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Determinants of the Endemicity of Waterborne Infectious Diseases in Luputa in the Province of Lomami in the DRC

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Abstract

Waterborne diseases of infectious origin are very common in developing countries due to lack of appropriate infrastructure. The City of Luputa, although having a drinking water supply system, still records a high rate of incidence of these diseases. This study aimed to identify the factors explaining this situation for suitable solutions. A transversal analytical study was carried out in 1 month in 16 Health Areas of Luputa in the Province of Lomami. The data collected using Kobocollect from the sampled people were analyzed with Epi info version 7.2.2.6 (CDC). The Chi square of independence and the Ficher exact test were used to establish the association between the variables, supplemented by logistic regression to identify the risk factors. In total, 476 respondents participated in the study. 266 of them (55.6%) had suffered from an infectious waterborne disease. 75% of respondents simultaneously used water from standpipes and other sources for drinking. After logistic regression, the factors associated with these diseases were: profession; non-observance of preventive methods against water-borne diseases, observance of hygienic measures; the use of other sources of drinking water and the storage of drinking water in the barrel with lid (p-value < 0.05, 95% CI). Achieving Sustainable Development Goal number 6 by 2030 is only possible in Luputa's City if several efforts are made. The population needs strong awareness on the exclusive use of water from standpipes and the best water management. Managers of the water supply system must in turn ensure the almost permanent availability of water.

Subject Areas

Public Health

Keywords

Determinants, Endemicity, Waterborne Infectious Disease, Luputa

1. Introduction

For several decades, reducing the incidence of water-borne diseases has remained the concern of several health authorities. On this, the challenge is to grant universal and equitable access to drinking water [1] [2].

Infectious waterborne diseases are induced by water containing pathogenic microorganisms. The most direct risk of transmission of water-borne diseases is linked to drinking water, especially if it is contaminated by various pathogenic germs present in feces of human or animal origin, direct or indirect [2] [3]. These pathologies constitute a real public health problem in sub-Saharan Africa, particularly in developing countries where water supply remains a challenge [4]. According to the WHO, 2 billion people in the world use dirty and unsafe water. It is estimated that 829,000 people die each year as a result of unsafe water, while 297,000 deaths among children under 5 would be avoided if we acted on all risk factors [2]. In the DRC, according to MICS 2018, 84.8% of the population does not have access to an improved water source. The Province of Lomami is not spared war. According to the same source, the quality of drinking water is not good. The province recorded respectively a very high level of contamination risk based on the number of E. coli per 100 ml of water of 74.6% at the source and 48.9% in drinking water present in households [5]. The City of Luputa being in the Province of Lomami was also confronted with this range of water-related problems. To reduce morbidity and mortality from water-borne diseases in this city, a drinking water supply system called "Kaya Lubilu" was installed thanks to the generosity of the Church of Latter-day Saints to serve the entire City and some surrounding villages taking into account scientific evidence from elsewhere [6]. However, analysis of reports from the Luputa Health District continued to reveal a fairly high morbidity rate for waterborne diseases of infectious origin [7]. In view of the above, it was important to understand why these diseases continued to be reported even though there was drinking water for the population. The objective of this study was to determine the factors which explain the persistence of infectious water-borne diseases in the city of Luputa in order to propose appropriate measures.

2. Methods

This transversal analytical study was carried out in the City of Luputa, Province of Lomami in the DRC. The City of Luputa is located at latitude 7˚09'50" south;

longitude 23˚42'55" East and covers a population of 336,152 inhabitants. The study was conducted for one month, from June to July 2022.

The general population constituted the source population in which people aged 9 and over were targeted for the study. We opted for an age below 9 because a person of this age could easily answer the survey questionnaire. Multistage sampling was used. At the first stage, it was a convenience sampling which consisted of retaining the 13 Health Areas (HA) of the city and 3 surrounding HA supplied with drinking water by the "Kaya Lubilu" water distribution network. In the second stage, we used simple random sampling. Then, a simple probabilistic method was used for the selection of 2 cells in each previously selected HA in which 2 avenues were selected. Finally, in each avenue, 2 households were systematically selected in which the peopole present were to be interviewed. The first household was chosen at random. The other households were obtained by applying a sampling interval calculated on the basis of the following formula: interval = (total number of households on the avenue)/(the number of households to be surveyed).

All person aged 9 and over living in the targeted households who gave informed consent were included in this study. The one who for some reason wanted to withdraw was automatically excluded from this study. Data was collected using the KoboCollect app v2022.4.4. through smartphones with a semi-structured questionnaire tested beforehand. The questionnaire was designed in French and translated for respondents who do not know French by the interviewer into Kanyoka, the local language. Ethical instructions were taken into account in our study. Anonymity, confidentiality, consent were guaranteed.

The dependent variable was infectious waterborne diseases and the independent variables, age, sex, profession, level of education, knowledge, status, means of prevention, investigation practices regarding infectious waterborne diseases.

Given the technique used, the sample size was not predictable before the field trip.

Data collected in the field were uploaded to KoboToolbox on Excel 2010 for processing and imported into Epiinfo version 7.2.2.6 (CDC) for statistical analysis. Excel 2010 software was used for the presentation of figures and tables. The chi-square test of independence and Fisher's exact were used to study the associations between the dependent variable and the independent variables. Furthermore, to minimize confounding, the significant factors were subjected to logistic regression. The significance level was set at $p < 0.05$ in all cases, value usually used in statistics.

3. Results

At the end of this survey in the households of 16 targeted HA, 476 subjects were interviewed. The minimum age of the respondents was 9 years, the maximum 85 years with an Average of 31.84 years Std Dev: 14.75. The age group of 17 to 24 was the most represented, *i.e.* 24.8%. The majority of respondents were farmers, 208 or 43.7%; followed by students who represented 29.8%. Around 72.7% of respondents had a secondary education level. (Table 1). The majority of respondents were female, *i.e.* 58.8% (Figure 1). Waterborne infectious diseases were known to 85.9% of respondents. Around 55.9% had suffered from at least one waterborne disease of infectious origin. Typhoid fever was the most common (70.2%) followed by verminoses (64.5%); other diseases were known in almost the same proportion. However, shigellosis or bacterial dysentery was very poorly known (4.6%). Boiling water was the most well-known method for water treatment. However, in practice, the majority of respondents (46.6%) found it good to observe hygiene rules to prevent waterborne diseases. Around 36.6% did not practice any method (Table 2). 75% of respondents used another source of drinking water apart from drinking fountains. Two major reasons were given for this: Firstly in the event of a water break at the standpipes (38%) and secondly, when residents found themselves in the field (30.1%). The can was the main container used for drawing water (95.8%) but also for storing drinking water (80.9%). Next to the can, there were approximate proportions which used the barrel or calabash with lid. The drinking water storage container was cleaned before putting water in it by about 35.3% and about 33.6% did it every day (Table 3). The bivariate analysis between the status of waterborne diseases and other variables showed statistically significant values ($p < 0.05$) in relation to a lot of occupation (cultivator, trader, teacher, student and others), non-observance of preventive methods against water-borne diseases, observance of hygienic measures; the use of other other sources of drinking water, the storage of drinking water in the barrel, the simultaneous use of the fountain and other source of water for drinking, conservation drinking water in the barrel with lid (Table 4). After logistic regression, the factors associated with these diseases were: profession (farmer, trader, teacher, student and others); non-observance of preventive methods against water-borne diseases, observance of hygienic measures; the use of other other sources of drinking water and the storage of drinking water in the barrel with lid (Table 5).

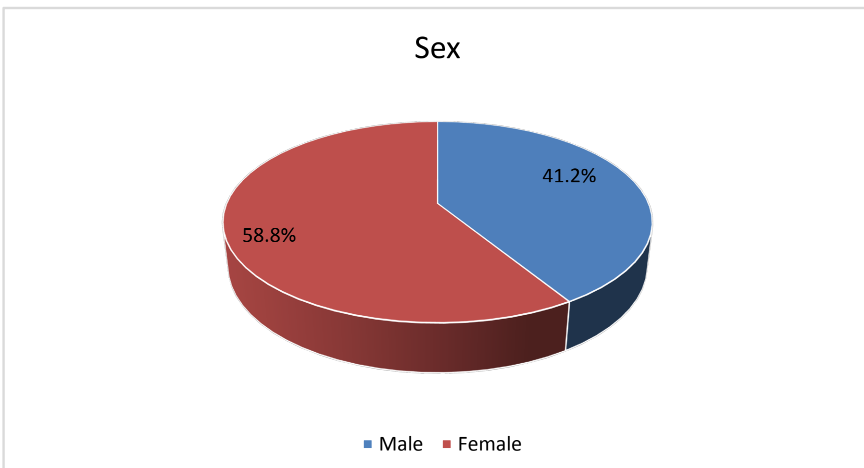

Figure 1. Distribution of respondent according to gender.

Table 1. Socio-demographic characteristics of respondents.

Variables	Size (476)	%
Age range		
9 - 16	74	15.6%
17 - 24	108	22.7%
25 - 32	84	17.7%
33 - 40	79	16.6%
41 - 48	56	11.8%
49 - 56	40	8.4%
57 - 64	24	5%
65 - 72	10	2.0%
73 et plus	1	0.2%
Mean: 31.84 Median: 30.00 Variance: 217.54 Std Dev: 14.75 Range: 76 Minimum: 9 Maximum: 85 Percentiles 25: 19; 50: 30; 75: 42		
Occupation		
Farmer	208	43.7%
Trader	34	7.1%
State agent	14	2.9%
Teacher	31	6.5%
Pupil	142	29.8%
Student	10	2.1%
Health Worker	27	5.8%
Other	10	2.1%
Educational level		
without level	21	4.4%
Primary	75	15.8%
Secondary	346	72.7%
Higher and university	34	7.1%

Table 2. Knowledge, status of infectious waterborne diseases and their prevention of respondents.

Variables	Size (476)	%
Knowledge of infectious waterborne diseases		
No	67	14.1%
Yes	409	85.9%
Status of infectious waterborne diseases		
No	210	44.1%
Yes	266	55.9%

Continued

Infectious waterborne diseases		
Typhoid fever	334	70.2%
verminosis	307	64.5%
amoebiasis	254	53.4%
diarrhea	244	51.3%
cholera	179	37.6%
Shigellosis	22	4.6%
Others	6	1.3%
Drinking water treatment methods (140)		
boiling	79	16.6%
chlorifocation	51	10.7%
filtration	6	1.3%
sunshine	3	0.6%
others	1	0.2%
Prevention method		
None	27	5.7%
Water treatment	174	36.6%
Observance of hygiene rules	222	46.6%
Combination treatment and hygiene	53	11.1%

Table 3. Practices of respondents in relation to water management.

Variables	Size (476)	%
Using another water source for drinking		
No	119	25%
Yes	357	75%
Origin of drinking water		
springs and standpipes	278	58.4%
river water and standpipes	79	16.6%
standpipes only	119	25%
Reasons for consuming water outside of a standpipe		
When I'm in the field	143	30.1%
High water cost	23	4.8%
Long distance between house and standpipes	7	1.5%
By habit	3	0.6%
In the event of a water break at the standpipes	181	38%

Continued

The container used to draw drinking water		
Can	456	95.8%
Bucket	6	1.3%
Basin	14	2.9%
Container used for storing drinking water		
Can	288	60.5%
Bucket with lid	43	9%
Bucket without a lid	8	1.7%
Barrel with lid	68	14.3%
Barrel without a lid	5	1.1%
Calabash with lid	64	13.4%
Average number of days to clean the drinking water container		
Each day	160	33.6%
Before putting water in it	168	35.3%
1 day	16	3.4%
2 days	80	16.8%
3 days	17	3.6%
4 days	17	3.6%
5 days	11	2.3%
6 days	7	1.4%

Table 4. Statistical associations.

Variables	Having suffered from waterborne disease			χ^2	p-value
	Yes (266)	No (210)	Total (476)		
Feminine	119	77	196	2.83	0.091
Male	147	133	280	1	Réf
Occupation					
Farmer	134	74	208	18.98	0.00
Trader	21	13	34	9.80	0.00
State agent	7	7	14	3.02	0.06
Teacher	20	11	31	10.64	0.00
Pupil	69	73	142	7.15	0.00
Student	2	8	10	0.00	1
Health Worker	5	22	27	1	Réf
Other	8	2	10	9.55	0.00

Continued

Educational level					
without level	8	13	21	1	Réf
Primary	42	33	75	1.45	0.21
Secondary	200	146	346	2.38	0.11
Higher and university	16	18	34	0.13	0.58
Prevention method					
None	19	8	27	4.63	0.02
respect for hygiene rules	135	87	222	8.062	0.00
water treatment	80	94	174	1	Réf
Combinationwater treatment and hygiene	32	21	53	2.81	0.08
Using another water source for drinking					
Yes	218	139	357	14.72	0.00
No	48	71	119	1	Réf
Origin of drinking water					
springs and standpipes	181	97	278	19.94	0.00
river water and standpipes	37	42	79	0.57	0.38
standpipes only	48	71	119	1	Réf
The container used to draw drinking water					
Can	258	198	456	2.38	0.09
Bucket	1	5	6	1	Réf
Basin	7	7	14	0.80	0.32
Container used for storing drinking water					
Can	142	146	288	0.00	1
Bucket with lid	21	22	43	1	Réf
Bucket without a lid	7	1	8	2.66	0.05
Barrel with lid	59	9	68	16.98	0.00
Barrel without a lid	4	1	5	0.71	0.34
Calabash with lid	33	31	64	0.00	0.84
Average number of days to clean the drinking water container					
Each day	94	66	160	1.88	0.11
Before putting water in it	103	65	168	2.51	0.10
1 day	6	10	16		1
2 days	30	50	80	0.00	1
3 days	11	6	17	1.47	0.16
4 days	12	5	17	2.42	0.08
5 days	6	5	11	0.23	0.54
6 days	4	3	7	0.71	0.65

Table 5. Statical associations after logistics regression.

Variables	Having suffered from waterborne disease			p-value	p-value (regression)
	Yes	No	Total		
Occupation					
Farmer	134	74	208	0.00	0.00
Trader	21	13	34	0.00	0.00
Teacher	20	11	31	0.00	0.00
Pupil	69	73	142	0.00	0.00
Other	8	2	10	0.00	0.00
Prevention method					
None	80	94	174	0.02	0.00
respect for hygiene rules	135	87	222	0.00	0.04
Using another water source for drinking					
Yes	218	139	357	0.00	0.00
Origin of drinking water					
springs and standpipes	181	97	278	0.00	0.10
Container used for storing drinking water					
Barrel with lid	59	9	68	0.00	0.00

4. Discussion

After statistical analysis, profession (farmer, trader, teacher, student and others); non-observance of preventive methods against water-borne diseases, observance of hygienic measures; the use of other sources of drinking water and the storage of drinking water in barrels with lid were identified as a determinant of the endemicity of water-borne diseases in the City of Luputa. The breakdown of water at the standpipes and the absence of potable drinking water in the fields were the main reasons why the population resorted to other sources of supply of this essential commodity.

Certainly, setting up a drinking water supply system is one of the interventions to reduce morbidity and mortality from water-related diseases [1]. However, this study demonstrated that the objective pursued by installing the "Kaya Lubilu" water supply in the City of Luputa was not completely achieved. She identified some factors and reasons which explain the presence of water-borne diseases in this region. There are various types of water-borne diseases, the certainty of which requires biological confirmation. However, in this study, we were satisfied with the confirmation of having suffered or not from one of these diseases by the declarations of the people surveyed. In view of the above, there is a probability that the person affected may have confused the diagnosis of water-borne diseases or forgotten if they suffered from them in the previous period. This constitutes a limitation in this study. This limit would be minimized if the people to be interviewed were identified from health structures where the diagnosis of water diseases would be confirmed.

Knowledge of infectious waterborne diseases among the population is good because the majority of respondents were aware of them. Five diseases were best known with typhoid fever at the top followed by intestinal parasitoses, diarrheal diseases and cholera. In a Cameroonian study, typhoid fever was at the top followed by shigellosis and other pathologies [8]. This result was also similar to a Beninese study [9]. Referring to microbiological studies carried out on water quality, it should be noted that although the situation varied from one environment to another, salmonella were largely in the lead followed by enterobacteria [10]. This would explain the fact that typhoid fever is at the top in our study and those of others. For the remains, in our opinion, the difference would depend on the epidemiological profile linked to the environment.

The prevalence of waterborne infectious diseases from this study was 55.9% with the 95% CI [51.4%; 60.3%]. It is higher than the average for different African countries estimated at around 49% [11]; although this prevalence is less than 68% found in Mbouda in Cameroon [8]. It is a corollary to several risky practices observed in this study population.

The result of this study indicates that the proportion of men who suffered from water-borne diseases was higher compared to women. This finding is similar to the results of a study conducted in China. Although the environment of this study is different from ours, the result is similar [12]. In our environment, this situation could be explained by the fact that it is men who are most likely to be found in the professions and conditions favoring the occurrence of water-borne diseases. However, there was no statically significant association between sex and the occurrence of water-borne diseases.

Water-borne diseases were significantly associated with the consumption of drinking water from springs or wells and rivers, which is unfit for consumption following contamination by germs. This result is similar to those of studies carried out elsewhere, especially in developing countries [8] [10] [12] [13] [14] [15] [16]. Given that a large part of the population does not treat water, given the results presented in this study, it goes without saying that they suffer. The use of springs or rivers in this study is linked to the following reasons: the water shortage at the standpipes, the unavailability of standpipes in the field where the sources or rivers are found, the long distances between houses and standpipes but also the cost of water considered high. Some of these reasons have also been reported in other studies carried out, notably the unavailability of water in the event of a malfunction of the supply system, long distances and the high cost of water [9] [16] and the unavailability of water in a metalysis [16].

We found a statically significant association between water-borne diseases and occupation. Being in a rural environment, the majority of the population is a farmer. She stays almost all day in the field where thirst can only be quenched by water from springs or rivers.

The analysis of the occurrence of waterborne diseases and the level of education did not find a statistically significant association. This result is similar to that of a study carried out in Yaoundé [17]. On the other hand, in a Beninese study, an association was found [9]. This difference would be linked to the methods used in these different comparative studies.

By deeply analyzing the results of this study, it emerges that although a majority of the population claimed to know about water-borne diseases, they ignored the various prevention practices which ultimately become risk factors.

Boiling and chlorification were the two best known methods (27%) for water treatment but poorly applied (36.6%) by the population in our study. These results are not similar to those of an Ethiopian study where around 40% knew the different methods and the application of 25% [18]. In an American-Canadian study, 80% of the population surveyed had access to treated water [19]. A considerable proportion of our study population preferred to observe hygiene measures related to drinking water to protect themselves against related diseases. There is an association between hygienic practices and water-borne diseases. Which demonstrates that the population of the City of Luputa does not correctly observe hygiene measures related to drinking water.

We found an association between waterborne diseases and storing drinking water in a barrel with a lid. In our opinion, the duration of many days of conservation of drinking water in the barrel being prolonged, and the difficulties of properly cleaning the interior of the barrel would facilitate this contamination [20].

Factors associated with waterborne diseases vary from one environment to another. In this study the elements found were profession, insufficient hygienic measures for drinking water, use of other water sources. Studies carried out in America and Canada have mentioned the use of groundwater and the lack of treatment of the conveyance system [15], the contamination of water wells in China [12], the low proportion linked to supplied water, increased precipitation or temperature and infection [21] [22].

Water is vital for life but also constitutes a major risk factor for the occurrence of certain diseases if the necessary precautions are not taken. In view of the results obtained at the end of this study, we suggest that the following measures be observed to slightly reduce the morbidity rate of water-borne diseases. If a water supply is available, the managers of these infrastructures must do their best to keep the water flowing for as long as possible at least every day. Thus, the availability of quality drinking water will be permanent and will prevent the population from resorting to other sources whose water is not drinkable. Furthermore, the population must be sufficiently informed about the risk linked to the consumption of water from sources, wells and rivers. To remedy this, the ideal would be to educate people in rural areas to bring drinking water to the field in small containers to use it all the time they are in the field. In the same vein, the population must be educated on water management ranging from supply, conservation and use on the one hand and on the other hand, on hygiene rules to be observed and possible treatment of drinking water.

The situation under examination in this study being infectious waterborne diseases, it would be desirable to couple the field survey with bacteriological analyses. This is all the more important because the water tank, the distribution piping which has already lasted can be sources of water contamination because the literature indicates that after a certain time a film containing bacteria can form. build up on water supply pipes and contaminate it [23]. From the above, it would be desirable to carry out a bacteriological study on the water from this supply to the collection center, in the central reservoir, the pipes and on some distribution terminals to exclude the hypothesis of upstream contamination. It can be supplemented by a study relating to the bacteriological analysis of drinking water collected from the households of people whose diagnosis is confirmed in hospital after their informed consent, of course.

5. Conclusion

Water-borne diseases continue to be reported in the City of Luputa despite a water supply system because the population consumes both drinking water from this infrastructure and other sources; weakly observes hygiene rules and water treatment. At this rate, achieving Sustainable Development Goal 6 will remain hypothetical. To reverse the trend, the manager of the drinking water supply will have to ensure its almost permanent availability on the one hand and on the other hand, the population will have to be educated and made aware of the exclusive use of tap water. fountain, the best water management and the basic rules to follow regarding drinking water.

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Authors' Contributions

Kazadi KT designed the study, conducted the collect, data analysis and drafted the manuscript; Beya contributed to the development the manuscript and analysis the data; Tshikez, Mbuyi and Kazadi TJ contributed more to the supervision and collection of data on the ground; Tshibangu and Luboya carried out the final analyzes of the data. All have read and approved the latest version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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