



# Why the Endemoepidemicity Persistence of Cholera in Moba (DR. of Congo)?: Preliminary Study in the Health Area of Regeza in 2016

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## Abstract

**Background:** Cholera is a very old endemo-epidemic disease linked to the conditions of defective hygiene. It is a public health problem, mainly in Africa and Asia. **Aim:** The purpose of this preliminary study was to determine the level of knowledge of the population in relation to the factors favoring the endemicity and epidemicity of cholera among the exposed populations. **Methods:** This is a prospective, descriptive cross-sectional and analytical study. Interviewing and document analysis techniques were used in the different strata over the three-month period, from April to June 2016. **Results:** The profile of the respondents was mostly male (56.7%) aged over 30 years (61.2%), farmers (40.9%) or fishermen (26.1%) with a low level of instruction. The mean age was  $32.1 \pm 2.3$  years with extremes ranking from 18 to 57 years. This study revealed that the main factors contributing to endemicity and epidemicity persistence of cholera were the low level of education, the environmental proximity with rivers and Lake Tanganyika, the incorrect habits of the population to think of the mystic in the genesis of cholera cases disease, low

level of mobilization for cholera control, poor knowledge of the pathways of transmission of cholera, poor treatment of drinking water and the large consumption of inadequate water, knowledge of the critical moments of hand-washing, the low use of soap or ash when washing hands, the large proportion of plots without latrines or with unhygienic latrines, poor management of household waste, poor organization of placement sessions at the level of cholera, poor knowledge of the means available to fight against cholera, poor management of faecal peril and poor general hygiene conditions. **Conclusion:** The conditions of poor knowledge of cholera and of deficient hygiene combined in our environment are favorable to the endemicity and sometimes the occurrence of cholera epidemics. Efforts should be made in relation to the improvement of hygiene conditions (individual and collective), communication for behavioral change and education of the population in the fight against cholera. The tree of solution to the problems of cholera encountered in this study (in Appendix) may be the model to follow.

### Subject Areas

Epidemiology, Infectious Diseases, Public Health

### Keywords

Cholera, Health, Hygiene, *Vibrio cholerae*

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## 1. Introduction

In developing countries, transmitted infectious diseases are costly to the public and a public health problem [1] [2] [3]. These include those usually expressed by acute diarrhea such as cholera, *Escherichia coli* infection, *Campylobacter jejuni* infection, Rotavirus infection, Giardiasis, Intestinal amoebiasis, Salmonellosis, Shigellosis, etc. [4] [5].

Cholera is a very old bacterial infectious disease (1503 by an officer of the explorer Vasco De Gama in Calcutta: the initial focus of the world on the Ganges River in India) and contagious [5] [6]. It is caused by a gram-negative bacillus called *Vibrio cholerae* (which has the tropism for the epithelium of the small intestine after oral ingestion by food and contaminated water). Clinically, cholera is characterized by colorless, painless, diarrhea and mainly rice form appearance preceding vomiting [2] [3] [4] [5]. Severe dehydration following acute diarrhea leads the victims to death in the absence of treatment.

Cholera is an endemic and epidemic disease linked to defective hygiene conditions, the virulence of the responsible microorganism (*Vibrio cholerae*) and the capacity of the body to defend itself by the various natural and immune immunological mechanisms [2] [6] [7].

Each year around 1.3 to 4 million cholera cases are reported with 21 miles to 143 thousand deaths worldwide [5] [7] [8]. For the World Health Organization,

notifications appear to be less in some countries due to a deficit in national surveillance systems and a refusal to alert potential tourists for fear of risk of economic loss [8].

Several cholera epidemics have been recorded worldwide and Africa is more concerned with prevalence and death [6] [8] [9] [10], followed by Asia [11]. Europe and North America would be spared [9] [11]. The reasons seem to be unknown but the world of life and collective hygiene measures in these developed countries can have a great influence on the absence of cholera cases in Europe and North America [5] [6] [10] [11] [12] [13] [14].

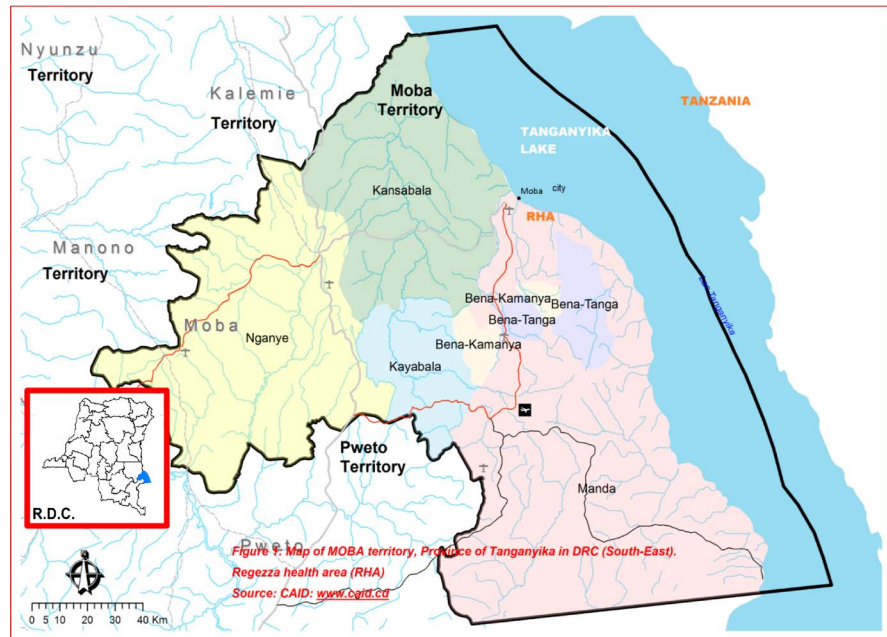
The Democratic Republic of the Congo (DRC) was among the five countries representing about eighty-five percent of cases notified with Ghana, Haiti, Nigeria and Afghanistan in 2013 [9]. In DRC, the first cases of cholera were reported in 1975. The most important cholera outbreaks are found in the Lake Provinces of North Kivu, South Kivu, and the former Katanga (including Moba) and along the Congo River where the disease has endemoepidemic cyclical characteristics. In the areas bordering Lake Tanganyika (Moba, Kalemie, Fizi and Uvira) in the DRC, cholera is endemic throughout most of the year with epidemic outbreaks accompanied by deaths, especially during the rainy season. In the context of Moba, several non-governmental organizations have been funded to combat the morbidity and mortality associated with *Vibrio cholerae*. Despite these financial means, cholera remains a public health problem (especially for health areas along Lake Tanganyika). This endemo-epidemic state of cholera in Moba had prompted us to ask a question: Why is the persistence of cholera in Moba? To answer this question, a preliminary study was first recommended. The objective of this study is to determine the level of knowledge of the population in relation to the factors favoring the endemicity and epidemicity of cholera among the populations exposed. The results of this study will be necessary tools to take into account by any partner involved in the fight against cholera in our province and middle of Moba.

## 2. Methods

### 2.1. Site of the Study

This study was conducted in health area of Regeza (Moba Health Zone and Territory, Tanganyika Provincial Health Division, South-East DRC) (Figure 1). This young health area follows the division of the Moba-Port health area and comprises 11 villages and blocks (Belair block, Kipushi block, Likasi block, Moba block, Tanganyika block, Tsholwe village, Nkondwe village, Mufaume village, Katende village, Kapeso village and Mushende village).

The population of the Regeza Health Area (13,334 inhabitants in 2016) is mainly composed of the Tabwa tribe and the main activities are agriculture and fishing on Lake Tanganyika. The population has a low level of education, which often explains the rarity of university executives. In terms of health, Regeza, Mulunguzi, Kansenge, Liombe, Kizike, Kiku and Moliro health areas are part of



**Figure 1.** Map of Moba's territory in democratic republic of Congo. There is the Regeza Health Areas (RHA) in Moba, near Tanganyika Lake.

the health areas in the Moba Zone where the cholera is endemic and epidemic. We only meet the nurses. Public health centers and private health Posts are in most cases less equipped. It should be noted that the Moba Health Zone is part of the territory of Moba (24,500 Km<sup>2</sup> and 609,406 inhabitants in 2016) and has six major diseases: Malaria, acute respiratory infections, simple diarrhea, dysentery (Especially in areas of artisanal mining), measles, cholera and sexually transmitted infections (STIs).

## 2.2. Types, Period and Population of Study

This study was prospective, descriptive cross-sectional and analytical. Interviewing and document analysis techniques were used. The period of our investigation was three months, from April to June 2016. The study population was composed of the inhabitants of the health area of Regeza. The study sample was simple random and calculated using the mathematical below formula of Schwartz. In the absence of the prevalence in the literature that corresponded to our objective, we had considered the prevalence of 50%.

$$n \geq \frac{Z_{\alpha}^2 \times p(1-p)}{d^2} = \frac{1.96^2 \times 0.5 \times 0.5}{(0.05)^2} = \frac{0.9604}{0.0025} \cong 384$$

The minimum sample in this study should be 384. Following the possible 10% refusal to answer our questions, 39 people to be interviewed had been added. For this study, 430 individuals had been selected. The population of the health area was subdivided into strata. The expected 430 individuals were distributed in the strata (11 in total) according to the welding weight expected in each stratum.

The inclusion criteria was : living in the Regeza Health Area, agreeing to par-

ticipate in this study, being over 18 years of age and being part of the targeted household, completing the desired variables. Any person did not meet these criteria had been excluded. The parameters studied in this study include the Age, the sex, the educational level, the Occupation, the drinking water (source, preservation and treatment), the handwashing (critical moment, use of soap or ash), the existence of latrines in the plot, the waste management Behavioral change communication in favor of cholera and knowledge of cholera control measures.

### 2.3. Statistical Processing and Analysis of Data

Data collected on survey forms have been processed and analyzed using Excel software (Microsoft, USA, 2010). The results were presented in the form of tables comprising successively the observed numbers, frequencies, means and standard deviation. The unadjusted Pearson Chi-Square test was used to assess the relationship between the variables. The threshold of 0.05 for the alpha error was retained.

## 3. Results

During the period of our survey, 430 individuals had agreed to respond to our interview. 418 people (97.2%) were aware of cholera and 2.8% (n = 12) of those interviewed during the study period did not know the existence of cholera. Those persons who knew the existence of cholera were retained as a study population (418).

### 3.1. Socio-Demographic Characteristics

In our study series, individuals over 30 years of age (n = 256 or 61.2%) were significantly more likely (p < 0.05). The mean age was  $32.1 \pm 2.3$  years with extremes ranging from 18 to 57 years. Men were more likely than female 237 (56.7%) compared with 181 (43.3%). The sex-ratio was 1.3 in favor of the male sex (**Table 1**). According to **Table 1**, the majority of respondents had a primary education level (n = 190 or 45.5%) followed by illiterates (n = 124 or 29.6%) and those at the secondary school level (n = 102 or 24.4). Only two respondents had a higher education and university level.

Farmers were the first professions in our study series (n = 171 or 40.9%) followed by fishermen (n = 109 or 26.1%), teachers (n = 56 or 13.4%), traders (n = 45 or 10.8%). Public officials accounted for 11 people, or 2.6%.

### 3.2. Knowledge of the Pathways of Transmission of Cholera and Drinking water Consumed

During the period of our investigation, dirty hands were cited by 353 respondents (84.4%) as the main pathways or route of transmission of *Vibrio cholerae* and consequently the occurrence of cholera cases (**Table 2**). Contaminated food and water were weakly respectively evoked with 39.0% (n = 163) and 36.1% (n = 151).

**Table 3** indicates that the main source of drinking water supply was the River

**Table 1.** Socio-demographic characteristics (n = 418).

Socio-demographic characteristics	n (%)
<b>Age (Years)</b>	
≤30	162 (38.8)
>30	256 (61.2)*
<b>Gender</b>	
Male	237 (56.7)
Female	181 (43.3)
<b>Education level (Studies)</b>	
Illiterate	124 (29.6)
Primary	190 (45.5)
Secondary	102 (24.4)
High studies and University	2 (0.5)
<b>Profession</b>	
Farmers	171 (40.9)
Fishers	109 (26.1)
Traders	45 (10.8)
Teachers	56 (13.4)
Public administration	11 (2.6)
Others	26 (6.2)

\*Significant at  $p < 0.05$ ; Meansage  $32.1 \pm 2.3$  years and extremes 18 to 57 years.

**Table 2.** Knowledge of pathways for transmission of cholera.

Pathways for transmission of cholera	n	%
Hands halls (n = 418)	353	84.4
Contaminated foods (n = 418)	163	39.0
Contaminated water from fecal matter (n = 418)	151	36.1

(Moba River) and Lake Tanganyika (n = 211 or 50.5%) followed by the wells (n = 148 or 35.4%), Tap (n = 36 or 8.6%) and unmanaged source (n = 23 or 5.5%). The proportion of individuals who consume water from the protected wells was higher than that of individuals who consume the water that flows through the tap (“REGIDESO” Company of the DRC) with 137 vs 36. The cans were cited as the first container (n = 198 or 47.4%) followed by Bassins (n = 117 or 28.0%), Pitches (n = 70 or 16.7%) and Drums (n = 19, 4.5%) (Table 3). It was found after our survey that the majority of respondents did not consume significantly ( $p < 0.05$ ) the treated water (n = 249 or 59.6%). Water treatment was carried out for only 169 households (40.4%): the main means of water treatment was chlorination (n = 159 out of 169, *i.e.* significantly 94.1%), Boiling (ten households or 2.4%).

**Table 3.** Drinking water consumed by respondents.

Drinking water consumed	n	%
<b>Main source of supply (n = 418)</b>		
<b>Well</b>		
Protected	137	32.8
Unprotected	11	2.6
Subtotal	148	35.4
<b>Source</b>		
Furnished	-	-
Unfurnished	23	5.5
Subtotal	23	5.5
<b>River and lake (Tanganyika)</b>	211	50.5
<b>Tap water</b>	36	8.6
<b>Container for home preservation (n = 418)</b>		
Cans/Bottles	198	47.4
Drums	19	4.5
Basins	117	28.0
Pitchers	70	16.7
Large cooking pots	2	0.5
Fridge	12	2.9
<b>Home treatment of water (n = 418)</b>		
<b>Yes</b>		
Chlorine	159	38.0
Boiling	10	2.4
Sub-total	169	40.4
<b>No</b>		
	249	59.6*

\*Significant at  $p < 0.05$ .

### 3.3. Hygiene: Handwashing, Existence of Latrines and Management of Household Waste

**Table 4** indicates that the greatest critical time for handwashing was before eating or feeding or nursing the baby ( $n = 371$ , 88.8%). The other critical moments, essential in hand hygiene, were less evoked: before preparing food ( $n = 142$  or 34.0%), after cleaning or changing clothes in the baby ( $n = 95$  or 22.7%), after having groomed ( $n = 135$  or 32.3%) and after the walk ( $n = 72$  or 17.2%). In the majority of cases ( $n = 288$  or 68.9%); handwashing was done without soap or ash ( $n = 130$  or 31.1%). The difference between those using soap and hand washing ash and those who did not have this habit was significant ( $p < 0.05$ ).

In the majority of the plots visited, latrines ( $n = 339$  or 81.1%) were significantly ( $p < 0.05$ ). However, these latrines were essentially unhygienic



**Table 4.** Washing the hands.

Hand washing	N	%
<b>Knowledge of Critical Moment (n = 418)</b>		
Before eating or eating or breastfeeding	371	88.8
Before preparing food	142	34.0
After cleaning or changing linen in children	95	22.7
After having been at the toilet	135	32.3
After the walk	72	17.2
<b>Practical use of soap or ash (n = 418)</b>		
<b>Yes</b>		
Soap	119	28.5
Ash	11	2.6
Subtotal	130	31.1
<b>No</b>		
	288	68.9*

\*Significant at  $p < 0.05$ .

( $n = 285$  or 68.2%). Plots without latrines were encountered in 79 cases, or 18.9% (Table 5).

According to Table 5, household waste was managed in 214 households (51.2%) by trash holes ( $n = 128$  or 30.6%) and garbage ( $n = 86$  or 20.6%). No plot had the incinerator at its disposal. In the majority of cases, the waste was left in the air without burial: 388 households (92.8%) vs 30 (7.2%). The difference observed is very significant ( $p < 0.05$ ).

### 3.4. Communication for Behavior Change (CBC) and Cholera Control

In terms of Table 6, Radio and Churches were mainly listed as the main channels for raising awareness, with respectively 49.3% ( $n = 206$ ) and 28.2% ( $n = 118$ ). Community Relay was only mentioned in 33 households (7.9%). The neighbor's role was recognized as the fourth channel of communication in the fight against cholera ( $n = 30$  or 7.2%). DRC Red Cross volunteers (DRCRC) were cited as the only non-governmental organization to mobilize against cholera ( $n = 12$  or 2.9%). Cholera exchange visits were only discussed in 54.2% ( $n = 227$ ) and 309 ( $n = 73.9%$ ) individuals who had never participated in a public cholera information session. The question of knowing how to fight cholera, washing hands at critical times ( $n = 364$  or 87.1%) and improving hygiene and sanitation conditions around the home ( $n = 335$  or 80.1%) were the main means mentioned. Treatment of drinking water was less cited ( $n = 195$  or 46.6%). For 111 individuals or 26.5%, it was necessary to go to the treatment center of cholera (CTC) in case of suspected diarrhea. The means of control were not known in 44 households questioned (10.5%).



**Table 5.** Existence of latrines in the plot and waste management.

Latrines and waste	n	%
<b>Existence of latrines (n = 418)</b>		
<b>Yes</b>	339	81.1
Hygienic	54	12.9
Unhygienic	285	68.2*
<b>No</b>	79	18.9
<b>Waste management (n = 418)</b>		
<b>Yes</b>	214	51.2
Dustbin	86	20.6
Recycle hole	128	30.6
<b>No</b>	204	48.8
<b>Waste burial (n = 418)</b>		
<b>No</b>	388	92.8*
<b>Yes</b>	30	7.2

\*Significant at  $p < 0.05$ .**Table 6.** Communication for behavior change and cholera control.

Communication for behavioral change and cholera control	n	%
<b>Awareness Channel (n = 418)</b>		
Radio	206	49.3
Television*	19	4.6
Community Relay	33	7.9
Neighbor	30	7.2
NGOs (DRCRC)	12	2.9
Church	118	28.2
<b>Visit or visitation for exchange on cholera (n = 418)</b>		
<b>Yes</b>	227	54.3
<b>No</b>	191	45.7
<b>Participation in the cholera information session (n = 418)</b>		
<b>Yes</b>	109	26.1
<b>No</b>	309	73.9**
<b>Means or ways of control</b>		
Wash hands at critical times (n = 418)	364	87.1
Treatment of drinking water (n = 418)	195	46.6
Improved hygiene and peri-residential conditions (n = 418)	335	80.1
Going to the CTC in case of suspected diarrhea (n = 418)	111	26.5
Does not know (n = 418)	44	10.5

\*International and national chains; \*\*Significant at  $p < 0.05$ ; CTC: Cholera Treatment Center; NGOs: Non-Governmental Organization; DRCRC: Red Cross of the DRC.

## 4. Discussion

*Vibrio cholerae* colonizes the epithelium of the small intestine and produces a toxic toxin for enterocytes [4] [9]. The infected individual presents several symptoms including vomiting, fever, hypotension, muscle spasms and diarrhea. The greatest complication is dehydration with life-threatening risk following acute diarrhea [5] [6] [7] [12] [15] [16]. Cholera is the preferred companion of natural disasters, situations of conflicts with massive displacements of population and precarious hygiene [16]-[22]. Africa is the continent most affected by the cases notified to WHO [23].

Among the most affected countries is the Democratic Republic of Congo, where Moba is one of the places where cholera is endemic with epidemics in some places [9].

Our work consisted in highlighting the factors favoring this endemicity in order to contribute to the improvement of cholera control. In view of the results of interviewees, conditions are favorable for the occurrence and perpetuation of cholera in our environment. Indeed, while the majority of the population (97.2%) recognized the existence of cholera (which can be considered a good indicator of community awareness), knowledge about risk factors and control is disappointing.

The notion of factors favoring cholera has been mentioned by several authors, unanimous on the risk of triggering the cholera epidemic in case of deficient hygiene [3]-[10]. The World Health Organization, WHO in its acronym, is constantly encouraging member countries to see closely the various elements incriminated in the genesis of cholera [8].

As regards this series of studies, as found by several authors [3]-[17] [22], the main factors that could be evoked in this preliminary work would be, notwithstanding some positive points: low level of education, proximity with the rivers and Tanganyika Lake, the incorrect habits of the population to think of the mystic in the genesis of cholera, the low level of mobilization in favor of the fight against cholera, the poor knowledge on the means of transmission of cholera, poor drinking water treatment and inadequate water consumption, poor knowledge of critical handwashing times, low use of soap or ash when handwashing, large proportion of plots without latrines, poor management of household waste, poor organization of cholera upgrading sessions, poor knowledge of the available means to fight cholera, poor management of fecal peril and poor hygiene. In several studies, the absence of hygiene measures in relation to drinking water and food has been cited as one of the major elements in the occurrence and sustainability of a cholera epidemic [3] [8] [13]-[19] [22] [23].

Water is an essentially reputed element in the cycle of cholera transmission. A significant proportion of the population consumes water that is unsuitable, poorly preserved and untreated, despite the various mobilizations in the health area: 50.5% consume mainly river and lake water, 2.6% for water from unprotected wells and only 40.4% consume treated water; 47.4% conserve drinking water in cans/big bottles and 28.0% in basins. Chlorination was mainly the

**Table 7.** (a) Problems and preliminary solutions with cholera in the health area of Regeza: factors favoring cholera endemicity: trees of problem; (b) Problems and preliminary solutions with cholera in the health area of Regezza: factors favoring cholera endemicity: trees of solutions.

(a)		
ROOTS = CAUSES	TRONC = CONNECTED	BRANCHES = CONSEQUENCES
1) Insufficiency of structure for water supply.		1) River water supply, lake (Waterborne diseases: diarrhea, dysentery, cholera).
2) Poor management of water and waste.	– <b>Inaccessibility to drinking safe water.</b>	2) Sustainability of water-borne diseases.
3) Health Regeza center without C.T.C.	– <b>Lack of hygiene.</b>	3) A CTC is established in Regezza.
4) Presence of backwaters.	– <b>Low level of education.</b>	4) Maintenance of potential reservoirs (natural or human).
5) Insufficient Garbage Holes.	– <b>Poverty.</b>	5) Unhealthy with risk of contagion or contamination.
6) Polluted water, hand washing In common after burials.	– <b>Lack of adequate information.</b>	6) Dissemination and direct spreading of microbes, including pathogenic cholera germs.
7) Latrines broken annually by Floods.		
(b)		
RACINES = SPECIFIC OBJECTIVES	TRONC = STRATEGIES	BRANCHES = ACTIVITIES
<b>To supply the health area with drinking water.</b>	Water supply by REGIDESO; Identify the water sources to be developed and make them operational.	<b>Advocacy with REGIDESO Managers for at least 10 wells in proportion to the density of the population.</b>
<b>Properly impede drinking water; Reject garbage properly.</b>	Digging of garbage holes Incineration system.	<b>Raise public awareness of the consequences of unhealthy households.</b>
<b>Provide Regeza health centre with a C.T.C.</b>	Consolidate a reference structure.	<b>Advocacy at the head health zone.</b>
<b>Destroy or clog all artificial backwaters from manufacturing bricks.</b>	Impose brick manufacturing outside the villages.	<b>Activate the administrative organization (head of territory and the hygiene unit in Moba).</b>
<b>Impose garbage holes in each household.</b>	Take sanctions against the head of household re-offending.	<b>Involvement of the Head of the territory and the hygiene unit in Moba.</b>
<b>Raise community awareness of environmental health.</b>	Demonstrate the importance of prevention against waterborne diseases.	<b>Door to door sensitization.</b>

technique used and is usually carried out by agents of the Red Cross of the DRC, voluntarily posted to around Lake Tanganyika and rivers to add chlorine diluted in pulsed water. The use of cans to conserve drinking water is being extended to the DRC [24] and is the main alternative due to lack of financial resources.

The low consumption of tap water in this study (8.6%) is on the one hand related to the smallest extent of the distribution network of the “REGIDESO” (State Water Supply Company) and other irregularity in the distribution of water. The proximity to the lake and the consumption of its waters was mentioned in Kenyan [6]. **Table 4** indicated that 68.9% of the population did not use soap or ash when washing hands, and knowledge of critical handwashing times was low. Handwashing is a determining factor in the circulation of germs during greetings [21] [22]. Hence, the use of soap should be recommended in order to combat the risk of contamination by the germs of dirty hand diseases.

During our investigation, the hygiene measures were not predominantly good according to the answers of the interviewees. Parts of the population (18.9%) lack latrines and among those who have it 68.2% are unhygienic. Waste management is not as satisfactory and landfill is only very low at 7.2% compared to

92.8%. The difference observed is statistically significant after resorting to the law of homogeneous distribution.

The various aforementioned arguments make it possible to perpetuate the endemicity of cholera and the episodic epidemic in our region, as also some authors [2] [5] [6].

Finally, awareness-raising channels should be improved because it is from them that good, appropriate information can reach the population. No channel reaches 50% in respondents' responses, although radio and church cover 49.3% and 28.2% specifically. Access to cholera information is not available for 73.9% of respondents and there are also several gaps in the control of cholera control (**Table 6**). The mobilization and information of the population in the fight against waterborne diseases and dirty hands are therefore necessary as pillars in the fight against cholera. It is said that "ignorance kills".

The various elements listed above would explain why cholera is endemic in our environment, especially in the rainy seasons where fecal waste can easily contaminate drinking water. It is important to control them and adopt firm measures to reduce significantly the impact of these risk factors and remove Moba from the list of endemic areas of cholera according to problem trees and solution (see below) mentioned in this study.

The results of this preliminary study demonstrate our willingness to understand why cholera persists cyclically in our environment. Future studies could address the factors that determine the sustainability of cholera on a larger, multicenter sample and generalize the results to the region as a whole.

## 5. Conclusion

The conditions of poor knowledge of cholera and of deficient hygiene combined in our environment are favorable to the endemicity and the occurrence of cholera epidemics in our environment. In this study, low levels of education, environmental proximity to rivers and lakes, ignorance about ways or means of contamination and prevention of cholera, poor mobilization, improper water use, poor hygiene in terms of fecal peril and handwashing, limited access to quality information in place of fear and panic are favorable to endemo-epidemic persistence of cholera in the Regeza Health Area. To some extent, with limitations, these arguments can be applied in all the health areas around Lake Tanganyika. Efforts should be made in relation to the improvement of hygiene conditions (individual and collective), communication for behavioral change and education of the population in the fight against cholera. The solution tree (**Table 7(a)** and **Table 7(b)**) contained in this study may be the model to follow.

## Conflict of Interest

The authors do not report any conflicts of interest in this study.

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