limitations, environmental conditions, and household handling practices (Bain et al., 2014; Shaheed et al., 2014).

In Indonesia, challenges in achieving universal access to safe drinking water persist. National surveys show that only around half of households obtain water that meets drinking-water safety requirements, and contamination is common in both piped and non-piped sources (Riskesdas 2018; Ummah & Adriyani, 2019;). Refillable drinking-water depots—widely used due to their affordability—often fail to comply with hygiene and sanitation standards, resulting in microbiological contamination (Rahayu &

Herniwanti, 2022; Ronny & Syam, 2016). Similar problems are documented for household wells, particularly shallow dug wells that are prone to fecal intrusion.

The Ministry of Health has introduced the Household Drinking Water Quality Surveillance (KAMRT) approach to support the operationalization of STBM pillar 3 and enable PHCs to monitor drinking-water safety at the community level systematically. However, no KAMRT-based surveillance has previously been conducted in the Rumbai Bukit PHC area, despite the known reliance on varied water sources—dug wells, PDAM, and refill depots—and the absence of routine quality-monitoring reports.

This study addresses this local gap by assessing the microbiological and physicochemical quality of household drinking water in the Rumbai Bukit PHC area using the KAMRT framework. The findings aim to inform STBM programming, strengthen PHC surveillance, and contribute to achieving local progress toward SDG 6.1. Previous studies have emphasized the need for technology-based water quality monitoring systems, such as WaterScope, which can expand sustainable water monitoring access in urban settings (Hasan et al., 2022). On the other hand, the Community-Based Total Sanitation (STBM) program has also proven effective in improving clean and healthy living behavior (PHBS) among communities and reducing the risk of diarrheal diseases (Novi et al., 2022). This reinforces the urgency of household drinking water quality research to support the achievement of Sustainable Development Goals (SDGs) point 6.

The research gaps is the first KAMRT-based household surveillance in Rumbai Bukit PHC to inform STBM-pillar 3 implementation and local SDG-6.1 progress . Therefore, drinking water quality is a multidimensional issue involving environmental, technical, social, and behavioral factors. This study aims to assess household drinking water quality in the Rumbai Bukit Public Health Center area, Pekanbaru City, contributing to the mapping of local safe water challenges and supporting the achievement of SDG 6.1.

Methods

Study Design and Setting

A cross-sectional surveillance assessment was conducted from July to September 2024 in the Rumbai Bukit Public Health Center (PHC) area, Pekanbaru City, Indonesia. The assessment followed the operational steps of the Household Drinking Water Quality Surveillance (KAMRT) program.

Sampling Strategy and Sample Size Justification

A stratified purposive sampling approach was used to ensure representation of the three major household water-source categories identified by the PHC: dug wells, PDAM connections, and refill-water depots. Within each source category, households were selected based on PHC household lists and accessibility during the surveillance period.

A total of 24 samples were collected. The number was determined based on (1) representation of all major water-source types, (2) available laboratory processing capacity for weekly batch testing, and (3) resource constraints typical of routine PHC surveillance activities. The sample composition was: 10 dug wells, 6 PDAM household connections, and 8 refill-water depot samples. The final sample size of 24 reflected operational constraints, including limited reagent availability from the District Health Office and insufficient laboratory staffing. This sampling is part of an ongoing annual surveillance effort that will continue each year until the full target sample coverage is achieved.

Water Quality Parameters and Laboratory Examination

Each water sample was analysed for:

- **Microbiological:** *Escherichia coli* using the Most Probable Number (MPN) method.
- **Physical:** colour, turbidity, odour, total dissolved solids (TDS).
- **Chemical:** pH, iron (Fe), manganese (Mn).

All examinations followed the Indonesian Ministry of Health Regulation No. 2/2023. Results were compared with the national drinking-water quality standards (MoH Regulation No. 492/2010).

Data Analysis

Findings were summarized descriptively using frequencies and percentages. Non-compliance patterns were examined across different source types to identify contamination profiles.

Results

The findings showed that the majority of household drinking water samples contained E. coli, indicating microbiological contamination. The highest percentage of contamination was found in groundwater and refill water depots . Laboratory testing of 24 household drinking water samples revealed that four parameters exceeded acceptable standards.

Table 1. Summary of Household Drinking Water Quality Analysis

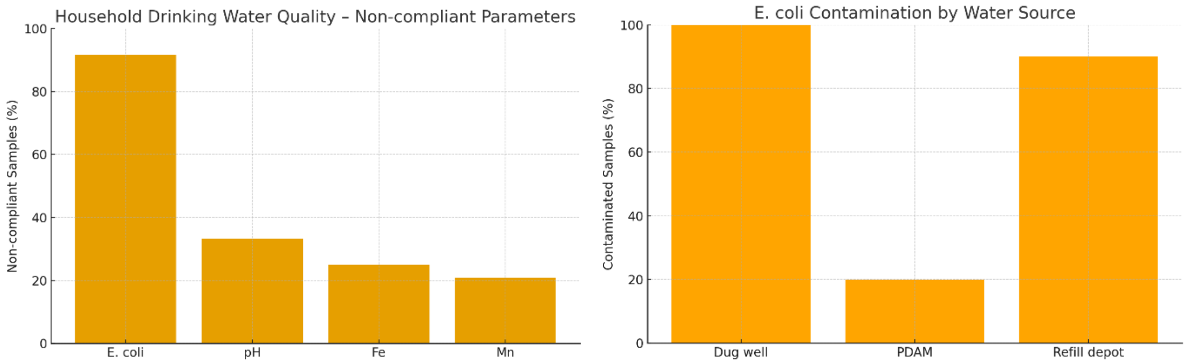
Parameter	Non-compliant Samples	Percentage (%)
E. Coli	22	91.7
pH	8	33.3
Fe	6	25.0
Mn	5	20.8
Color, odor, turbidity, TDS	0	0

A total of 24 household water samples were collected, consisting of 10 from dug wells, 6 from PDAM connections, and 8 from refill-water depots. Laboratory analysis assessed the compliance of each sample with national drinking-water quality standards for microbiological (E. coli), pH, iron (Fe), and manganese (Mn), as well as physical parameters (colour, odour, turbidity, and TDS). Table 2 summarizes the distribution of non-compliant samples for each parameter across the different water sources.

Table 2. Household Drinking-Water Quality by Parameter and Water Source

Water Source	No. of Samples (n)	E. coli positive (%)	pH non-compliant (%)	Fe non-compliant (%)	Mn non-compliant (%)
Dug well	10	10 (100 %)	3 (30 %)	2 (20 %)	2 (20 %)
PDAM	6	1 (16.7 %)	2 (33.3 %)	1 (16.7 %)	1 (16.7 %)
Refill-water depot	8	7 (87.5 %)	3 (37.5 %)	3 (37.5 %)	2 (25 %)
Total	**24**	**22 (91.7 %)**	**8 (33.3 %)**	**6 (25.0 %)**	**5 (20.8 %)**

Notes: No samples failed on colour, odour, turbidity, or TDS.



Fiqure 1,2. Household drinking water- non compliant parameter and E.coli contamination by water source

To complement the tabulated findings, Figure 1 illustrates the percentage of non-compliant samples for each tested parameter (E. coli, pH, Fe, and Mn). Figure 2 displays the distribution of E. coli contamination according to the household water sources—dug wells, PDAM, and refill-water depots—highlighting that contamination was highest in dug-well and refill-depot water.

A total of 24 household drinking-water samples were analysed. Overall, 22 samples (91.7%) were positive for *E. coli*, indicating widespread microbiological contamination. Non-compliance was also recorded for pH (33.3%), Fe (25%), and Mn (20.8%), while all samples met standards for colour, odour, turbidity, and TDS.

Contamination patterns varied substantially by water source. Dug-well water showed universal contamination (100%), suggesting persistent fecal intrusion likely related to shallow well construction, poor sealing, and proximity to sanitation facilities. Refill-water depots also exhibited high contamination (87.5%), indicating inadequate sanitation during processing or distribution. In contrast, PDAM water had the lowest contamination (16.7%), though still not fully compliant.

Chemically, non-compliant pH and metal concentrations were found across all water sources, with the highest proportion of pH failures in refill-water depots (37.5%) and PDAM connections (33.3%). These issues may reflect distribution-system conditions, treatment processes, or household storage practices.

Discussion

This surveillance revealed that most household drinking-water samples in the Rumbai Bukit PHC area failed to meet microbiological safety standards, with E. coli detected in 91.7% of samples. The contamination levels are consistent with national reports showing that many Indonesian households still consume water that does not meet safety requirements (Ummah & Adriyani, 2019; Aisyah & Sukarno, 2020). International research similarly indicates that improved water sources may remain unsafe at the point of consumption (Bain et al., 2014; Shaheed et al., 2014).

High contamination in dug-well water (100%) likely reflects structural and environmental vulnerabilities. Many wells in the study area are shallow, unlined, and located close to septic tanks, allowing for infiltration of fecal matter during rainfall or through permeable soil. These findings align with studies showing that well design, distance from sanitation facilities, and groundwater vulnerability are strong predictors of microbial contamination.

Refill-water depots also exhibited substantial contamination (87.5%), which is concerning given that depot water is widely perceived as safer than other sources. Possible contributors include poor maintenance of filtration and UV systems, inadequate operator training, and inconsistent hygiene practices during bottling and transport—issues previously documented in other Indonesian cities (Rahayu & Herniwanti, 2022; Sari et al., 2020). Household handling of jerry cans and galon containers may further compound contamination risks. Such contamination increases the risk of diarrheal diseases, stunting, and other waterborne illnesses, echoing WHO's (2019) warning on the health burden of unsafe water.

The comparatively low contamination rate in PDAM samples indicates that treated piped water generally performs better; however, even a 16.7% failure rate suggests vulnerabilities such as leakage, intermittent flow causing pressure drops, or contamination during storage at the household level.

The chemical non-compliance (pH, Fe, Mn) suggests additional water-quality issues related to groundwater characteristics, corrosion of distribution pipes, and inadequate household storage. While these values do not pose immediate acute risks, they may influence aesthetic quality and consumer acceptability. Strengthening KAMRT implementation is crucial. Evidence indicates that community-based monitoring, combined with decision-support tools, enhances local risk identification and prioritization (Tzeng et al., 2021; Howard et al., 2021). Integrating this approach with PHC-level STBM activities may improve adherence to hygiene practices and promote safer household storage and treatment behaviors.

Our findings are consistent with previous research in Riau Province that reported high bacterial contamination in refill-water depots (Herniwanti et al., 2022) and align with evidence from other Indonesian cities where household water often fails to meet national health standards (Novi et al., 2022; Aisyah & Sukarno, 2020). Internationally, similar patterns of fecal contamination in low- and middle-income countries have been documented by Bain et al. (2014), Shaheed et al. (2014), highlighting that "improved" water sources may still be unsafe at the point of use.

Rahaman et al. (2020) noted that urban water distribution systems often face complexities that influence water quality at the household level. Therefore, regular water quality evaluations are essential to prevent exposure to harmful pathogens that pose public health risks. Previous studies also support these findings. For example, Bain et al. (2014) highlighted widespread fecal contamination in drinking water across low- and middle-income countries. Prüss-Ustün et al. (2019) estimated the global burden of disease attributable to unsafe water, sanitation, and hygiene. Shaheed et al. (2014) noted that "improved" water sources are not always microbiologically safe. In Bangladesh, Ercumen et al. (2015) demonstrated that animal feces contribute significantly to domestic water contamination. Gundry et al. (2004) systematically reviewed health outcomes linked to poor household water quality in developing nations.

Indonesian studies by Aisyah & Sukarno (2020) and Saputra & Handayani (2021) confirmed high E. coli contamination in refill drinking water depots. Meanwhile, emergency contexts highlight the importance of household treatment technologies (Lantagne & Clasen, 2012). Howard & Bartram (2003) emphasized the role of water service levels in health outcomes. Finally, hygiene interventions in Bangladesh demonstrated significant reductions in water contamination and diarrheal diseases among children (Islam et al., 2011). Thus, these findings emphasize the importance of strengthening external monitoring by public health centers and health authorities, along with community education on safe household water management. Overall, the findings highlight the need for more rigorous oversight of refill depots, better protection and rehabilitation of household wells, and strengthening of PHC-led drinking-water surveillance.

Limitations Study

This study has several limitations. First, the relatively small sample size (n = 24) limits the generalizability of the findings to the wider community. Second, the cross-sectional and descriptive design does not allow for causal inference between water quality and health outcomes. Third, sampling was conducted only during the dry season (July–September 2024) so possible seasonal variations in contamination—such as during the rainy season—were not captured. Finally, laboratory testing was limited to selected physicochemical and microbiological parameters; future studies should include a broader range of chemical contaminants to provide a more comprehensive risk assessment.

Conclussion

Most household drinking-water samples in the Rumbai Bukit PHC area failed to meet microbiological standards, with particularly high contamination in dug wells and refill-water depots. Chemical non-compliance was also present across water sources. These findings underscore the urgent need to strengthen PHC-led KAMRT surveillance, improve hygiene and operational standards in refill depots, and promote safe household water-treatment and storage practices. Implementing these measures will support local progress toward SDG 6.1 and reduce the risk of waterborne diseases in the community.

Funding

This study was financially supported by the Institute for Research and Community Service Universitas Hang Tuah Pekanbaru.

Acknowledgments

I would like to thank the committee of the 5th International Seminar and Workshop on Public Health Action (ISWOPHA 2025) for the opportunity and support in this publication process. Also the authors express gratitude to Rumbai Bukit Public Health Center, Environmental Health students, and all parties who supported the implementation of this surveillance

Conflicts of Interest:

The authors declare no conflict of interest.

References

Aisyah, S., & Sukarno, R. (2020). Kontaminasi bakteri E. coli pada depot air minum isi ulang di Kabupaten Bandung. Jurnal Kesehatan Lingkungan Indonesia, 19(2), 112–120.

Atyikah, S., Herniwanti, H., Rany, N., Dewi, O., & Iswadi, I. (2021). Operational evaluation of refillable drinking water depots in Rambah Health Center area. *Jurnal Kesehatan Manarang, 7*(2), 116–124. https://doi.org/10.33490/jkm.v7i2.320

Bain, R., Cronk, R., Wright, J., Yang, H., Slaymaker, T., & Bartram, J. (2014). Fecal contamination of drinking-water in low- and middle-income countries: A systematic review and meta-analysis. PLoS Medicine, 11(5), e1001644. https://doi.org/10.1371/journal.pmed.1001644

Ercumen, A., Pickering, A. J., Kwong, L. H., Arnold, B. F., Parvez, S. M., Alam, M., ... Colford, J. M. (2015). Animal feces contribute to domestic fecal contamination: Evidence from Bangladesh. Environmental Science & Technology, 49(3), 1416–1424. https://doi.org/10.1021/es503786x

Gundry, S., Wright, J., & Conroy, R. (2004). A systematic review of the health outcomes related to household water quality in developing countries. Journal of Water and Health, 2(1), 1–13. https://doi.org/10.2166/wh.2004.0001

Hasan, M., et al. (2022). Expanding access to water quality monitoring: The case of WaterScope. Journal of Water Resources, 45(3), 112–125. https://doi.org/10.1080/07900627.2022.2035689

Herniwanti, H., & Ray, D. K. (2022). Evaluating the sanitary hygiene of drinking water depots in Pekanbaru City. *Jurnal Kesehatan Lingkungan Indonesia, 21*(3), 335–343. https://doi.org/10.14710/jkli.21.3.335-343

Herniwanti, H., Sudarto, E., Zaman, K., Dewi, O., & Rany, N. (2022). The sanitary hygiene of refilled drinking water depots during the COVID-19 pandemic. *Jurnal Penelitian Pendidikan IPA, 8*(5), 2476–2482. https://doi.org/10.29303/jppipa.v8i5.2343

Howard, G., & Bartram, J. (2003). Domestic water quantity, service level and health. Geneva: World Health Organization.

Howard, G., et al. (2021). Evaluation of water quality: Community participation in citizen science-based monitoring. Science of the Total Environment, 765, 142–158. https://doi.org/10.1016/j.scitotenv.2020.142158

Islam, M. S., Mahmud, Z. H., Gope, P. S., Zaman, R. U., Hossain, Z., Islam, K., ... Sack, D. A. (2011). Hygiene intervention reduces contamination of drinking water in rural households and diarrhea among children in rural Bangladesh. Tropical Medicine & International Health, 16(9), 1087–1094. https://doi.org/10.1111/j.1365-3156.2011.02815.x

Lantagne, D. S., & Clasen, T. F. (2012). Use of household water treatment and safe storage methods in acute emergency response: Case study results from Nepal, Indonesia, Kenya, and Haiti. Environmental Science & Technology, 46(20), 11352–11360. https://doi.org/10.1021/es301842u

Ministry of Health, Republic of Indonesia. (2010). Regulation of the Minister of Health No. 492/2010 on Drinking Water Quality Requirements.

Ministry of Health, Republic of Indonesia. (2023). Regulation of the Minister of Health No. 2/2023 on Hygiene and Sanitation Requirements for Drinking Water Depots.

Prüss-Ustün, A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C., … Johnston, R. (2019). Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: An updated analysis with a focus on low- and middle-income countries. International Journal of Hygiene and Environmental Health, 222(5), 765–777. https://doi.org/10.1016/j.ijheh.2019.05.004

Rahaman, M., et al. (2020). Complexities of the urban drinking water systems: Challenges and opportunities. Environmental Monitoring and Assessment, 192(6), 411. https://doi.org/10.1007/s10661-020-08321-1

Rahayu, E., & Herniwanti, H. (2022). Perceptions of sanitation hygiene refill drinking water depot in the region of Indonesia. *Gaceta Médica de Caracas, 130*(2), S669–S678.

Ronny, R., & Syam, A. (2016). Quality of refillable drinking water depots based on physical, chemical, and microbiological parameters. *Media Kesehatan Masyarakat Indonesia, 12*(2), 123–131.

Saputra, R., & Handayani, E. (2021). Analisis kualitas mikrobiologi air minum isi ulang di Kota Padang. Jurnal Kesehatan Masyarakat Andalas, 15(1), 45–53.

Sari, S. Y. I., Faisal, M., & Raksanagara, A. S. (2020). Water quality and factors associated with compliance of drinking water refilling stations as a choice for middle–low urban households in developing countries. *Journal of Water and Health, 18*(3), 404–415. https://doi.org/10.2166/wh.2020.285

Shaheed, A., Orgill, J., Montgomery, M. A., Jeuland, M. A., & Brown, J. (2014). Why "improved" water sources are not always safe. Bulletin of the World Health Organization, 92(4), 283–289. https://doi.org/10.2471/BLT.13.119594

Tzeng, G. H., et al. (2021). Decision-support systems based on a multiple criteria decision analysis for water management. Water Policy, 23(5), 1203–1215. https://doi.org/10.2166/wp.2021.123

Ummah, S., & Adriyani, R. (2019). Hygiene and sanitation of refillable drinking water depots in Surabaya. *Jurnal Kesehatan Lingkungan, 11*(1), 45–53.

World Health Organization. (2019). *Drinking-water*. Geneva: WHO.

World Health Organization (WHO) & UNICEF. (2022). *Progress on drinking water, sanitation and hygiene in households 2000–2020*. Geneva: WHO.

Zhang, Y., et al. (2021). Health risk assessment of heavy metals and physicochemical parameters in drinking water. Environmental Science and Pollution Research, 28, 12345–12358. https://doi.org/10.1007/s11356-021-12345