Environmental Health Engineering and Management Journal. 2025;12:1399
http://ehemj.com
doi 10.34172/EHEM.1399

Environmental Health Engineering and Management Journal

Original Article

Environmental Health Engineering and Management

Open Access Publish Free

Factors associated with appropriate household water treatment method in Thailand

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Abstract

Background: Household water treatment is a vital public health measure, particularly in regions with limited access to clean drinking water. While several studies have explored water treatment practices globally, there is limited understanding of the specific factors influencing these practices in Thailand. This study addresses this gap by investigating the determinants of water treatment adoption and the role of socioeconomic, regional, and demographic factors in shaping these behaviors.

Methods: Secondary data from the Multiple Indicators Cluster Survey (MICS), conducted by the National Statistical Office (NSO) of Thailand and UNICEF from June to October 2022, was analyzed. The survey covered 29 784 households across 12 provinces in Thailand. Analytical methods included univariate, bivariate, and multivariate techniques, with binary logistic regression applied to identify significant predictors, using a 95% confidence interval.

Results: Water treatment practices were observed in only 19.11% of households. The most significant factors identified through multivariate analysis were household wealth and religion. Households in the wealthiest quintile were 2.84 times more likely to treat water compared to the poorest. Additionally, Muslim heads of households were 1.98 times, and those practicing other religions were 1.65 times, more likely to adopt water treatment methods compared to Buddhist.

Conclusion: Although few households engaged in water treatment, key findings reveal strong associations with wealth, religion, and the presence of young children in the household. These insights highlight the need for targeted, context-specific interventions to address disparities and enhance water safety practices across Thailand.

Keywords: Household, Water-safety, Treatment, Thailand

Citation: Suyitno, Maretalinia, Supriatin, Suryani D. Factors associated with appropriate household water treatment method in Thailand. Environmental Health Engineering and Management Journal. 2025;12: 1399. doi: 10.34172/EHEM.1399.

Article History:
Received: 29 July 2024
Revised: 11 September 2024
Accepted: 14 September 2024
ePublished: 22 February 2025

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Introduction

Household water treatment is a critical component in ensuring access to safe drinking water, particularly in regions where clean water sources are scarce or unreliable. Numerous studies emphasize the importance of point-of-use water treatment methods, including boiling, filtration, chlorination, and other techniques, as effective interventions to reduce waterborne diseases and improve public health (1-4). These practices are especially important in low-resource settings like Ethiopia, where unimproved water sources are common, and household water treatment is a critical intervention to safeguard health (5-7).

However, the factors influencing the adoption of household water treatment methods are complex and multidimensional (1,8). At the individual level, factors such as knowledge, attitudes, and perceptions of water quality can drive or hinder the adoption of safe water practices. Household decision-making processes, often shaped by socioeconomic status, education level, and income, also play a significant role in determining whether water treatment methods are employed (9). Studies have consistently shown that higher education and income levels are associated with a greater likelihood of adopting water treatment methods due to increased awareness of health risks (10). Additionally, household characteristics such as the presence of young children or elderly individuals, who are more vulnerable to waterborne illnesses, may further incentivize the use of water treatment methods.

At the community level, social norms, cultural beliefs, and perceptions of water safety strongly influence household behaviors (11). For example, in rural communities in northwest Ethiopia, a lack of awareness, negative attitudes, and limited experience with alternative water treatment technologies present significant barriers to the widespread adoption of safe water practices (12). Thailand presents a unique context for examining household water treatment practices due to its regional variability in water quality and access. Water quality investigations among hill tribes and rural populations indicate that household-level water treatment methods are both effective and widely accepted in certain areas, particularly where access to clean water is limited (13). However, challenges persist in ensuring consistent adoption of water treatment practices across different regions, particularly in rural and marginalized communities. The implementation of sustainable, cost-effective water treatment systems has been shown to significantly reduce the burden of waterborne diseases in rural areas in Thailand, underscoring the need for targeted interventions that are responsive to local conditions (14). This underscores the importance of understanding community-specific challenges and attitudes in promoting water safety interventions. Studies have demonstrated that community-based initiatives, such as participatory research and localized educational campaigns, can successfully improve water treatment practices and reduce the incidence of waterborne diseases, particularly in vulnerable populations (15,16).

Socioeconomic status is a key determinant of water treatment practices, with wealthier households more likely to have access to and use advanced water treatment technologies. Education is another critical factor, as higher levels of education are associated with increased awareness of water contamination risks and a greater likelihood of adopting preventive measures (9,10). Environmental factors, such as the quality of available water sources and regional climate conditions, also play a role in shaping water treatment behaviors. For example, regions with higher levels of water contamination or limited access to clean water may experience higher adoption rates of household water treatment methods (12).

In Thailand, disparities in water access and treatment practices are further influenced by regional environmental conditions and socioeconomic disparities. Water treatment adoption is often higher in regions with better infrastructure and greater access to water purification technologies, such as urban areas and wealthier communities. In contrast, rural areas with limited infrastructure face greater challenges in implementing effective water treatment practices, highlighting the need for region-specific interventions (13). Community perceptions of water quality and safety are crucial in determining the effectiveness and acceptance of household water treatment practices. Studies have shown that user perceptions of drinking water quality significantly impact the adoption of water treatment and storage practices, making community-based approaches essential for improving water safety (15). Furthermore, community-based participatory research has proven effective in enhancing household water treatment behaviors and reducing waterborne diseases, particularly in vulnerable populations such as children under five (16). Sustainability is a key consideration in promoting water treatment practices, especially in rural and resource-constrained settings. The development and dissemination of cost-effective, easy-to-use water treatment technologies can greatly enhance adoption rates and ensure long-term success in improving water safety. Tailoring interventions to meet the specific needs of different communities, while ensuring that these methods are sustainable and culturally acceptable, is essential for maximizing the impact of water treatment initiatives (14).

A significant gap in the literature exists concerning how these factors interact in the Thai context, where regional and socioeconomic disparities play a critical role in shaping water treatment practices. This study seeks to address this gap by examining the household characteristics that influence the use of water-safety treatment methods in Thailand. By focusing on community-specific challenges and fostering engagement at the local level, this research aimed to inform targeted strategies to enhance the adoption of sustainable water treatment practices across diverse regions of the country. This study will contribute to the growing body of literature on water safety by identifying the key factors that affect household water treatment in Thailand. In doing so, it will provide insights into how socioeconomic status, education, religion, and regional differences shape water safety behaviors, and offer recommendations for interventions that can reduce waterborne disease risks and improve public health outcomes in Thailand's most vulnerable populations.

Materials and Methods

The present study used secondary data from the Multiple Indicators Cluster Survey (MICS), which has been collaborated by the National Statistical Office of Thailand (NSO) and UNICEF. The original survey was done between June and October 2022 in selected provinces in Thailand including Mae Hong Son, Tak, Nakhon Phanom, Kalasin, Nakhon Ratchasima, Sisaket, Ranong, Songkhla, Satun, Pattani, Yala, and Narathiwat (Figure 1). The unit of analysis of this study is households that were selected using the strata sampling method by urban and rural areas, then, selected by probability proportional to size (PPS) of enumeration areas. At the national level, 34 540 homes and a total of 1727 sample Enumerators Areas were chosen. After the data cleaning process, 29 784 households fully participated in the present study.

The instrument used in this study was the standardized

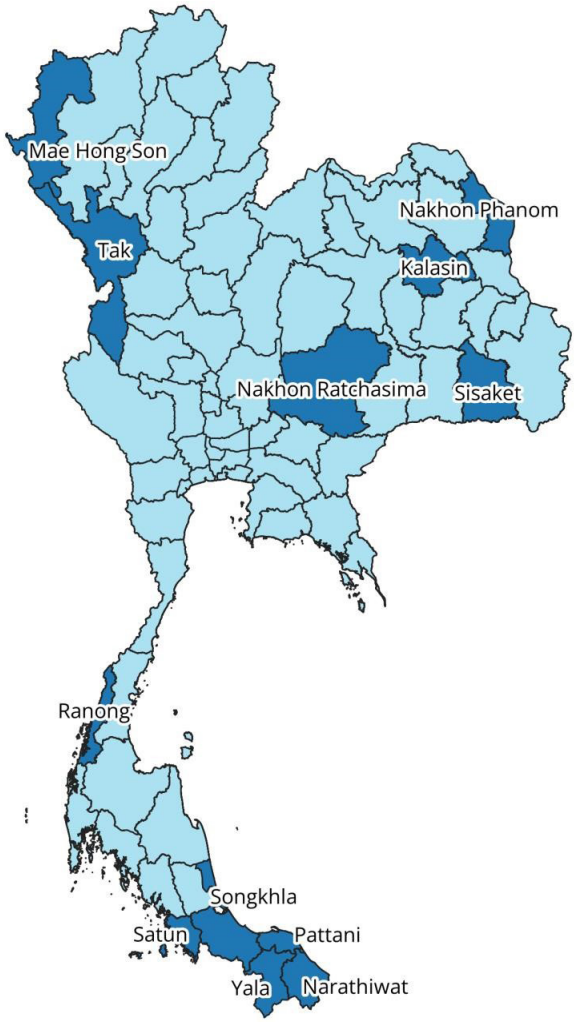

Figure 1. The selected provinces of MICS Thailand 2022

questionnaire of MICS6, which was translated from English to Thai. The translated version was tried as the preliminary study in the province of Pathum Thani from April 5 to 7, 2022 to check validity and reliability. The dependent variable in this study is the water treatment used in the household. It refers to the percentage of appropriate drinking water treatment methods used in the household. The dummy answer was none/yes. Yes, if the households boiled the water before drink, strain through a cloth, use a water filter, solar disinfection, let it stand, and settle. None, if the households did not do any treatment mentioned before. The multivariate analysis was done using binary logistic regression because that statistical test fits the study with a dummy dependent variable and the majority of independent variables are categorical. The independent variables of this study included place of residence (urban/rural), region (Bangkok/central/north/northeast/south), the language used (Thai/English/others), household members (0–4/5–10/11–more), have children under five years (no/yes), religion (Buddhist/Islam/others), sex of head of household (male, female), in reproductive age (yes/no), educational level (lower than primary/primary/lower secondary/upper secondary/higher), and wealth index (poorest/ second/middle/fourth/richest).

Computer-assisted personal interviewing (CAPI) and MICS-specific survey processing system (CSPro) software were used for data collection and management. There is potential bias due to estimate sampling error, but normalized weight can solve this during the analysis (17). The data of this current study were tested using univariate, bivariate, and multivariate. Univariate analysis is used to explore the general characteristics of respondents that are presented in frequency and percentage. Bivariate analysis in this study used the Chi-square test to examine the correlation between each independent variable and breastfeeding practice. Multivariate analysis was done using binary logistic regression to examine all adjusted independent variables related to household water treatment. The 95% confidence interval was used as the cut-off of the significant level. All the tests were done using STATA version 17 for Windows. The ethical approval of the MICS survey was guaranteed by UNICEF and under the supervision of the NSO of Thailand.

Results

The findings in this study consisted of three parts including univariate, bivariate, and multivariate analyses. As shown in Table 1, the univariate analysis results revealed that 19.11% of households did the treatment to make drinking water safer. According to the demographic characteristics of the households, the results found that more than half of them reside in urban areas (54.10%), and the highest proportion lived in the Northeast region (28.86%) (more detail in Figure 2). The majority of them used Thai as their daily language (95.96%). Most of the households had members 0 to 4 (75.52%). More than half of households had children under five years old (69.09%). The information about heads of households revealed that they were Buddhist (86.55%), male (57.28%), not of reproductive age (61.96%), graduated from primary school (50.13%), and were the poorest (22.60%).

The results of bivariate analysis in this study (Table 2) revealed that some variables correlated with water safer treatment before drinking the water. Those variables were place of residence, region, number of household members, religion, sex, age, education level, and wealth index ($P < 0.005$). However, two variables were not significantly associated with the water treatment, including language used for daily life and having children under five years old ($P > 0.05$).

Multivariate analysis in this study (Table 3) was done using binary logistic regression. The results found that some variables were significantly associated with doing water treatment such as regions, having children under five, religions, sex of household head, age of household head, educational level, and wealth index. The variables

Table 1. The general characteristics of the study samples (n = 29784)

Variables	Frequency	Percent
Household water treatment		
No	24093	80.89
Yes	5691	19.11
Place of residence		
Urban	16113	54.10
Rural	13671	45.90
Region		
Bangkok	3449	11.58
Central	4254	14.28
North	5016	16.84
Northeast	8595	28.86
South	8470	28.44
Language		
Thai	28580	95.96
English	53	0.18
Others	1151	3.86
Household member		
0 to 4	22493	75.52
5 to 10	7214	24.22
11 or more	77	0.26
Have children under five		
No	20578	69.09
Yes	9206	30.91
Religion		
Buddhist	25779	86.55
Islam	3650	12.25
others	355	1.19
Sex of the head		
Male	17060	57.28
Female	12724	42.72
Reproductive age of the head		
Yes	11330	38.04
No	18454	61.96
Education level		
Less than primary	1790	6.01
Primary	14932	50.13
Lower secondary	3372	11.32
Upper secondary	4036	13.55
Higher	5654	18.98
Wealth index		
Poorest	6730	22.60
Second	6676	22.41
Middle	6519	21.89
Fourth	5624	18.88
Richest	4235	14.22

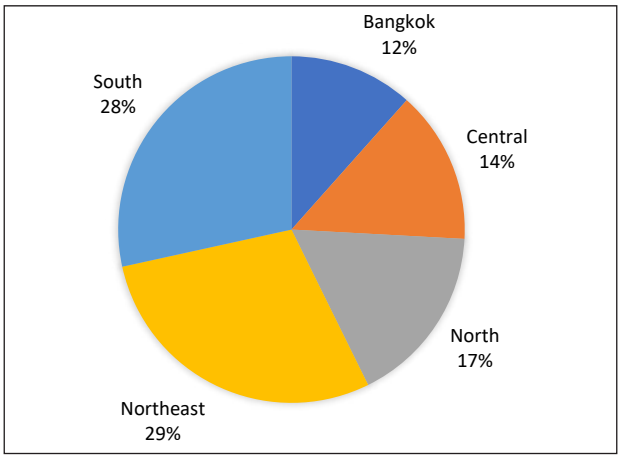

Figure 2. The distribution of household water treatment by region in Thailand

found to be insignificantly associated were place of residence, language used, and number of household members. In detail, households located in central, North, northeast, and south decrease the probability of doing water treatment by 62%, 70%, 94%, and 72%, respectively compared to the Bangkok region. Households that had children under five years were 1.14 times more likely to treat the water before drinking compared to households that had children under five years. In terms of the religion of the head of household, compared to the Buddhist ones, Islam and others were 1.98 and 1.65 times more likely to treat the water. Head of households who were female decreased the probability of treating the water by 7% compared to males. Heads of household who were not of reproductive age were 1.54 times more likely to treat the water compared to those of reproductive age. In heads of households with primary, lower secondary, upper secondary, and higher education levels, the probability of treating water decreased by 23%, 28%, 27%, and 29% compared to those with education levels lower than primary school. According to the wealth index, in households in the second quantile, the probability of treating the water decreased 24% compared to the poorest ones. Additionally, fourth and richest households were 1.32 and 2.84 times more likely to do water treatment compared to the poorest ones after adjusting to other independent variables.

Discussion

This study found that only 19.11% of Thai households treated water before drinking, with key influencing factors including region, presence of young children, religion, gender, age, education level, and wealth index. The most significant predictors were being in the wealthiest group and belonging to the Islamic faith. Water treatment practices vary by region, with Central Thailand showing higher rates due to better access to water purification technologies, particularly around Bangkok. In contrast, the Northeast region faces limited access to treatment

Table 2. The correlation between each predictor on household water treatment (n = 29784)

Household water treatment	Household water treatment (%)		Total	*P* value
	No	Yes		
Place of residence				0.000
Urban	77.97	22.03	16113	
Rural	84.33	15.67	13671	
Region				0.000
Bangkok	56.92	43.08	3449	
Central	75.93	24.07	4254	
North	79.96	20.04	5016	
Northeast	95.51	4.49	8595	
South	78.87	21.13	8470	
Language				0.326
Thai	80.94	19.06	28580	
English	84.91	15.09	53	
Others	79.41	20.59	1151	
Household member				0.000
0 to 4	81.48	18.52	22493	
5 to 10	79.10	20.90	7214	
11 or more	77.92	22.08	77	
Have children under five				0.701
No	80.83	19.17	20578	
Yes	81.02	18.98	9206	
Religion				0.000
Buddhism	82.25	17.75	25779	
Islam	72.05	27.95	3650	
Others	72.96	27.04	355	
Sex of the head				0.003
Male	80.3	19.70	17060	
Female	81.69	18.31	12724	
Reproductive age of the head				0.000
Yes	82.59	17.41	11330	
No	79.85	20.15	18454	
Education level				0.000
Less than primary	76.15	23.85	1790	
Primary	83.62	16.38	14932	
Lower secondary	81.52	18.48	3372	
Upper secondary	79.88	20.12	4036	
Higher	75.54	24.46	5654	
Wealth index				0.000
Poorest	86.72	13.28	6730	
Second	86.56	13.44	6676	
Middle	82.42	17.58	6519	
Fourth	78.5	21.50	5624	
Richest	64	36.48	4235	

Table 3. The binary logistic regression of factors associated with the treatment of safer water

Variables	AOR	*P* value	95% CI	
			Lower	Upper
Place of residence				
Rural	1.01	0.761	0.94	1.09
Region				
Central	0.38	0.000	0.34	0.42
North	0.30	0.000	0.27	0.34
Northeast	0.06	0.000	0.05	0.07
South	0.28	0.000	0.26	0.32
Language				
English	0.60	0.204	0.27	1.32
Others	0.86	0.068	0.73	1.01
Household member				
5 to 10	1.05	0.212	0.97	1.15
11 or more	0.88	0.653	0.49	1.55
Have children under five				
Yes	1.14	0.001	1.06	1.24
Religion				
Islam	1.98	0.000	1.78	2.19
Others	1.65	0.000	1.28	2.13
Sex of the head				
Female	0.93	0.031	0.88	0.99
Reproductive age of the head				
No	1.54	0.000	1.43	1.66
Education level				
Primary	0.77	0.000	0.68	0.88
Lower secondary	0.72	0.000	0.62	0.85
Upper secondary	0.73	0.000	0.63	0.85
Higher	0.71	0.000	0.61	0.83
Wealth index				
Second	0.76	0.000	0.68	0.84
Middle	1.03	0.573	0.93	1.15
Fourth	1.32	0.000	1.18	1.47
Richest	2.84	0.000	2.52	3.19

facilities. These regional disparities highlight the need for targeted interventions, especially in areas where water treatment is more challenging. Wealth is a critical determinant, with richer households more likely to treat water, likely due to their ability to afford treatment technologies and a greater emphasis on health.

The reason is the high technology of water machines in surrounding Bangkok City that enables people to drink safer water. The different results show by Northeast region where access to water treatment is difficult. Understanding specific water-source sharing networks and human-animal contact patterns is crucial for designing effective control programs to prevent and manage waterborne diseases like leptospirosis (18). Reusing treated wastewater aligns with

sustainable water resource management goals outlined in Thailand's Water Management Plan (19). In Thailand, the agricultural sector disproportionately consumes water, necessitating strategies to ensure equitable water distribution (20). Regional variations in temperature, humidity, and precipitation trends across Thailand impact water availability and quality, highlighting the need for tailored water safety measures in different areas (21). Environmental factors such as light intensity, soil composition, and humidity can influence water quality and treatment practices in diverse regions (22). The region itself has unique characteristics that are different from others. Moreover, the predominant sectors applied water could be affect how water treatment implemented.

The establishment of wastewater reclamation trends in Thailand emphasizes the importance of implementing water reuse measures across sectors like agriculture, industry, tourism, and services to address climate change and water stress challenges (23,24). Coastal water quality surveillance programs in Thailand should include monitoring for antimicrobial resistance in bacteria to ensure food safety and protect coastal water resources (25,26). Government policies on rice production and water management have been instrumental in improving yields and sustainability, with variations in implementation across regions (27). Regional differences in admissions and treatment outcomes for diseases like hepatocellular carcinoma highlight disparities in healthcare access and outcomes across different parts of Thailand (28). The volume of precipitation and its impact on economic growth in various regions of Thailand underscores the importance of water resources in supporting different sectors of the economy (29). Additionally, fluoride concentration in tap water varies across regions in Thailand, necessitating monitoring and control measures to prevent dental and skeletal fluorosis (30).

Households with children under five years are more likely to treat water, driven by concerns about preventing waterborne diseases. Older household heads (aged 49 years and more) also show a higher likelihood of treating water, likely due to their greater vulnerability to chronic diseases, which necessitate safer water consumption. Gender differences emerged, with female-headed households being less likely to treat water, potentially due to limited access to water treatment resources. Educational attainment strongly correlates with water treatment, as individuals with higher education are more aware of waterborne health risks. Factors associated with household water treatment concerning children under five years in Thailand encompass a range of considerations crucial for safeguarding their health. The reason for treating water before drinking for households with children under five years is to ensure the health aspects of preventing water-borne diseases. Existing studies have highlighted the importance of nutrition status, immunization coverage, and safe hygiene practices in this vulnerable age group (31). Additionally, the provision of safe drinking water and sanitation facilities is essential for preventing diarrheal diseases, which pose a significant threat to young children (32). The association between household water treatment and child health outcomes underscores the need for comprehensive interventions that address multiple determinants of health. Factors such as food security, access to clean water, and sanitation play a critical role in reducing the risk of stunting and improving overall health outcomes in young children (33). Moreover, the impact of environmental factors on water quality and safety practices underscores the importance of region-specific interventions tailored to the unique challenges faced by different communities in Thailand (21).

Religion plays a significant role in water treatment practices. Islamic households, compared to the majority Buddhist population, show higher rates of water treatment, likely influenced by religious teachings on cleanliness. This underscores the potential for leveraging religious institutions to promote water safety practices. Cultural and religious beliefs often shape individuals' attitudes and behaviors toward water usage and purification methods. In a diverse country like Thailand, where Buddhism is the predominant religion, spiritual beliefs, and practices may impact people's perceptions of water purity and cleanliness (34). Religious teachings emphasizing cleanliness and purity may influence the adoption of water safety practices within communities. Moreover, religious institutions can serve as influential platforms for promoting hygiene and sanitation practices, including the importance of safe water treatment methods. Collaborating with religious leaders and organizations can help disseminate information about the significance of clean water and proper sanitation, thereby encouraging adherence to water safety protocols (35). Religious gatherings and events can also be utilized as opportunities to educate the community about the importance of using safe water sources and implementing water treatment practices.

Factors associated with household water treatment concerning gender in Thailand can be influenced by various social, cultural, and biological factors. Studies have shown that gender dynamics can impact water-related behaviors and practices, highlighting the need for gender-sensitive approaches in water safety promotion. In this study, the female as the head of household is lowering the odds of treating the water before drinking. The reason behind this might be due to the lack of access to the technology of water treatment that is difficult to apply. For instance, research has indicated that engaging with a gender transformative approach in water safety education campaigns can help address high rates of fatal drowning among males and promote a broader range

of masculinities in water safety practices (36). Access to safe water is more vulnerable for women than men (37). Understanding these gender-specific vulnerabilities is essential for designing interventions that address the intersection of water safety and gender dynamics in Thailand. In addition, the efficacy and safety of certain treatments, such as anticoagulant utilization for cancer-associated thrombosis, may vary based on gender, highlighting the importance of considering sex-specific factors in healthcare interventions (38). Similarly, studies on the impact of age and gender on treatment outcomes for diseases like chronic hepatitis C virus infection emphasize the need to assess differences in efficacy, safety, and quality of life based on gender (39).

Factors associated with household water treatment concerning age in Thailand can have significant implications for public health interventions and water management strategies. Understanding how age influences water safety practices is essential for developing targeted initiatives catering to different age groups' diverse needs. In this study, it was found that heads of households aged more than 49 years old treated the water than in reproductive age. The reason behind this is that the prevention and treatment of chronic diseases require the healthy and safe water. Previous research has shown that age can impact health-seeking behaviors, with older individuals often facing unique challenges related to chronic diseases and health-related quality of life (40). In the context of household water treatment, age-related factors may influence the adoption of safe water practices, especially among older populations who may be more susceptible to waterborne illnesses. Moreover, age can play a role in treatment outcomes and adverse events in healthcare interventions. Studies on the impact of age on treatment efficacy and safety in conditions like hepatocellular carcinoma have highlighted the importance of considering age-specific factors in medical interventions (41). Tailoring household water treatment methods to different age groups based on their specific health needs and vulnerabilities is crucial for promoting optimal health outcomes. Furthermore, age-related trends in waterborne disease risk, treatment outcomes, and health impacts underscore the importance of considering age as a key determinant in water safety initiatives (42). By recognizing the influence of age on water safety practices and health outcomes, policymakers and public health authorities can develop targeted interventions that address the specific needs of different age groups and contribute to improved water quality and safety in Thailand.

Education level is a significant factor influencing household water treatment practices in Thailand. The result of this study revealed that higher education levels were more likely to treat the water. This is related to knowledge and information received about the importance of drinking safer drinking water and the consequences of waterborne disease. Existing research has shown a strong correlation between education level and water safety practices, emphasizing the role of educational attainment in promoting safe water behaviors (43). Individuals with higher levels of education are more likely to be informed about water quality issues, pollution incidents, and the importance of water safety measures (44). Additionally, education can impact water-saving awareness and water use efficiency, leading to enhanced water management practices (45). Higher education levels are associated with increased water-saving behaviors and a better understanding of sustainable water use. This indicates that educational interventions targeting water safety knowledge and water conservation practices can be particularly effective among individuals with higher education levels. In rural areas, education level has been identified as a crucial factor influencing health literacy among farmers, underscoring the role of education in promoting health-enhancing behaviors and improving health outcomes. By improving health literacy through educational programs, individuals can make informed decisions regarding water safety practices and adopt behaviors that contribute to better health and well-being.

Additionally, the wealth index significantly influenced the water treatment. The findings of this study revealed that the richest households are more likely to treat water before drinking. This is also related to the purchasing power of water treatment technology that only rich and richest households can get it (46). Being the richest is also related to the high demand for high-quality facilities in the household (47,48). They are also more likely to care about health once providing the household infrastructure (49,50). The study contributes to the environmental issue related to water proposed microbial fuel cell for wastewater (51). Another issue is the organic load of poultry slaughterhouse wastewater which proposed the use of Chlorella vulgaris (52). The importance of environmental issue treatment including solid waste could be emphasized by segregation and cycling the domestic solid waste (53).

The odds of treating the water before drinking are associated with being the richest, Islamic head of household. Older age of head of household, having children under five years, and living in a rural area. The factors found insignificantly associated with water treatment are place of residence, language of daily, number of household members, and some categories in the wealth index. The most influential factors for water treatment in Thailand are wealth and religion, with the wealthiest and Islamic households showing the highest likelihood of treating water. Other contributing factors include the presence of young children, the age of the household head, and education level. This study has not covered all provinces in Thailand, while the proportion of provinces in the South took more part. However, the

proportion between rural and urban areas is up to balance. These findings suggest the need for targeted public health interventions that account for regional, socioeconomic, and cultural differences to improve water safety practices across the country.

Conclusion

This study found that the prevalence of households treating their water before consumption was 19.11%. Key factors significantly associated with water treatment practices included regional variations, the presence of children under five years old, female heads of households, and households with heads aged 40 or older. These findings highlight the importance of tailoring water treatment interventions to address demographic and regional characteristics. While this study provides valuable insights, it is limited by its sample size and scope. Future research should adopt a multilevel approach to comprehensively examine the factors influencing water treatment practices across diverse contexts in Thailand. Additionally, qualitative studies are essential for understanding household motivations and barriers regarding water treatment, as they can provide deeper insights into the lived experiences of families and their water management practices. To enhance the well-being of young children and reduce the incidence of waterborne diseases, it is critical to emphasize the interconnections between nutrition, immunization, hygiene practices, and access to safe drinking water. Targeted interventions must consider age-specific vulnerabilities, educational attainment, and regional disparities to effectively manage water safety. Policymakers and stakeholders should prioritize initiatives that promote education and awareness about safe water practices, especially in regions with lower treatment rates.

In conclusion, by addressing these multifaceted determinants of water treatment, stakeholders can work towards achieving improved health outcomes for children and advancing overall public health in Thailand. Future research could also explore the applicability of successful interventions from other contexts to the Thai setting while ensuring that any adaptations are relevant to local cultural and environmental conditions. This comprehensive approach will be beneficial in developing effective strategies for water safety management in Thailand.

Acknowledgments

The authors would like to express their sincere gratitude to the NSO of Thailand and UNICEF for their collaboration in conducting the MICS, which provided valuable data for this study. Their heartfelt thanks go to all the households in Thailand who participated in the survey, contributing their time and information to this important research.

Authors' contributions

Conceptualization: Suyitno.
Data curation: Suyitno and Maretalinia.
Formal analysis: Maretalinia.
Investigation: Dyah Suryani.
Methodology: Maretalinia.
Project administration: Supriatin.
Resources: Suyitno.
Software: Maretalinia.
Supervision: Dyah Suryani.
Validation: Suyitno.
Visualization: Suyitno.
Writing–original draft: Suyitno and Maretalinia.
Writing–review & editing: Suyitno and Maretalinia.

Competing interests

The authors declare no competing interests related to this study. All research was conducted independently without any financial or personal relationships that could have influenced the work reported in this paper.

Ethical issues

The study utilized secondary data from the MICS, which received ethical approval from UNICEF and the NSO of Thailand (NSO). All data were collected and managed using CAPI and CSPro software, ensuring the confidentiality and privacy of respondents. Ethical considerations included informed consent and adherence to ethical standards throughout the data collection and analysis processes.

Funding

There are no financial resources allocated for this study.

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