

## **ASSESSMENT OF HOUSEHOLD DRINKING WATER QUALITY IN GORONTALO DISTRICT, INDONESIA**

Lisa Djafar<sup>1</sup>, Moh. Rivandi Dengo<sup>2</sup>, Nining Batalipu<sup>3</sup>, Nur Ayini S. Lalu<sup>4</sup>, Apriyani<sup>5</sup>, Ririn Pakaya<sup>6</sup>

<sup>1,2,3,6</sup>Public Health Faculty, Universitas Gorontalo

<sup>4</sup>Faculty of Sports and Health, Universitas Negeri Gorontalo

<sup>5</sup>Public Health Faculty, Universitas Widya Gama Mahakam Samarinda

Email: [ririn.pakaya@mail.ugm.ac.id](mailto:ririn.pakaya@mail.ugm.ac.id)

### **ABSTRACT**

WHO data shows that in 2018, an estimated 829,000 people worldwide died annually due to diarrheal diseases caused by poor sanitation and non-compliant drinking water quality. According to the National Socioeconomic Survey conducted in March 2019, out of approximately 260 million Indonesians, 89.27% had access to improved drinking water sources. This study aims to describe the quality of household drinking water in Gorontalo Regency in 2020. The research design employed a quantitative descriptive approach, analyzing frequency, mean, maximum, and minimum values. The study population consisted of 383 samples based on household drinking water quality survey data. The sampling method was total sampling, including all 383 samples collected in the 2020 survey. The results of the study showed that the household drinking water quality in Gorontalo Regency, based on pH and total coliform levels, did not meet the standards for household drinking water. However, parameters such as temperature, TDS (Total Dissolved Solids), total *E. coli*, total nitrate, total nitrite, and total chromium indicated that the drinking water sources met the household drinking water quality standards. Further research using qualitative methods is recommended to provide deeper insights into the factors influencing household drinking water quality.

**Keywords:** *drinking water, pH, temperature, TDS, coliform, E. coli, nitrate, nitrite, chromium*

### **INTRODUCTION**

Globally, deteriorating drinking water quality is a major public health issue that contributes to disease transmission and death. As a result, quality control monitoring must be conducted on a regular basis (Birhan et al., 2023) (Ondieki et al., 2021) (WHO, 2006). Water is the essence of life, serving as a fundamental necessity for survival and the foundation of all biological processes (WHO, 2011b).

Access to safe drinking water is not only a basic human right but also a critical factor in promoting health, well-being, and social equity. It plays a pivotal role in preventing waterborne diseases, ensuring proper nutrition, and supporting hygiene practices essential for individual and community health. Moreover, the availability of

*safe drinking water is indispensable for achieving sustainable development, as it underpins economic productivity, educational opportunities, and environmental preservation. Recognizing its significance, safeguarding access to clean and safe water must remain a global priority to ensure a healthy and sustainable future for all (De Guzman et al., 2023).*

*World Health Organization (WHO) data shows that in 2018, an estimated 829,000 people in the world died each year from diarrheal diseases caused by poor sanitation and substandard drinking water quality (World Health Organization, 2019). Water contamination and inadequate sanitation have been connected to the spread of diseases like cholera, diarrhoea, dysentery, hepatitis A, typhoid fever, and polio. Individuals face avoidable health hazards when water and sanitation facilities are unavailable, inadequate, or poorly managed. This is especially true in health care institutions, where a shortage of water, sanitation, and hygiene services increases the risk of infection and sickness for both patients and personnel. Out of every 100 patients in acute-care hospitals, 7 in high-income countries (HICs) and 15 in low- and middle-income countries (LMICs) will contract at least one health-care-associated infection (WHO, 2023).*

*The objective of this study is to analyze the quality of household drinking water in Gorontalo Regency. The research gap in this study lies in the limited comprehensive data on the quality of household drinking water in Gorontalo Regency, particularly concerning its physical, chemical, and microbiological parameters. While previous studies may have examined water quality in specific areas or addressed isolated aspects of contamination, there is a lack of integrated and localized analysis tailored to the unique environmental and socio-economic conditions of Gorontalo. Furthermore, the absence of detailed studies linking water quality issues to health outcomes in this region highlights the need for targeted research to inform policy interventions and public health strategies. This study addresses these gaps by conducting a thorough assessment and providing actionable insights to enhance water quality management.*

## METHODS

This study utilized a quantitative descriptive research design to assess the quality of household drinking water in Gorontalo Regency. The research was conducted at the Gorontalo District Health Office. The population consisted of 383 household drinking water sources in Gorontalo Regency, as recorded in the Household Drinking Water Quality Survey.

The sample in this study included the entire population, totaling 383 households. A total sampling method was employed to ensure all household water sources were represented (Riyanto, 2011). Data collection involved the use of structured forms to record respondent characteristics and measure the following parameters of drinking water quality: pH, water temperature, Total Dissolved Solids (TDS), total coliform, *Escherichia coli* (*E. coli*), nitrate levels, nitrite levels, and chromium levels. Data analysis was performed using univariate analysis to describe each research variable in terms of frequency distribution percentages. The results were presented in terms of key water quality parameters, including pH, temperature, TDS, total coliform, *E. coli*, nitrate, nitrite, and chromium levels. Descriptive statistics, such as mean, maximum, minimum, and standard deviation, were used to summarize the findings.

## RESULTS

Table 1. Distribution of Respondents Based on pH (Potential Hydrogen) of Household Drinking Water in Gorontalo Regency

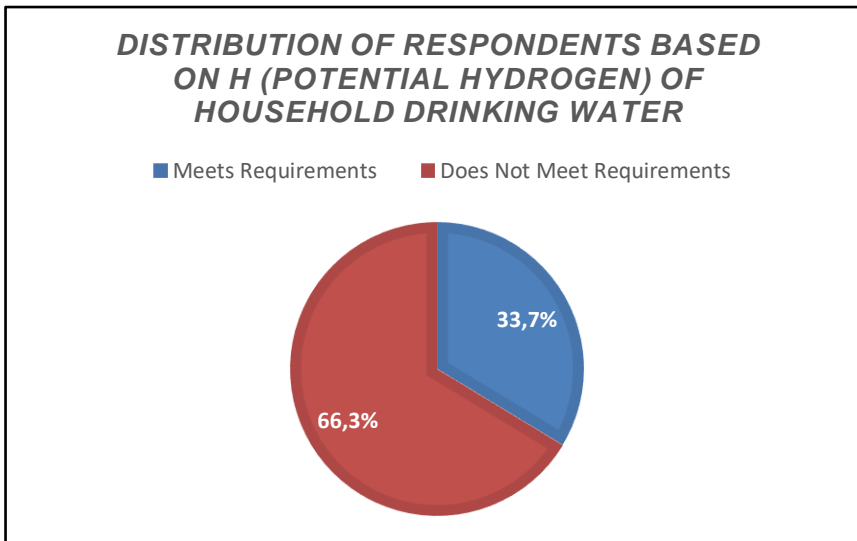
pH Value	N	%	Mean	Min	Max	Standard Deviation
Meets Requirements	129	33,7				
Does Not Meet Requirements	254	66,3	7,439	6,3	9,2	0,652
Total	383	100,0				

Source: Secondary Data

The distribution of respondents based on the pH value of household drinking water in Gorontalo Regency reveals that the majority of household water samples, totaling 254 samples (66.3%), did not meet the recommended standards for pH. In contrast, 129 samples (33.7%) met the acceptable pH requirements.

The mean pH value of the water samples was 7.439, with a minimum of 6.3 and a maximum of 9.2. The standard deviation was 0.652, indicating moderate variability in the pH levels among the samples. These findings highlight a significant proportion of households with suboptimal water pH, emphasizing the need for interventions to ensure water quality compliance.

Below is a pie chart illustrating the distribution of respondents based on pH values:



Source: Secondary Data

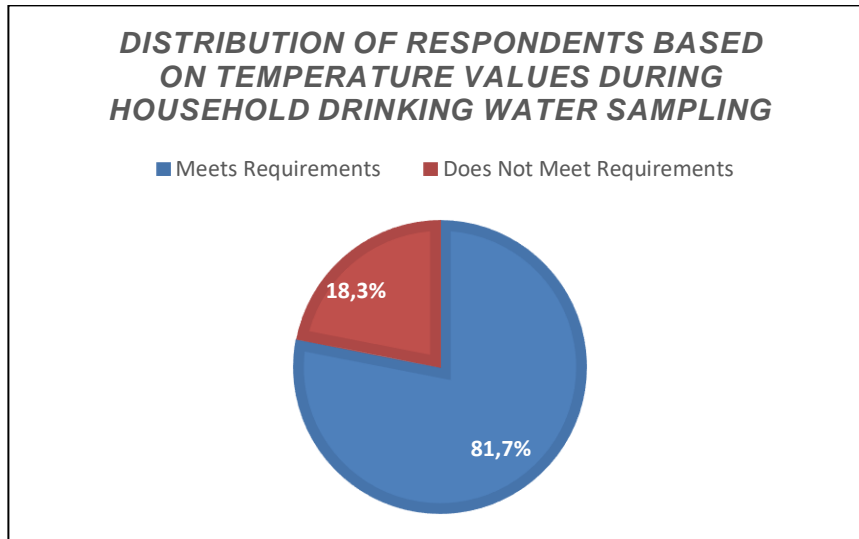
Picture 1: Distribution of Respondents Based on pH (Potential Hydrogen) of Household Drinking Water in Gorontalo Regency

The pie chart above illustrates the distribution of respondents based on the pH values of household drinking water in Gorontalo Regency. A significant majority (66.3%) of the samples did not meet the required pH standards, while only 33.7% were compliant.

Table 2. Distribution of Respondents Based on Temperature Values During Household Drinking Water Sampling in Gorontalo Regency

Temperature Value	N	%	Mean	Min	Max	Standard Deviation
Meets Requirements	313	81,7				
Does Not Meet Requirements	70	18,3	29,453	24,0	35,0	1,5093
Total	383	100,0				

Source: Secondary Data



Source: Secondary Data

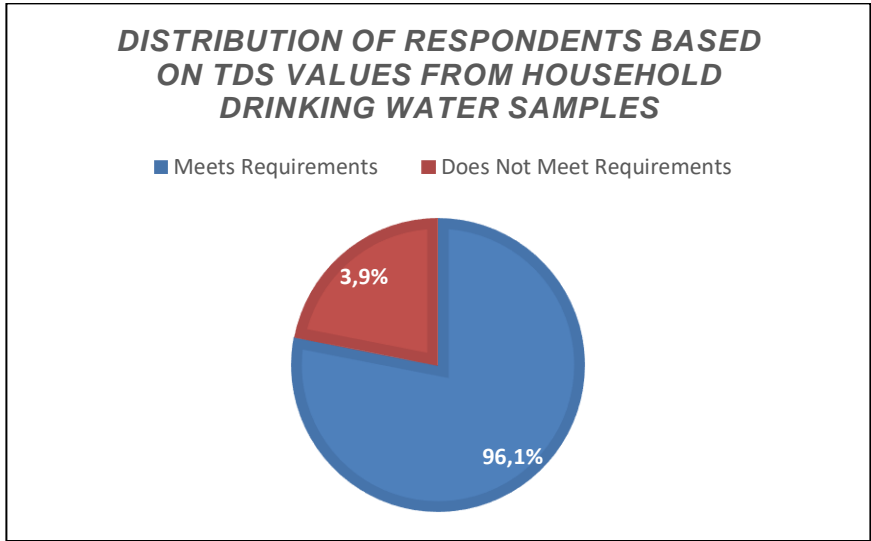
Figure 2. Distribution of Respondents Based on Temperature Measurements from Household Drinking Water Samples in Gorontalo Regency

Based on the table and figure above, it can be observed that the majority of household drinking water samples met the temperature quality standard, accounting for 313 samples (81.7%). The mean temperature value was 29.453°C, with a minimum temperature of 24.0°C, a maximum temperature of 34.0°C, and a standard deviation of 1.5093.

Table 3. Distribution of Respondents Based on TDS Values from Household Drinking Water Samples in Gorontalo Regency

TDS Values	N	%	Mean	Min	Max	Standard Deviation
Meets Requirements	368	96,1				
Does Not Meet Requirements	15	3,9	218,69	1	649	145,257
Total	383	100,0				

Source: Secondary Data



Source: Secondary Data

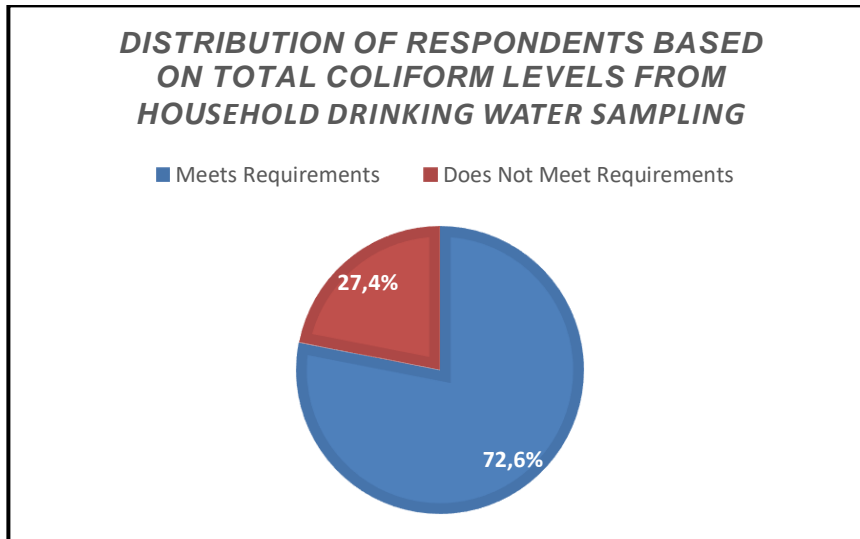
Figure 3. Distribution of Respondents Based on TDS Values from Household Drinking Water Sampling in Gorontalo Regency

Based on the table and figure above, it can be observed that the majority of household drinking water samples met the TDS quality standard, totaling 368 samples (96.1%). The mean TDS value was 218.69 mg/L, with a minimum value of 1 mg/L, a maximum value of 649 mg/L, and a standard deviation of 145.257.

Table 4. Distribution of Respondents Based on Total Coliform Levels from Household Drinking Water Sampling in Gorontalo Regency

<b>Total Coliform Levels</b>	N	%	Mean	Min	Max	Standard Deviation
Meets Requirements	105	27,4				
Does Not Meet Requirements	278	72,6	2,60	0	101	7,590
<b>Total</b>	<b>383</b>	<b>100,0</b>				

Source: Secondary Data



Source: Secondary Data

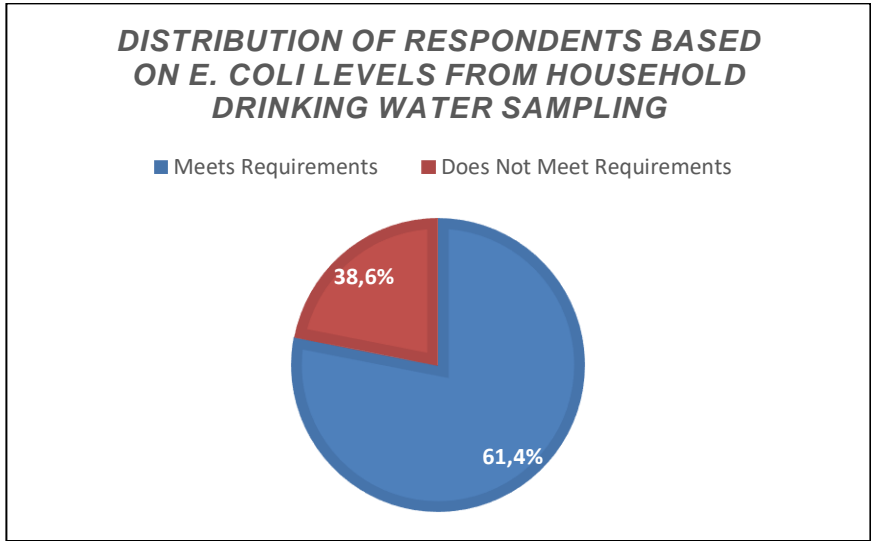
Figure 4. Distribution of Respondents Based on Total Coliform Levels from Household Drinking Water Sampling in Gorontalo Regency

Based on the table and figure above, it can be observed that the majority of household drinking water samples did not meet the total coliform quality standard, totaling 278 samples (72.6%). The mean total coliform value was 2.60, with a minimum value of 0, a maximum value of 101, and a standard deviation of 7.590.

Table 5. Distribution of Respondents Based on E. Coli Levels from Household Drinking Water Sampling in Gorontalo Regency

Total E. Coli Levels	N	%	Mean	Min	Max	Standard Deviation
Meets Requirements	235	61,4				
Does Not Meet Requirements	148	38,6	1,03	0	10	1,820
Total	383	100,0				

Source: Secondary Data



Source: Secondary Data

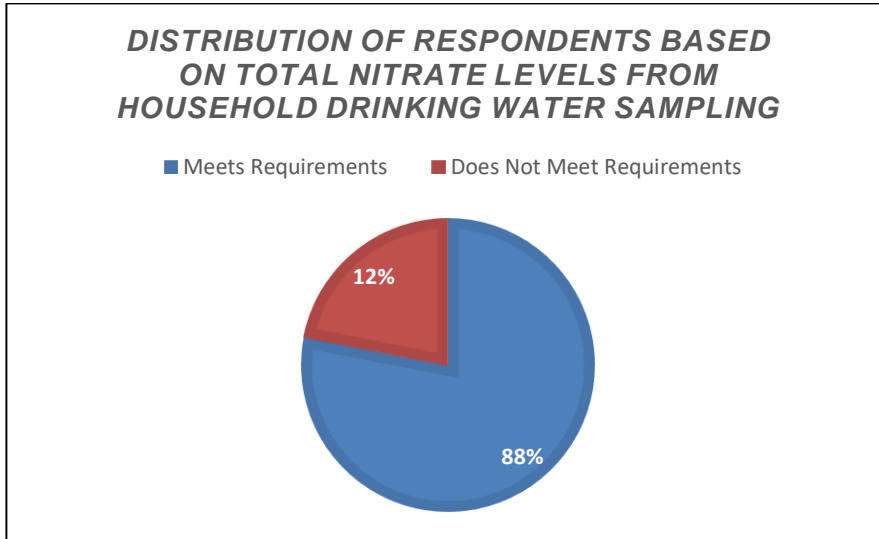
Figure 5. Distribution of Respondents Based on Total E. Coli Levels from Household Drinking Water Sampling in Gorontalo Regency

Based on the table and figure above, it can be observed that the majority of household drinking water samples met the total nitrate quality standard, with 337 samples (88.0%). The mean total nitrate value was 24.9, with a minimum value of 0.23, a maximum value of 97.9, and a standard deviation of 28.13.

Table 6. Distribution of Respondents Based on Total Nitrate Levels from Household Drinking Water Sampling in Gorontalo Regency

Total Nitrat	N	%	Mean	Min	Max	Standard Deviation
Meets Requirements	337	88,0				
Does Not Meet Requirements	46	12,0	24,9	0,23	97,9	28,13
Total	383	100,0				

Source: Secondary Data



Source: Secondary Data

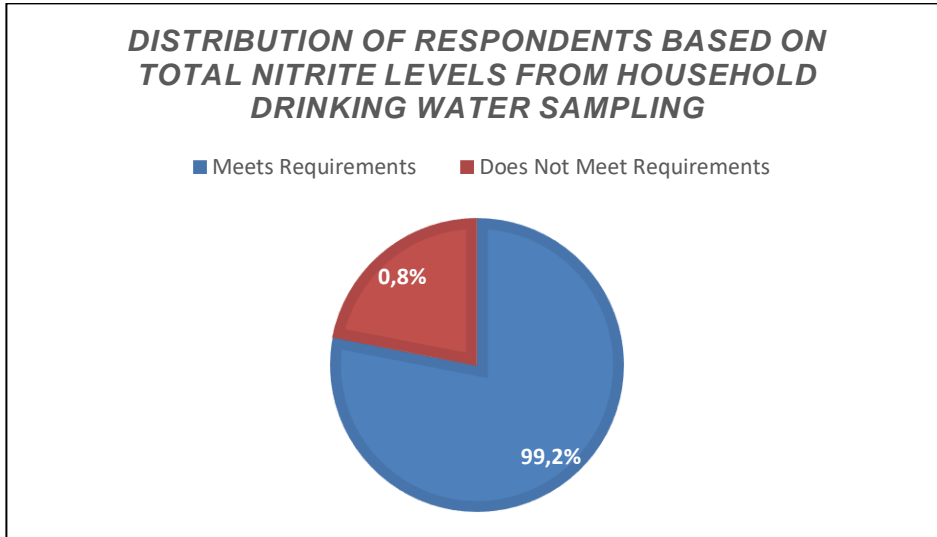
Figure 6. Distribution of Respondents Based on Total Nitrate Levels from Household Drinking Water Sampling in Gorontalo Regency

Based on the table and figure above, it can be observed that the majority of household drinking water samples met the total nitrate quality standard, with 337 samples (88.0%). The mean total nitrate value was 24.9, with a minimum value of 0.23, a maximum value of 97.9, and a standard deviation of 28.13.

Table 7. Distribution of Respondents Based on Total Nitrite Levels from Household Drinking Water Sampling in Gorontalo Regency

Total Nitrite	N	%	Mean	Min	Max	Standard Deviation
Meets Requirements	380	99,2				
Does Not Meet Requirements	3	0,8	0,247	0,00	8,31	0,722
Total	383	100,0				

Source: Secondary Data



Source: Secondary Data

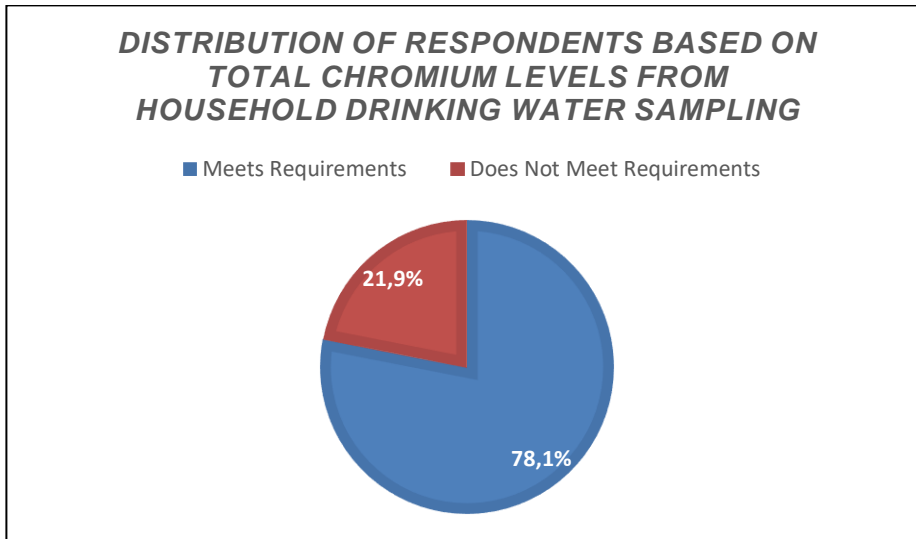
Figure 7 Distribution of Respondents Based on Total Nitrite Levels from Household Drinking Water Sampling in Gorontalo

Based on the table and figure above, it can be observed that the majority of household drinking water samples met the total nitrite quality standard, with 380 samples (99.2%). The mean total nitrite value was 0.247, with a minimum value of 0.00, a maximum value of 8.31, and a standard deviation of 0.722.

Table 8. Distribution of Respondents Based on Total Chromium Levels from Household Drinking Water Sampling in Gorontalo Regency

Total Kromium	N	%	Mean	Min	Max	Standard Deviation
Meets Requirements	299	78,1				
Does Not Meet Requirements	84	21,9	0,047	0,00	0,84	0,068
Total	383	100,0				

Source: Secondary Data



Source: Secondary Data

Figure 8. Distribution of Respondents Based on Total Chromium Levels from Household Drinking Water Sampling in Gorontalo Regency

Based on the table and figure above, it can be observed that the majority of household drinking water samples met the total chromium quality standard, with 299 samples (78.1%). The mean total chromium value was 0.047, with a minimum value of 0.00, a maximum value of 0.84, and a standard deviation of 0.068.

## DISCUSSION

The study's findings provide critical insights into the quality of household drinking water in Gorontalo Regency (Marlinae et al., 2024; Piu et al., 2022; Raharini & Yuniarti, 2023). Despite compliance with several key parameters, the failure to meet standards for pH and total coliform levels raises significant public health concerns (Barrell et al., 2000; Figueras & Borrego, 2010; Martin et al., 2016; WHO, 2011a). A pH level outside the acceptable range can affect the taste, corrosion potential, and overall safety of drinking water, while elevated coliform counts are indicative of fecal contamination and potential exposure to harmful pathogens. These results align with global studies highlighting the persistent challenge of microbial contamination in household water supplies, particularly in regions with insufficient water treatment infrastructure (WHO, 2011a).

*One of the primary observations is the satisfactory levels of temperature, Total Dissolved Solids (TDS), total E. coli, nitrate, nitrite, and chromium. These parameters are crucial for assessing water quality as they reflect both chemical stability and potential contamination risks. Temperature influences microbial growth, while TDS levels indicate the presence of dissolved substances such as salts and organic matter. The compliance of TDS levels within acceptable limits suggests minimal contamination from dissolved solids in the region's water sources. Moreover, the absence of concerning levels of E. coli and heavy metals such as chromium implies a lower risk of immediate health hazards due to chemical contamination. However, this does not diminish the need for vigilance, as long-term exposure to suboptimal levels of certain contaminants can have chronic health effects (Islam et al., 2017; Oyem et al., 2014; Pushpalatha et al., 2022; Zhang et al., 2017).*

*The inconsistency between microbial and chemical parameter compliance highlights the complexity of water quality management (Nnane et al., 2011; Tan et al., 2015; Van Winckel et al., 2021). While chemical contaminants are often addressed through improved infrastructure and source protection, microbial contamination requires consistent monitoring and effective disinfection strategies. The presence of total coliforms suggests that water treatment practices may be inadequate or that post-treatment contamination is occurring during distribution or storage. Factors contributing to these issues may include insufficient sanitation facilities, poor handling practices, and environmental conditions that favor microbial proliferation. These findings point to the necessity for community education programs aimed at improving safe water handling and storage practices at the household level.*

*Future research is essential to explore the socio-economic and environmental factors influencing drinking water quality in Gorontalo Regency. A qualitative approach can provide a deeper understanding of how local practices, infrastructure, and governance affect water safety. Engaging with local communities to identify barriers to effective water management and incorporating their perspectives can foster more sustainable solutions. Additionally, integrating routine water quality monitoring with public health interventions will be crucial for mitigating risks and*

ensuring long-term improvements in drinking water safety. This comprehensive approach can help bridge the gap between compliance with certain parameters and overall water quality that ensures public health protection (Lienert et al., 2013; Wiek & Larson, 2012).

## CONCLUSION AND SUGGESTIONS

The findings of this study indicate that household drinking water quality in Gorontalo Regency, based on pH and total coliform levels, does not meet the established standards for household drinking water. Conversely, other parameters such as temperature, Total Dissolved Solids (TDS), total *E. coli*, total nitrate, total nitrite, and total chromium comply with the prescribed quality standards. These results underscore the need for targeted interventions to improve drinking water safety, particularly concerning pH balance and microbial contamination control. Future research employing qualitative methods is essential to explore the underlying factors influencing the quality of household drinking water and to develop effective strategies for sustainable water quality management.

## REFERENCES

- Barrell, R. A., Hunter, P. R., & Nichols, G. (2000). Microbiological standards for water and their relationship to health risk. *Commun. Dis. Public Health*, 3(1), 8–13.
- Birhan, T. A., Bitew, B. D., Dagne, H., Amare, D. E., Azanaw, J., Andualem, Z., Dessie, A., Guyasa, G., Getaneh, A., Addisu, A., Genet, M., Engdaw, G. T., Tesfaye, A. H., Asmare, T. K., & Yimer, T. F. (2023). Household drinking water quality and its predictors in flood-prone settings of Northwest Ethiopia: A cross-sectional community-based study. *Heliyon*, 9(4), e15072. <https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e15072>
- De Guzman, K., Stone, G., Yang, A. R., Schaffer, K. E., Lo, S., Kojok, R., Kirkpatrick, C. R., Del Pozo, A. G., Le, T. T., DePledge, L., Frost, E. L., & Kayser, G. L. (2023). Drinking water and the implications for gender equity and empowerment: A systematic review of qualitative and quantitative evidence. *International Journal of Hygiene and Environmental Health*, 247, 114044. <https://doi.org/https://doi.org/10.1016/j.ijheh.2022.114044>
- Figueras, M. J., & Borrego, J. J. (2010). New perspectives in monitoring drinking water microbial quality. *International Journal of Environmental Research and Public Health*, 7(12), 4179–4202.
- Islam, R., Faysal, S. M., Amin, R., Juliana, F. M., Islam, M. J., Alam, J., Hossain, M. N., & Asaduzzaman, M. (2017). Assessment of pH and total dissolved substances (TDS) in the commercially available bottled drinking water. *IOSR Journal of Nursing and Health*

Science, 6(5), 35–40.

- Lienert, J., Schnetzer, F., & Ingold, K. (2013). Stakeholder analysis combined with social network analysis provides fine-grained insights into water infrastructure planning processes. *Journal of Environmental Management*, 125, 134–148.
- Marlinae, L., Arifin, S., Husaini, H., Muhayah, R., Khairiyati, L., Waskito, A., Berliana, J. D., & Setiyawan, B. (2024). The Relationship Between Drinking Water Treatment and Clean Water Sources on The Incidence of Stunting. *River Studies*, 2(2), 232–242.
- Martin, N. H., Trmčić, A., Hsieh, T.-H., Boor, K. J., & Wiedmann, M. (2016). The evolving role of coliforms as indicators of unhygienic processing conditions in dairy foods. *Frontiers in Microbiology*, 7, 1549.
- Nnane, D. E., Ebdon, J. E., & Taylor, H. D. (2011). Integrated analysis of water quality parameters for cost-effective faecal pollution management in river catchments. *Water Research*, 45(6), 2235–2246.
- Ondieki, J. K., Akunga, D. N., Warutere, P. N., & Kenyanya, O. (2021). Bacteriological and physico-chemical quality of household drinking water in Kisii Town, Kisii County, Kenya. *Heliyon*, 7(5).
- Oyem, H. H., Oyem, I. M., & Ezeweali, D. (2014). Temperature, pH, electrical conductivity, total dissolved solids and chemical oxygen demand of groundwater in Boji-BojiAgbor/Owa area and immediate suburbs. *Research Journal of Environmental Sciences*, 8(8), 444.
- Piu, F., Aneta, A., Ilato, R., & Kamuli, S. (2022). The Effect of Apparatus Behavior and Community Participation on Pamsimas Policy Implementation in North Gorontalo Regency. *Webology*, 19(2).
- Pushpalatha, N., Sreeja, V., Karthik, R., & Saravanan, G. (2022). Total dissolved solids and their removal techniques. *International Journal*, 2(2).
- Raharini, H., & Yuniarti, E. (2023). The Relationship Between Water Quality and Stunting in Indonesia: Literature Review. *Jurnal Penelitian Pendidikan IPA*, 9(9), 664–670.
- Tan, B., Ng, C., Nshimiyimana, J. P., Loh, L. L., Gin, K. Y.-H., & Thompson, J. R. (2015). Next-generation sequencing (NGS) for assessment of microbial water quality: current progress, challenges, and future opportunities. *Frontiers in Microbiology*, 6, 1027.
- Van Winkel, T., Cools, J., Vlaeminck, S. E., Joos, P., Van Meenen, E., Borregán-Ochando, E., Van Den Steen, K., Geerts, R., Vandermoere, F., & Blust, R. (2021). Towards harmonization of water quality management: A comparison of chemical drinking water and surface water quality standards around the globe. *Journal of Environmental Management*, 298, 113447.
- WHO. (2006). *Guidelines For Drinking-Water Quality [Electronic Resource]: Incorporating First Addendum. Vol. 1, Recommendations. – 3rd ed.* World Health Organization (WHO). <https://doi.org/10.1248/jhs1956.35.307>
- WHO. (2011a). *Guidelines for drinking-water quality. WHO Chronicle*, 38(4), 104–108.

WHO. (2011b). *Guidelines for Drinking-water Quality FOURTH EDITION*. World Health Organization (WHO).

WHO. (2023). *Drinking-water*. World Health Organization (WHO).

Wiek, A., & Larson, K. L. (2012). *Water, people, and sustainability—a systems framework for analyzing and assessing water governance regimes*. *Water Resources Management*, 26, 3153–3171.

Zhang, C., Zhang, W., Huang, Y., & Gao, X. (2017). *Analysing the correlations of long-term seasonal water quality parameters, suspended solids and total dissolved solids in a shallow reservoir with meteorological factors*. *Environmental Science and Pollution Research*, 24, 6746–6756.