FACTORS CONTRIBUTING TO DIARRHEAL DISEASES
IN THE MUNICIPALITY OF LILOAN, CEBU, PHILIPPINES

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ABSTRACT – Although the Philippines has its 2007 Philippine National Standards for Drinking Water (PNSDW), it was reported that water-borne diseases still occurred. The study's main objective was to assess the factors contributing to diarrheal diseases in the Municipality of Liloan, Cebu, Philippines. Using stratified random sampling, twenty-eight household respondents from each of the fourteen barangays (the basic political unit in the country) were selected. Questionnaires and personal interviews were conducted. The statistical significance between the group with water-borne diseases and those without water-borne diseases in terms of water usage, sanitation practices, community problems (environmental pollution and water scarcity), and perceptions about water were calculated. Results showed that the factors mentioned above contributed to the incidences of diarrheal diseases in the municipality. Purified drinking water was preferred by half of the respondents; households using purified water from water refilling stations were less prone to diarrheal diseases than those relying on other drinking water sources. Seventy-three percent of the households without incidences of diarrheal diseases had good to very good sanitation practices, which was significantly higher than households with incidences of diarrheal diseases. Both groups also considered 'Poor solid waste disposal' as the foremost source of pollution. Recommendations to reduce incidences of diarrheal diseases were then presented.

Keywords: diarrheal disease, Cebu Philippines, sanitation practices

INTRODUCTION

In the Philippines, to ensure quality drinking water, the country has its 2007 Philippine National Standards for Drinking Water (PNSDW). However, it was revealed in the Cebu Integrated Area Development Master Plan Study (CIADMPS) of the Province of Cebu, that water-borne diseases still occurred (Mercado 1998). This is often observed in developing countries where increasing urban life affects water quality in the area (Rashid et al 2018). Between 2.4 to 2.6 billion people do not have access to improved sanitation facilities in the early 2000 (Mara 2003; Van Minh and Hung 2011) where improved access would refer to connection to a public sewer or septic system or use of ventilated pit latrines and some simple pit latrines (Montgomery and Elimelech 2007). In Cebu, a one-year epidemiological-microbiological study showed that children drinking water with greater than 1000 E. coli per 100 ml water had significantly higher rates of getting a diarrheal disease, one of the leading causes of morbidity and

mortality in less developed countries (Fewtrell et al 2005), than those drinking less contaminated water (Moe et al 1991).

The National Statistical Coordination Board (NSCB) revealed in its 2010 data that 16% of all households in the country still did not have access to clean and potable water, with the situation expected to worsen in the coming years due to increasing population. The quality and availability of ground and surface water in the country, especially near major metropolitan areas, have been significantly compromised by the improper disposal of household, industrial, and agricultural wastes, resource mismanagement, insufficient investments in physical infrastructure, and the rising threat of climate change (Senate Economic Planning Office 2011).

This study consisted of the following: 1) household survey in the fourteen barangays of the Municipality of Liloan, Cebu on the factors contributing to the incidences of diarrheal diseases, including water usage practices (water supply source, preferred home-water treatment, and water storage), sanitation practices, perceptions on water quality, as well as related environmental community problems such as pollution and water supply scarcity; and   2) assessment of the existing data on the microbiological quality of the drinking water in the Municipality of Liloan, Cebu, Philippines vis-à-vis the 2007 PNSDW. Although food sanitation is a major contributing factor to diarrheal diseases, it was not part of this study.

MATERIALS AND METHODS

Location of the Study

The Municipality of Liloan, Cebu, is situated in the northern part of Cebu, Philippines (Figure 1). Fourteen *barangays* (the basic political unit in the country) comprise the municipality's total land area. The municipality, with 20,143 households, has a population of 99,077 as of the year 2010 (IT – Liloan, 2010–2014). For 2011 and 2012, 9% and 11% of the households did not have toilet facilities, respectively, with the mountainous barangays having the most number of households with no toilet (Vallente and Montajes, 2013).

Data Collection

This study made use of both primary and secondary data. Primary data including water use practices, sanitation practices, and related environmental community problems such as environmental pollution and water scarcity, were collected from the survey conducted among the households in the Municipality of Liloan, Cebu; particular attention was given to the incidences of diarrheal diseases from among the households. The survey questionnaires and personal interviews were distributed in the fourteen *barangays* through the stratified random sampling method. The sample size in this study was in terms of the number of households because there were items in the survey questionnaire that could be answered only by one representative for every household.

Descriptive statistics was used to analyze the survey data obtained. For this study, the survey data was divided into two groups - those with diarrheal/ water-borne diseases and those without diarrheal/ water-borne diseases, using the following factors for the evaluation -   water usage, sanitation practices, related environmental community problems such as environmental pollution and water scarcity and perceptions pertaining water. For water usage, the factors taken into consideration were: 1) water source; 2) home water treatment; and 3) water storage practices.

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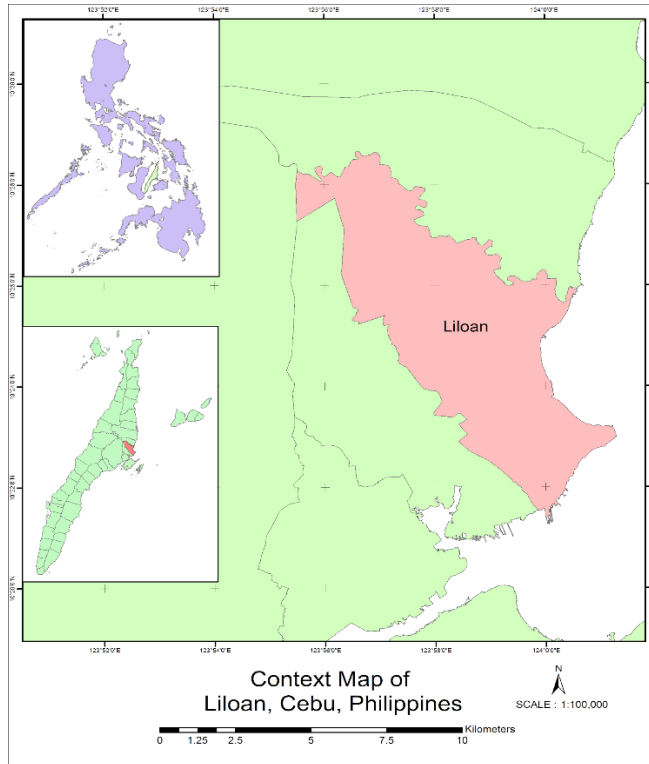
Figure 1. Context Map of the Municipality of Liloan, Cebu, Philippines (Source: UP Cebu Center for Environmental Informatics).

The criteria considered in classifying households as far as sanitation practices were concerned included the presence of toilet facility in the house; the practice of solid waste segregation and proper waste disposal; the practice of defecating and urinating at private or public toilet; anal cleansing using water or tissue paper after defecating; washing of hands after anal cleansing using soap and water; consultation with the doctor in case of diarrhea; and the absence of drainage or related community problems. Based on the above criteria, the sanitation practices of the households were then classified based on their scores: a score from 8 -9 as equivalent to Very Good; a score of 6-7 as Good and a score of 4-5 as Poor.

The statistical significance between the two groups was evaluated by calculating the probability of error (p-value) by the t ratio. The difference between the two groups was statistically significant when $p = 0.05$ or less (Long, 1995 – 2011).

Secondary data included the microbiological analysis of water samples in the municipality obtained from the Liloan Rural Health Unit, and the community water systems collected from 2012 - 2013. As microbiological indicators of water quality, total coliform (TC) and fecal coliform (FC) were the priority parameters.

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RESULTS AND DISCUSSION

Survey on the number of households with and without incidences of diarrheal diseases in relation to the quality of drinking water in the Municipality of Liloan, Cebu, Philippines

The total number of households surveyed with and without incidences of diarrheal diseases per barangay in the Municipality of Liloan, Cebu, Philippines is presented in Table 1. Of the 392 households surveyed in Liloan, 97 (24.7%) households have reported having incidences of diarrheal diseases in relation to drinking water. Meanwhile, 295 (75.3%) households have reported no incidents of diarrheal diseases caused by drinking water (Table 1). Barangays Cabadiangan and San Roque had the highest incidences of diarrheal diseases among the barangays surveyed in Liloan, with 75% and 61% respectively (Table 1). The present study investigates several factors contributing to the incidences of water-borne diseases, specifically, diarrheal diseases, in relation to the quality of drinking water in the municipality and is summarized in Table 2.

Table 1. Households with and without incidences of diarrheal diseases per barangay in the Municipality of Liloan, Cebu, Philippines based on the survey.

Barangay	No. of Households	With Diarrheal Incidences (wDD)		Without Diarrheal Incidences (WoDD)	
		No.	Percentage (%)	No.	Percentage (%)
Cabadiangan	28	21	75	7	25
Calero	28	4	14	24	86
Catarman	28	8	29	20	71
Cotcot	28	5	18	23	82
Jubay	28	10	36	18	64
Lataban	28	0	0	28	100
Mulao	28	1	4	27	96
Poblacion	28	4	14	24	86
San Roque	28	17	61	11	39
San Vicente	28	3	11	25	89
Sta. Cruz	28	9	32	19	68
Tabla	28	5	18	23	82
Tayud	28	7	25	21	75
Yati	28	3	11	25	89
TOTAL	392	97		295	

Factors contributing to diarrheal diseases in the Municipality of Liloan, Cebu, Philippines

1. ***Water usage practices***

    1.1 Water sources. According to the Municipal Engineer, the residents sourced their water from either the 17 wells of the Metropolitan Cebu Water District (MCWD, a government-owned and controlled corporation), private providers, or other wells/deep wells that were beyond their monitoring. In the study, only 36% of the households without incidences of diarrheal diseases sourced their drinking water from these treatment facilities and fifty-three percent (53%) were using purified water from water refilling stations (*Table 2*). Meanwhile, for households with incidences of diarrheal diseases, more than 50% were reliant on water from six municipal water supply sources and the MCWD and only 43% were using purified water (*Table 2*). It can be inferred from this that the majority of the households who had experiences getting diarrhea were those who were sourcing their water from government-owned water facilities. From the survey, respondents from the barangays with the highest incidences of diarrheal diseases complained of the undesirable color, odor, and taste of the drinking water coming from their water treatment system, as well as water scarcity. A respondent also mentioned the presence of worms in the water tank of this water treatment facility that could have affected the water quality and contributed to the incidences of diarrhea in the area.

    Hlaing et al (2016) reported that the source of household water and the types of drinking water were significantly associated with gastrointestinal diseases. Where people sourced their water also depends on a lot of factors; a study by Boithia et al (2016) in the local communities of Laos found that their water sources depend on locality, availability, and water quality perception. A similar study in Ethiopia also showed that income, distance, quality, adequacy, and presence of alternative sources were among the factors as to why 21% of the surveyed households would opt to use unimproved water sources (not treated) (Gebremichael et al 2021). While improved water sources (well-maintained municipal waters, protected wells) should be the standard source of water for consumers, it is inevitable for people to look for other alternative unimproved sources especially when water from improved water sources are scarce; particularly in remote areas where access to water is difficult and availability also depends on seasons (Boithias et al 2016).

    Additionally, despite using water from improved water sources (e.g. bottled water) for drinking, people will still use untreated secondary water sources for other activities such as cooking and washing, hence, there is still risk for water-borne diseases (Boithias et al 2016). In addition, use of polluted water for domestic activities pose risk to human health and is not only limited to gastrointestinal diseases but also skin problems (Lin et al 2022).

    1.2. Preferred Home-Water Treatment. Sixty-four percent 64% of the households with incidences of diarrheal diseases had their own home water treatment methods and only 40% of the households were without incidences of diarrheal diseases. As explained by some household respondents who were without incidences of diarrheal diseases, they no longer needed home water treatment because they were already using purified water coming from various water refilling stations for their drinking water needs. Boiling of water and the use of a 'filtering system' were one of the common methods practiced by those who have their own water-treatments. Of those who boiled their drinking water, 71% were without incidences of diarrheal diseases; whereas, 29% still experienced diarrheal diseases (Table 2). Meanwhile, 68% of those using a filtering system were without incidences of diarrheal diseases, and 34% were with incidences of diarrheal diseases (Table 2).

Table 2. Factors contributing to diarrheal incidences in the municipality of Liloan, Cebu.

Factors	With Diarrheal Diseases (%)	Without Diarrheal Diseases (%)
1. Water Sources		
Water Treatment Systems	52%	36.6%
Water Refilling Stations	43%	52.9%
Wells	5%	10.5%
2. Availability of Home Water Treatment		
Yes	64%	40%
No	34%	58%
3. Treatment Methods		
Boiling	29%	71%
Filter system	32%	68%
4. Storage Practices (Container)		
Closed	72.1%	80.34%
Open	2.1%	5.08%
Closed and Open	3.1	0.34%
5. Sanitation Practices		
Good to Very Good	61%	73%
Poor to Very Poor	39%	27%
6. Environmental Community Problems		
Poor solid waste	27%	73%
Poor drainage	24%	76%
Poor sanitation practices	25%	75%

Other less common home water treatment methods used in the municipality were chlorination and solar disinfection. In a similar study by Gebremichael and colleagues (2021) they found that the majority of the surveyed households used boiling as a treatment method as it can be done easily and is cheaper compared to other treatment methods. Boiling is an old and is still widely used home treatment for drinking water and is effective against most pathogen-causing-water-borne diseases (Clasen et al 2007; Rosa et al 2010). A study by Rosa and colleagues (2010) reported that boiling significantly improves the microbiological quality of water, however, they also observed contamination in stored boiled water, which was caused by recontamination. This implies that while boiling works effectively it still does not remove the potential risk for microbial growth and contamination. Hence, it is highly recommended to store treated water properly. Brown and Sobesy (2012) observed that storing water in covered containers after boiling was associated with safer water quality compared to boiled water left to cool in boiling pots.

1.3. Water storage practices. About 89% of the surveyed households in the Municipality of Liloan, Cebu, practiced water storage in a container. The storage container used may either be with a lid,

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without a lid, or a combination of both. Majority of the households used containers with lids to store their drinking water. Survey results showed that both households with and without incidences of diarrhea preferred using closed containers for storage (Table 2). Although this was the case and households sourced their water from water refilling stations, and had home water treatments, more than 70% still experienced diarrhea. This suggests that there is contamination at a household level.

There are a lot of factors that can be attributed to water contamination at home in relation to user storage practices. Studies by Gebremichael et al (2021) and Agensi et al (2019) reported that storage material was one of the factors that affected water quality consumed by locals in Ethiopia and Uganda. In a review by Manga and colleagues (2021), they cited that water quality stored in tanks/vessels deteriorates depending on the tank material, color, design, location, cover, and maintenance. Such that the material used, color, and where the storage vessel is located are affected by environmental changes, particularly, temperature. Plastic containers are susceptible to microbial growth; meanwhile steel, uncoated ones are prone to rusting. Dark-colored tanks placed under direct sunlight absorb heat more, increasing the water temperature, and therefore promotes bacterial growth. Uncovered containers are at a high risk of contamination by outside debris.

Lastly, complex designs of storage tanks can complicate cleaning and emptying out of old static water, which leaves build up biofilms that facilitate microbial growth, thereby affecting water quality and increasing water contamination. In another study by Nnaji et al (2019), where they induced the deterioration of water quality, they found that prolonged storage of water significantly increased the concentration of heterotrophic bacteria, total coliforms, E. coli, and enterococci in their water samples. The longer the water is stored, the more it creates an environment for bacteria and pathogens to grow. While the present study did not account for the storage time and the material used to store drinking water, the above-mentioned factors could explain the incidences of diarrheal diseases for those households.

2. Sanitation practices

Seventy-three percent (73%) of the households without incidences of diarrheal diseases had good to very good sanitation practices, while only 61% of the households with incidences of diarrheal diseases had good to very good sanitation practices (Table 2). This result would show that sanitation practices of households affected the number of incidences of diarrheal diseases.

Results also showed an association between the absence of toilet facilities and drinking water contamination. Five of the mountainous barangays with the most number of households with no toilet facilities had incidences of coliform/fecal coliform contamination.

Household members with no toilet facilities who would urinate and defecate in open areas may have contributed to the contamination. Porous and permeable soils of these open areas allow these contaminants to permeate and reach the aquifers and groundwater, which serve as sources of water for these barangays. Moreover, households surveyed also had intermittent water supply, which could have resulted in the lack of proper sanitation practices and could have contributed to the incidences of diarrheal diseases.

A cross-sectional study in Manila found that diarrhea and its physiological effects (stunting, dehydration, malnutrition) on schoolchildren were associated with poor handwashing practices, lack of water in school restrooms, lack of access to safe drinking water, and lack of hygiene lessons. Furthermore, they observed that interventions through increasing the number of hand washing stations and restrooms in schools have lowered the risk for diarrheal diseases and dehydration in school children (Sangalang et al

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2022). Another study by Clemente and colleagues (2017) in Panglao, Bohol, found that incidences of diarrheal diseases were associated with latrine-ownership; such that the disease occurs more often in households without latrines, and or toilets (Clemente et al 2017).

3. Related Environmental Community Problems

Based on the survey conducted, 'poor solid waste disposal' was considered the foremost pollution source. The second most observed source of pollution was 'poor sanitation practices,' followed by 'poor drainage.' From amongst those who chose 'poor solid waste disposal' as the foremost source of pollution, 73% were without incidences of diarrheal diseases. From amongst those who chose 'poor drainage' and 'poor sanitation practices' as pollution sources, 76% and 75% were without incidences of diarrheal diseases, respectively (*Table 2*). According to some of the household respondents in this study, some of the residents in the municipality lacked discipline and orientation about proper sanitation and proper solid waste disposal. Some of the household members' urination and defecation practices had been an area of concern for some of the affected neighbors.

Ways to prevent water-related diseases and the perception of the respondents on water supply and quality

When asked how some water-related diseases could be prevented, the standard answers given by the household respondents were [a] boiling of water or [b] washing of hands with soap and water after toilet use (Table 3). Seventy-five percent of those who chose boiling of water to prevent diarrheal diseases did not have incidences of diarrheal diseases. On the other hand, 79% of those who chose washing of hands with soap and water after toilet use were without diarrheal incidences.

Results showed an association between the absence of toilet facilities and drinking water contamination. Although one *barangay* showed a relatively high number of households with no toilet facilities as of December 2012, the water sample from the water treatment system was negative of coliform organisms. The result was probably due to the proper maintenance of the water treatment facility in the said *barangay*, which could also explain the negative occurrence of diarrheal diseases from among the 28 surveyed households.

Table 3. *C*ommon ways to prevent water – borne diseases in the Municipality of Liloan, Cebu, Philippines based on the survey.

Home water treatment methods	Total no. of Households	With Diarrheal Disease n (%)	Without Diarrheal Disease n (%)
Boil drinking water	259	65 (25)	194 (75)
Wash hands with soap and water after toilet use	177	37 (21)	140 (79)
Chlorinate drinking water	53	5 (9)	48 (91)
Use toilet properly for defecation and urination	99	20 (20)	79 (80)
Use of disinfectants to clean house/ toilet	91	25 (27)	66 (73)

Perceptions on the water quality and water shortage problems

Fifty-five percent (55%) of the households without diarrheal diseases perceived the water in the municipality to be safe for drinking, while only 24.74% of the households with diarrheal diseases perceived the water to be safe for drinking. Based on the survey, the primary concern of the households which made them doubtful and or dissatisfied with the quality of the drinking tap water in the municipality was the taste or smell of the water, followed by the appearance of the water (dirty/cloudy/color/particles). Despite these cited factors, bacteriological assessments of the drinking water quality in the Municipality of Liloan often passed the 2007 Philippine National Standards for Drinking Water (PNSDW).

Furthermore, the majority of the surveyed households, both with incidences and without incidences of diarrheal diseases, considered water scarcity in their locality as a problem and is one of the factors contributing to the incidence of diarrheal diseases. It is important to address this, as households could hardly acquire good sanitation practices when water is scarce. Water quantity is as equally important as water quality. When water is readily available at home, there is sufficient water for drinking, personal and food hygiene, laundry and other domestic activities, and improved household sanitation practices, therefore improving the quality of life of the people and preventing diseases that may come with unsafe and poor water quality (WHO, 2022).

CONCLUSIONS

The present study shows that incidences of diarrheal diseases were evident in the surveyed households that relied on water from municipal water supply sources. Sixty-four percent of households with incidences of diarrheal diseases had their own home water treatment. Boiling and the use of a 'filtering system' were the common standard treatment practices among households both with- and without incidences of diarrheal diseases. More than half of the surveyed households without incidences of water-borne related diseases used purified drinking water from water-refilling stations and had no need for home-treatment methods. Households with- and without incidences of diarrheal diseases preferred storing their drinking water in closed containers. In addition, despite having good to very good sanitation practices, more than 50% of the surveyed households still have incidences of water-related diseases which can be attributed to contamination in their water supply sources and possible household contamination. The lack of toilet facilities, water scarcity, and poor solid waste disposal were among the main problems encountered and which contributed to the poor sanitation practices in the locality and are thus associated with poor drinking water quality which then led to higher risk of diarrheal diseases in these areas. Furthermore, the experience of having a diarrheal disease affected the perception of the people concerning the quality of water they are using. Many of the households experiencing diarrheal diseases are uncertain of the quality of the water they are consuming.

RECOMMENDATIONS

The following are recommended to improve the drinking water quality and to reduce, if not eliminate, the incidences of diarrheal diseases in the Municipality of Liloan, Cebu, Philippines:

- Municipal water supply sources, deep wells, as well as treatment facilities must be monitored regularly. Deep wells can dry up during dry seasons so multiple alternative sources of water must be available especially in remote areas.

- Proper waste management policies must be implemented.

- The local government is also urged to look into mitigating the lack of toilet facilities in rural, mountainous areas due to water scarcity.

- The consciousness of the contribution of sanitation practices to the incidences of diarrheal diseases must be strengthened in all of the barangays of the Municipality of Liloan. This may be done through seminars, video presentations, and other forms of information dissemination schemes at the strategic locations of every municipality's barangay, including barangay health centers, plazas, and others.

STATEMENT OF AUTHORSHIP

The first author conducted the literature search, prepared the conceptual framework, identified thematic points, formulated recommendations, and undertook the writing up. The second author initiated the concept, identified some issues, formulated recommendations, and reviewed the paper.

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