Open Access Library Journal
2018, Volume 5, e4554
ISSN Online: 2333-9721
ISSN Print: 2333-9705

The Recurrence of Cholera in the City of Lubumbashi: Investigation of Risk Factors for an Effective Response and Health Education Perspective

Kabyla Ilunga Benjamin[1], Ilunga Kandolo Simon[2*], Nora Luvungu[2], Basema Marie France[2], Kavira Lughuma Gladys[2], Mulang Irung Raphaël[2], Mukonkole Justin[3], Kimba Mukanya Pascal[1], Matungulu Matungulu Charles[2], Mashini Ngongo Ghislain[1]

[1]Faculty of Medicine, University of Lubumbashi, Lubumbashi, The Democratic Republic of the Congo
[2]School of Public Health, University of Lubumbashi, Lubumbashi, The Democratic Republic of the Congo
[3]Ministry of Public Health, Kinshasa, The Democratic Republic of the Congo
Email: *silungak@gmail.com

How to cite this paper: Benjamin, K.I., Simon, I.K., Luvungu, N., France, B.M., Gladys, K.L., Raphaël, M.I., Justin, M., Pascal, K.M., Charles, M.M. and Ghislain, M.N. (2018) The Recurrence of Cholera in the City of Lubumbashi: Investigation of Risk Factors for an Effective Response and Health Education Perspective. *Open Access Library Journal*, **5**: e4554.
https://doi.org/10.4236/oalib.1104554

Received: March 30, 2018
Accepted: May 14, 2018
Published: May 17, 2018

Abstract

Introduction: Cholera is one of the so-called dirty hand diseases. Its effective response saves lives. The city of Lubumbashi has recorded at least one cholera epidemic for almost ten years, each of which generates significant socio-economic costs. **Method:** We conducted a case-control study on cholera in the city of Lubumbashi in the Democratic Republic of Congo in 330 individuals, including 110 cases matched to 220 controls. The linear list of the cholera treatment center was used to identify the cases. **Results:** Half of the respondents were 50, 30% did not treat water before drinking, and the remaining 49.70% used the treatment of drinking water. The risk factors for the cholera outbreak that were found to be statistically significant include: poor food preservation (AOR = 3.32, 95% CI [1.85 - 5.96], and p value = 0.0001), contact with a cholera patient (AOR = 2.88, 95% CI [1.65 - 5.01], and p value = 0.0002) and stay outside Lubumbashi (AOR = 4.18, its 95% CI [1.83 - 9.55]). **Conclusion:** An urgent need for information on risk factors for cholera and a rapid organization of the response is the key to cope with this recurrent epidemic in the city of Lubumbashi.

Subject Areas

Epidemiology, Public Health

Keywords

Recurrence, Cholera, Risk Factor, Health Education, Lubumbashi

1. Introduction

Cholera is an acute diarrheal infection caused by the ingestion of food or water contaminated with Bacillus *Vibrio cholerae* [1]. It is a disease of faecal. It is a real emergency in public health. It is one of the oldest and most devastating diseases whose history goes back to more than 377 years BC according to the writings of Hyppocrates (460-377 BC) and Galen (129-216 AD) and which, unfortunately continues to maintain its magnitude [2]. The brief incubation period of two hours to five days is a factor that reinforces the potentially explosive dynamics of epidemics [3]. According to WHO estimates, there are 1.4 - 4.3 million cases of cholera every year, with 28,000 to 142,000 deaths, a lethality of 2% to 3.3% [1].

This disease came out of its traditional focus of Bengal and the Upper Ganges Valley in the early nineteenth century to spread throughout the world, along the trade routes, in the form of successive pandemics. Six pandemics followed each other from 1817 to 1859, killing tens of thousands of people in Asia, Europe and America to such an extent that a conference was held in Paris in 1851, inaugurating the internationalization of public health problems [4].

After having been ravaged by cholera during these first six pandemics, the northern countries (Europe and the United States of America) have succeeded in eliminating this disease as a public health problem through sanitation and improvement actions which have access to drinking water all in a context of development and improvement of the overall living situation of the populations [2].

Cholera is the preferred companion for natural disasters and conflict situations with massive population displacements. However, it can occur in a context of political stability and in the absence of any natural calamity, when the socio-economic conditions of the populations are favorable to its development [4].

Africa is currently the continent that reports more than half of all cholera cases and deaths worldwide. 190,549 cases and 2231 cholera-related deaths were reported worldwide in 2014; it has 105,287 cases and 1882 deaths, representing respectively 55% and 84% of the global total [4]. In Cameroon, in 2011, a cholera epidemic in the northern region affected 23,152 people and killed 843, and in the south, 336 cases and 13 deaths. A study conducted in this regard identified that poor food preservation was the factor significantly associated with the epidemic [5]. However, a few years before, with regard to the factors determining the endemicity of cholera in Douala, Cameroon, Guévart E. *et al.* found, among other things, insufficient sewage causing water overflows, especially during the rainy season, latrines often discharged into the environment, the persistence of traditional unfavorable attitudes towards the use of water devices resulting in by high-risk behavior which in turn constitutes a barrier to hygiene education [6]. The DRC is among the 5 countries that alone accounted for 84% of reported cases worldwide in 2014 [4]. Spared by the first 6 pandemics, the DRC recorded these first cases of cholera with the seventh pandemic in 1974 [7].

2. Methodology

The Kampemba Health District is one of the 11 Health districts of the Provincial Health Division of Upper Katanga. It straddles between two administrative communes of the city of Lubumbashi, namely, the communes of Kampemba and Annex. This health zone covers a total population estimated in 2016 at 430,935 inhabitants (source: population growth of 3% over the population of 2015), spread over 22 health areas. It has 80 integrated health facilities including 5 hospitals and a reference General Hospital.

Only two health facilities are state-owned and all 78 are private. It has an area of 150 km^2, with a density of 2873 inhabitants/km^2.

Note that the Kampemba General Referral Hospital is eccentric in the far East of the Health Zone.

The main causes of morbidity are malaria, typhoid fever, acute respiratory infections, diarrhea, cholera, measles.

This is a case-control study, which spanned the entire duration of the cholera epidemic in the health zone of Kampemba from January to June 2016.

The study population consisted of the inhabitants of the Kampemba Health Zone.

To select the cases, we used the registry and the linear list of cholera cases admitted to the Cholera Treatment Center of Kenya which is the only Cholera Treatment Center that receives all the patients of the city of Lubumbashi. Patients were admitted on the basis of the WHO cholera case definition and a positive agglutination test performed at the beginning and end of the epidemic.

From this linear list, we have returned that taking back only the patients of the Health District of Kampemba who were 326 patients during the study period. Our frame was obtained excluding children under 5 years; then we selected the cases to investigate by performing a simple random sampling using the ALEA function of Microsoft Excel 2013.

Based on the addresses, age and sex of the cholera cases retained and found on the linear list of the cholera treatment center, we were able to identify and recruit the witnesses to be investigated either in the same house, or in the same plot, or among the neighbors or in default on the same avenue taking into account the same sex and the difference in age with the case which should not exceed 5 years.

The sample size was calculated using the StatCalc function of the Epiinfo software version 7.1.4.0, taking into account the following parameters:

- Precision: 95%;
- Proportion of non-patients for a factor studied: 78%;
- Proportion of patients for a factor studied: 91.4%;
- Power: 80%;
- Number of controls per case: 2;
- Odds Ratio: 3.

This resulted in a minimum of 99 cases to which we added 10% margin to cover the nonrespondents and some cards with missing data that could be downgraded. Thus, after rounding, the number of expected cases was 110 cases and 220 witnesses a total size of 330 subjects.

Since this was a retrospective survey, there were no missing data because we had the possibility to automatically replace cases not found by another one.

The subjects we included in our study are those who met the following criteria:

- Case: Anyone who has had acute watery diarrhea admitted to the Kenya Cholera Treatment Center during the study period, resident of the Kampemba Health Zone and having signed their participation agreement.
- Witnesses: Any person of the same sex whose age difference with the case does not exceed five years, living in the same house or parcel, either the neighboring parcel or on the same avenue, with no history of cholera or diarrhea from the beginning to the end of the epidemic and who voluntarily agreed to participate in the study.

Data Collection Material and Procedure

During the preparatory phase, we proceeded by training investigators and supervisors. Aside from these, two Social Mobilizers from the Health Zone who are in charge of the disinfection of the homes of cholera patients were also recruited and made it possible to find the residences of the cases with less difficulty. A pre-test of the questionnaire was carried out in the Kenya Health Zone which presents the same context as that of the Kampemba Health Zone. This pretest enabled us to correct the weaknesses noted and to adapt the questionnaire. During the actual survey, the data were collected by interview based on this structured questionnaire which was administered at home to both cases and witnesses. The observation was made for certain variables such as the presence of the device of wash-hand and the state of the toilets. To ensure the quality of the data, supervision was provided by two people each with the responsibility of 3 investigators. In addition, each investigator marked his no on the sheet and an evaluation meeting was organized in the evening in the presence of the entire team. Which allowed us to correct in time some imperfections and inconsistencies.

The data thus collected were encoded in EPI info version 7.1.4.0 and analyzed in the same software and then exported to Excel 2013 and R software for further analysis.

3. Results

Our sample consisted of a total of 330 surveyed subjects including 110 cases and 220 controls. The majority of respondents came from the Kabanga health area, 61.82%, compared to 0.91% of the Circular health area (Table 1).

Out of a total of 330 people in our sample, it appears that their age ranged from 5 to 70 years with an average of 26.38 ± 15.59 years. The modal age was 10 years old.

Table 1. Distribution of respondents by Health Area.

Health Area	Frequency			Percentage
	Case	Control	Total	
Circulaire	1	2	3	0.91
Emmaüs	4	8	12	3.64
Kabanga	68	136	204	61.82
Kabwela	4	8	12	3.64
Kamasaka	5	10	15	4.55
Lapofa	5	10	15	4.55
Njanja	2	4	6	1.82
Polyvalent	3	6	9	2.73
Référence	5	10	15	4.55
Safina	3	6	9	2.73
Saint Habraham	4	8	12	3.64
Savio	3	6	9	2.73
Souzanela	3	6	9	2.73
Total	**110**	**220**	**330**	**100.00**

Figure 1 shows that 189 subjects surveyed out of 330 were female (57.27%) compared to 141 male subjects (42.73%). The male/female sex ratio in our sample was around 0.75.

The household size of the respondents ranged from 1 to 23 people with an average of 7.59 ± 3.65 people. The modal size was 7 people.

As for the treatment of drinking water, Table 2 shows that about half of the respondents were 50, 30% did not treat water before consumption, and the remainder 49.70% used water treatment of drinking water.

Table 3 shows that of those who claimed to treat drinking water, the majority used chemical methods in 98.17%; and the others boiling in 16.46% of cases. No respondent would use other means of water treatment.

Out of 330 respondents, 322% or 97.58% had a toilet against 8% or 2.42% who did not have one (Table 4).

Compared to the knowledge of hand washing times, Figure 2 shows that it was before eating that was cited by the majority of respondents, *i.e.* 315 out of 330 (95.45%); while before breastfeeding the child was recognized by only 22 respondents, *i.e.* 6.67%.

Table 2 shows that 306 respondents (92.73%) stated that they kept food in covered plates or pans, and 89% or 26.97% said they kept food in open plates or pans. No respondent cited another method of preserving food outside of these two (Table 5).

Table 3 shows that the risk factors for the cholera outbreak that were found to be statistically significant are: poor food preservation (AOR = 3.32, 95%

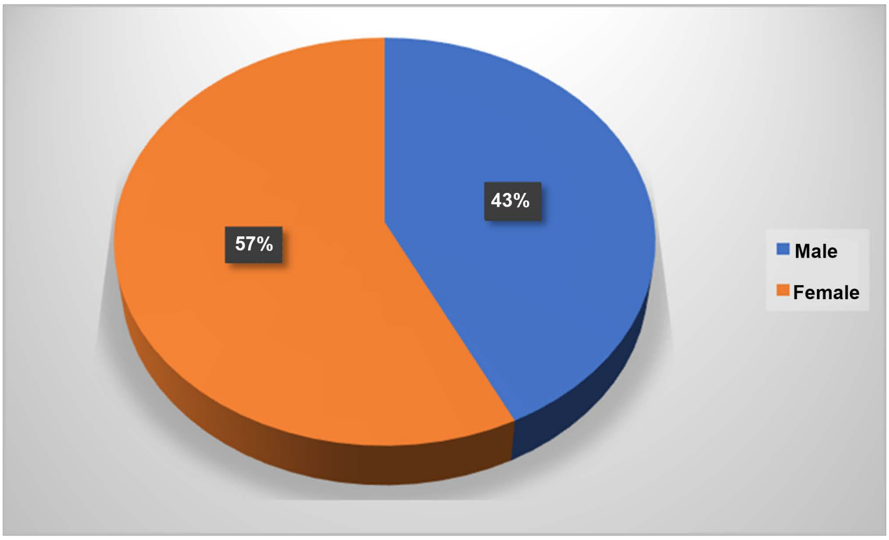

Figure 1. Distribution of respondents by gender.

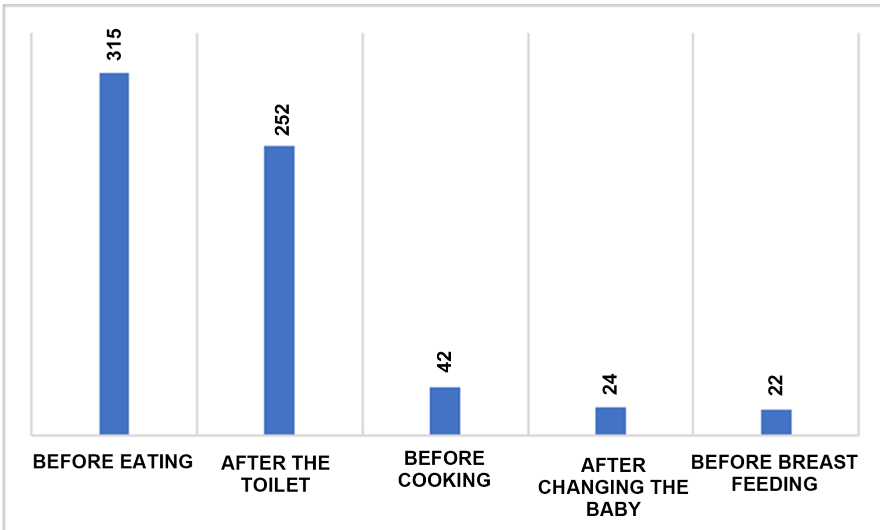

Figure 2. Distribution of respondents according to the knowledge of hand washing times.

Table 2. Distribution of respondents according to the treatment of drinking water.

Water treatment	Frequency	Percentage
No	166	50.30
Yes	164	49.70
Total	**330**	**100.00**

CI [1.85 - 5.96], and p value = 0.0001), contact with a cholera patient (AOR = 2.88, 95% CI [1.65 - 5.01], and p value = 0.0002) and the stay outside Lubumbashi (AOR = 4.18, its 95% CI [1.83 - 9.55], and p value = 0.0007). On the other hand, the availability of household washbasins (AOR = 0.35, its 95% CI [0.15 - 0.83]), and warming the rest of the foods before consumption (AOR = 0), 43, its 95% CI [0.25 - 0.76], and p value = 0.0033) were protective factors (Table 6).

Table 3. Distribution of respondents according to the means used to treat drinking water.

Means of water treatment practiced	Frequency	Percentage
Chemical methods	161	98.17
Boiling	27	16.46
Sedimentation	0	0.00
Solar rays	0	0.00
Filtration	0	0.00

Table 4. Distribution of respondents according to the availability of a toilet in the household.

Toilet	Frequency	Percentage
Yes	322	97.58
No	8	2.42
Total	**330**	**100.00**

Table 5. Distribution of respondents according to their methods of conservation of food.

Food preservation	Frequency	Percentage
Plates or covered pans	306	92.73
Uncovered plates or pans	89	26.97

However, monthly income and water treatment were no longer significantly associated with cholera.

4. Discussion

Our study aimed to determine the risk factors for the cholera epidemic in the Kampemba Health Zone to help reduce the morbidity and mortality associated with this disease. Our analyses focused on data from 330 surveyed subjects, including 110 cases and 220 controls.

This study found that the average age of patients was 26.38 ± 15.59 years and the age group of 16 - 30 years had the highest proportion, 34.55% of all cases. In a 2007 study in Lubumbashi [8], the mean age was 21.9 ± 16.5 years. Several studies conducted around the world have found various results. A study conducted in Buea in the health district of Cameroon found that the average age was 29.86 ± 14.51 years [5]. In an epidemic in the village of Haibatpur in West Bengal, India, the median age was 33 years [9]. For Gbary *et al.* in Benin, the average age was 23.72 years [10]. On the other hand, in East Akim, Ghana, the average age was 34 ± 18 years and the 20 - 29 age group was the most affected (30.1%). Previous studies have shown that cholera can affect people of all ages [11] [12].

These findings indicate that the age of those susceptible to cholera varies from one epidemic to another and from one country to another

Table 6. Cholera risk factors after logistic regression (pragmatic model of adjustment).

Variables	AOR	I.C. 95%	Coefficient	S. E.	Z-Statistic	P-value
Monthly income	0.998	[0.994 - 1.001]	−0.0025	0.0018	−1.4213	0.1552
Water treatment (Yes/No)	0.59	[0.34 - 1.03]	−0.5285	0.2827	−1.8696	0.0615
Availability of washbasins (Yes/No)	0.35	[0.15 - 0.83]	−1.0469	0.4376	−2.3921	0.0168
Food preservation (Bad/Good)	3.32	[1.85 - 5.96]	1.1999	0.2988	4.0156	0.0001
Consumption of raw fruits or tubers in the last 3 days (Yes/No)	0.91	[0.53-1.56]	−0.0981	0.2763	−0.3550	0.7226
Reheating the rest of the foods before consumption (Yes/No)	0.43	[0.25 - 0.76]	−0.8389	0.2853	−2.9407	0.0033
Contact with a Cholera patient in the last 5 days (Yes/No)	2.88	[1.65 - 5.01]	1.0572	0.2828	3.7385	0.0002
Stay outside Lubumbashi in the last 5 days (Yes/No)	4.18	[1.83 - 9.55]	1.4310	0.4209	3.3997	0.0007
CONSTANT	*	*	−0.4711	0.3751	−1.2560	0.2091

As for gender, our study found that the female sex was more affected than the male sex (57.27% and 42.73%) with a male/female sex ratio of around 0.75. These results are similar to those of Nsagha *et al.* in Buea, Cameroon (57.8% for females and 42.2% for males) [5] and O'connor *et al.* in Haiti is 58% [13]. Some authors have found contrary results [8] [14] [15] [16] [17]. Others have found a sex ratio of 1 [10] [12]. This high vulnerability of the female sex may be related to their traditional roles of food preparation, water collection and treatment, construction and cleaning of sanitation and domestic hygiene, the habits of the environment that are women who, in most cases, keep the patients at the center of the treatment of cholera and expose themselves a little more than men to contract the disease in a context where the preventive measures are insufficient and/or ignored by the population.

Regarding the distribution by residence, it emerges that Kabanga health area over half of cases or 61.82%. In his study on the endemic factors of cholera in Douala, Guevart *et al.* described the Bepanda area which was a starting point for cholera outbreaks as a slum area established on a garbage dump in an area fueled by drainage ditches carrying faecal pollution from nearby ascending areas. It is a mass sector overloaded with uncontrolled urbanization produced by the influx of poor newcomers who live there without adequate access to clean water or basic sanitation. And that, the most affected corners are those not urbanized, swampy with polluted dumps [6]. The same observation had stemmed from the study of Otshudiema *et al.* Increasing popular neighborhoods south of Bukavu city characterized by a conglomerate, derisory access to safe drinking water, and inadequate latrines, which were likely to have played a major role in the cholera epidemic from 2006 to 2007 [18]. The same is true of the Bocozel sector in Haiti where most of the population lives in extreme poverty, with toilets shared between 50 people and defecation often outdoors [19]. This is the image of the health zone Kabanga especially in its Bongonga district, which is a real suburb, marshy, very dense, sometimes with defecation in the open air, polluted wells, and improper toilets. This health area is hampered by serious problems of hygiene and public health as well as a lack of drinking water.

The majority of the population living in this health area uses water from unimproved wells for drinking. It is the very epicenter of this latest epidemic.

Regarding the treatment of water, half of the subjects surveyed (50.30%) use the treatment of drinking water while the other half do not treat it. The similar result was found in Chad where 55% of the respondents on behavioral determinants of water treatment in cholera prevention did not use water treatment [20]. These results, although still weak, show a certain improvement of the situation compared to those found in Lubumbashi in 2008 by Tubaya or 12.7% [8]. Among the reasons for non-treatment of drinking water, Msyalonza in Chikwawa and the city of Blantyre in Malawi, mentioned the bad taste and odors caused by the water treatment product [15]. Contrary to the result of Tubaya, this improvement could be related to the fact that during the epidemic the chlorine is distributed to households by the partners and could only be used in a context of fear of epidemic. Subsequent studies should be conducted outside any outbreak to assess the determinants of water treatment in this health zone.

In the bivariate analysis, the following factors were identified as significantly associated with cholera: low monthly income (Mann-Whitney/wilcoxon chi-square = 5.73 and p = 0.0167); treatment of drinking water (OR = 2.26, its 95% CI [1.41 - 3.62], and p value = 0.0006), non-availability of washbasins in the household (OR = 2.46, 95% CI [1.50 - 4.02], and p value = 0.0003), poor food preservation (OR = 4.60, 95% CI [2.75 - 7.69], and p value < 10-10), the non-reheating of food residues before consumption (OR = 2.65, its 95% CI [1.36 - 5.17]; value = 0.0037) and contact with a cholera patient in the 5 days preceding the disease (OR = 3.96, 95% CI [2.42 - 6.49], and p-value < 10-10). However, as with the study conducted in Papua, Guinea [21], Juba, Sudan [12], we found no significant association between sex and the occurrence of cholera; although more than half of the patients are female. Since transmission does not occur by point source, both sexes could be fairly exposed. On the other hand, Uthappa in India, in the village of Medipally, Colombara *et al.* in Bangladesh, and Izadi *et al.* in India found opposite results [22] [23] [24].

The level of study was not significantly associated with the disease; and between employment (occupation) and illness. These same results have been found elsewhere [12] [24]. Some authors have found that in children under 5 years, the risk of cholera increases with the low level of education of the mother in both rural and urban areas [23]. Although the majority of subjects surveyed were from the primary level and above, their distribution in both groups (patients and controls) was of equal proportions.

A significant association with drinking water quality was not demonstrated in this study (OR = 0.88, 95% CI [0.54 - 1.44], and p-value = 0.6161). More than half of the subjects surveyed (68.18%) did not have access to drinking water, including 69.09% among controls and 66.36% among patients. This would be within certain limits of this study with bacteriological analyzes of drinking water to provide evidence for the role of water in cholera transmission. However, some authors have shown that the poor quality of drinking water is associated with the increased risk of cholera [8] [23] [24] [25].

After multivariate analysis using logistic regression to identify risk factors for cholera taking into account the interactions of each other, the following results were obtained:

Regarding the non-selected factors, we note the monthly income which, during the bivariate analysis, showed that the monthly income was significantly lower in the cases than in the controls (chi-two of Mann-Whitney/wilcoxon = 5.73 and p = 0.0167). The regression showed that monthly income did not increase the risk of contracting cholera (AOR = 0.998, 95% CI: [0.994 - 1.001], p-value = 0.152). In bivariate analysis, the average monthly income for cases was 146.23 ± 78.96 USD. On the other hand among the witnesses, it is of the order of 170.53 ± 91.89 USD. These results corroborate with a study that was conducted in 2009 from data obtained from WHO reports and from the classification of the World Bank of countries engaged in their income. This study shows that low-income countries are more affected by cholera than those with medium or high incomes. This supports the phrase "cholera is a disease of poverty" [26]. A study conducted in Matlab, Banglandesh showed that the risk of cholera increased with low household income.

In addition, non-treatment of drinking water was identified as a factor that had twice the risk of cholera occurrence in bivariate analysis (OR = 2.26, 95% CI [1.41 - 3.62] and p value = 0.0006), is also considered not significant after multivariate analysis (AOR = 0.59, 95% CI: [0.34 - 1.03], p-value = 0, 0.615). Some authors had achieved the same results as those found during the bivariate analyzes. This is the case of TUBAYA, which found a nine-fold higher risk in subjects consuming untreated water (OR = 8.6, 95% CI: [4.58 - 16.4]) [8]. A study in Camarines Sur, Philippines, found that consumption of untreated chlorine water was about four times the risk of cholera (OR = 3.6, 95% CI: 1.6 - 8.5) [25]. In the same way, the other authors had found that the consumption of treated water constituted a protective factor [12] [13] [24].

As for the factors significantly associated with cholera that were retained, we note:

Poor food preservation (AOR = 3.32, 95% CI [1.85 - 5.96], and p-value = 0.0001); about one out of every two patients had poor food (in open plates or pots) against one out of six witnesses. This exposes food to flies in a polluted environment. Added to this is the poor quality of well water used by most households for washing utensils. Recent studies have shown that V. Cholerae can remain for more than 5 days in the digestive tract of houseflies and multiply there; which gives evidence in the role played by the latter in the transmission of the disease [27]. A study by Biswas in Nepal found that utensils were contaminated with pond water used for washing (OR = 7.31, 95% CI: 1.77 - 42.29) [9]. The same results were found in Buea, Cameroon, where the poor method of food preservation was significantly associated with the cholera epidemic (OR = 9.20, 95% CI: 3.67 - 23.08; p < 0.0001) [5].

Regarding contact with a cholera patient in the previous 5 days. This factor was considered significantly associated with cholera risk in both bivariate and multivariate analysis (AOR = 2.88, 95% CI [1.65 - 5.01], and p value = 0.0002). Indeed, more than half of the patients reported having been in contact with a cholera patient in the 5 days preceding the illness against 21.36% of the controls. The habits of the environment, which make the family members take care of the patient, rid him of these excretions from the house to the center of the treatment of cholera, a way to show him their love and compassion; in a context where almost half of the population is unaware of early signs and cholera prevention measures [28].

Many studies carried out and epidemics investigated throughout the world by some authors have resulted in the same results. This is the case of TUBAYA in Lubumbashi (OR = 93.43, 95% CI: [53.77 - 164.07] [8], Biswas *et al.*, in an epidemic in the village of Haibatpur, West Bengal, in India (OR = 3.41, 95% CI: [1.25 - 9.47]) [9], from Rosewell who found high risk among people who frequented a cholera-affected avenue in Papua in Guinea (AOR = 4.1, 95% CI 1.6 - 10.7) [29]. In Nigeria, the risk of cholera was 8.5 for those who had contact with a case of diarrhea at home or in the neighborhood in the last 7 days before onset of illness (OR = 8.5, 95% CI: 1.36 - 52.9) [30]. As in Matlab, Having a family member with diarrhea in the last seven days increased the risk of cholera hospitalization by 17% in children under 5 years of age (AOR = 1.17, 95% CI: 1.09 - 1.26) [22]. However, in the Eastern epidemic of Yakim Municipal in Ghana and in the province of Alborz in Iran, no significant association was found between contact with a person with diarrhea (OR = 1.11; 95% CI: 0.47 - 2.6). This difference would be due to the fact that the eastern epidemic of the Yakim municipality took place in a mining quarry whose common source of contamination was water; there were only a few cases per contact reported; while for Moradi *et al.*, there is limited evidence to prove the role of family contacts in the transmission of infection [16] [31].

Regarding the notion of travel, having stayed outside the city of Lubumbashi in the last 5 days before the onset of the disease had four times the risk of contracting cholera (AOR = 4.18; its 95% CI [1.83 - 9.55] and p value = 0.0007); nevertheless, during the bivariate analysis, this factor was not significant but nevertheless had a p < 0.20 which allowed us to integrate it into the multivariate analysis, the weight of its risk being masked by interactions with the other factors. This situation could be explained by the fact that the patients had stayed outside the city of Lubumbashi more than witnesses, *i.e.* 17.27% against 11.36%. Indeed, the city of Lubumbashi is surrounded by several other cities that are endemic and/or epidemic cholera, which are in intense trade facilitating the importation of epidemics of cholera. In addition, poor travel conditions do not take into account the basic principles of hygiene. Similar results were recorded during the investigation of an outbreak in Alborz Province, Iran, while taking into account the same 5-day delay (OR = 5.21, 95% CI: 2.21 - 9.72) [31]. According to Ujiga *et al.* in Juba, Sudan, the risk was 10-fold higher in subjects who traveled outside the village before the onset of the disease (OR = 10.14, 95% CI: 1.75 - 58.87) [12]. A cholera outbreak can very quickly be imported from one environment to another through different means of transport. Such is the case of the cholera epidemic in Haiti, imported from Nepal [32].

The availability of hand washing in households provides protection against the occurrence of cholera (AOR = 0.35, its 95% CI [0.15 - 0.83], and p-value = 0.0168). In other words, the subjects that result indicate that the witnesses had more washbasins than the patients. Bivariate analyzes had shown that the risk of contracting cholera was about twice as high for people without washbasins than for those who did (OR = 2.46, 95% CI [1.50 - 4.02] and p value = 0.0003). For UNICEF, the washbasin motivates and facilitates the practice of handwashing in the household, necessary for the prevention and control of cholera [33]. These results are consistent with those of Biswas in Haibatpur, India, who found that handwashing was a protective factor against cholera (OR = 0.08, 95% CI: 0.02 - 0.31) [17], and from Uthappa to Medipally village in India (OR = 0.23, 95% CI: 0.11 - 0.44) [24]. Rosewell meanwhile, the availability of handwashing soap was protective in Papua, Guinea (AOR = 0.41, 95% CI: 0.19 - 0.87), and those with access to running water in the house (handwash) was twice as likely to signal the availability of soap for handwashing [21]. Good care coupled with hand washing was enough to reduce the incidence of cholera in two health sectors in Benin [34]. On the other hand, for TUBAYA, the absence of washbasins in the household exposed about 12 times more the risk of cholera (OR = 11.74, 95% CI [6.83 - 20.29] [8].

Warming up the rest of the foods before they were consumed was a protective factor against the occurrence of cholera (AOR = 0.43, 95% CI [0.25 - 0.76], and p-value = 0.0033). Indeed more than three quarters of the witnesses warmed the food before its consumption against about half of the patients. In other words, people who did not warm up food leftovers prior to their consumption had an increased risk of contracting cholera. A study in Katanga reported that only 61% of those surveyed knew that cholera could be transmitted through food [28]. Of all food-borne illnesses reported at Ridge Hospital in Accra, Ghana, from 2009 to 2013, cholera comes out on top at 83.9% [35]. The results of this study are confirmed by those of Moradi *et al.* in Iran, who report that the consumption of leftover foods left out of the refrigerator and unheated has three times the risk of cholera transmission (OR = 3.05; 95%: 1.72 - 5.41) [31]; and Izadi *et al.* (OR = 4.03, 95% CI: 1.23 - 13.18) [23].

5. Conclusions

Cholera, a very old disease, remains as a public health problem in the Kampemba Health Zone. Our study set itself the goal of identifying the risk factors for the cholera epidemic in order to contribute to the reduction of morbidity and mortality related to this disease in this Health Zone.

At the end of this study, the following results were observed with regard to socio-demographic and economic characteristics: the average age was 26.38 ± 15.59 years ranging from 5 to 70 years, the female sex was the most affected *i.e.* 57.27%, 61.82% of the subjects came from of the Kabanga health area and about half of the subjects were single (50.30%). The majority had a low standard of living (64.85%) and were unemployed (60.00%) although they had a secondary level of education and more in 94.55% of cases.

As for hygiene conditions, 31.82% had access to drinking water, only one out of two subjects resorted to the treatment of water and that by chemical methods (98.17%). A good proportion of respondents had a toilet (97.58%) of which 36.96% were hygienic. Handwashing devices were available in only 16.97% of households and 27.27% did not retain food.

After multivariate analysis, the following factors were significantly associated with cholera: poor food preservation (AOR = 3.32, 95% CI [1.85 - 5.96]), contact with a patient with cholera in the 5 days preceding the disease (AOR = 2.88, its 95% CI [1.65 - 5.01]) and the stay outside the city of Lubumbashi in the last 5 days preceding the disease (AOR = 4.18, 95% CI [1.83 - 9.55]). In addition, the availability of household washbasins (AOR = 0.35, its 95% CI [0.15 - 0.83]), and warming the food remains before consumption (AOR = 0.43, its 95% CI [0.25 - 0.76]) were protective factors.

However, this study did not demonstrate a significant association between the quality of drinking water and the occurrence of cholera. The usual health communication channels were used (radio broadcasts, posters...) without the cholera being eradicated; however, some local channels such as churches, mosques, trade union movement, political parties and community health workers (as an organ community participation) can be privileged.

References

[1] WHO (2015) Choléra, Aide-mémoire No. 107.

[2] OMS (2016) Pandémies et conséquences du choléra. WHO, Geneva.

[3] Symington, V. (2011) Cholera: Death by Diarrhoea. The Society for General Microbiology.

[4] Gaüzère, B.-A. and Aubry, P. (2012) Les épidémies de choléra à La Réunion au XIXème siècle. *Medecine Et Sante Tropicales*, **22**, 131-136.

[5] Nsagha, D.S., Atashili, J., Fon, P.N., Tanue, E.A., Ayima, C.W. and Kibu, O.D. (2015) Assessing the Risk Factors of Cholera Epidemic in the Buea Health District of Cameroon. *BMC Public Health*, **15**, 1128. https://doi.org/10.1186/s12889-015-2485-8

[6] Guévart, E., *et al.* (2006) Factors Contributing to Endemic Cholera in Douala, Cameroon. *Médecinetropicale*: *Revue du Corps deSanté Colonia*, **66**, 283-291.

[7] MSP/RDC (2013) Plan Stratégique Multisectoriel d'Elimination du Choléra en République Démocratique du Congo 2013-2017. ReliefWeb.

[8] Tubaya, D. (2008) Memoire Online-Etude des facteurs de risque du choléra. Me-

moire Online.

[9] Colombara, D.V., Faruque, A.S.G., Cowgill, K.D. and Mayer, J.D. (2014) Risk Factors for Diarrhea Hospitalization in Bangladesh, 2000-2008: A Case-Case Study of Cholera and Shigellosis. *BMC Infectious Diseases*, **14**, 440. https://doi.org/10.1186/1471-2334-14-440

[10] Gbary, A.R., Sossou, R.A., Dossou, J.-P., Mongbo, V. and Massougbodji, A. (2011) Les déterminants de la faible létalité de l'épidémie de choléra dans le Littoral au Bénin en 2008. *Sante Publique* (*Paris*), **23**, 345-358. https://doi.org/10.3917/spub.115.0345

[11] Ernst, S., Weinrobe, C., Bien-Aime, C. and Rawson, I. (2011) Cholera Management and Prevention at Hôpital Albert Schweitzer, Haiti. *Emerging Infectious Diseases*, **17**, 2155-2157. https://doi.org/10.3201/eid17110.11815

[12] Ujjiga, T.T.A., *et al.* (2015) Risk Factors for Sustained Cholera Transmission, Juba County, South Sudan, 2014. *Emerging Infectious Diseases*, **21**, 1849-1852. https://doi.org/10.3201/eid2110.142051

[13] Childs, L., *et al.* (2016) Evaluation of Knowledge and Practices Regarding Cholera, Water Treatment, Hygiene, and Sanitation before and after an Oral Cholera Vaccination Campaign—Haiti, 2013-2014. *The American Journal of Tropical Medicine and Hygiene*, **95**, 1305-1313. https://doi.org/10.4269/ajtmh.16-0555

[14] CDC (2009) Cholera Outbreak—Southern Sudan, 2007.

[15] Msyamboza, K.P., Kagoli, M., M'bang'ombe, M., Chipeta, S. and Masuku, H.D. (2014) Cholera Outbreaks in Malawi in 1998-2012: Social and Cultural Challenges in Prevention and Control. *The Journal of Infection in Developing Countries*, **8**, 720-726. https://doi.org/10.3855/jidc.3506

[16] Opare, J., *et al.* (2012) Outbreak of Cholera in the East Akim Municipality of Ghana Following Unhygienic Practices by Small-Scale Gold Miners, November 2010. *Ghana Medical Journal*, **46**, 116-123.

[17] Biswas, D.K., *et al.* (2014) Contaminated Pond Water Favors Cholera Outbreak at Haibatpur Village, Purba Medinipur District, West Bengal, India, Contaminated Pond Water Favors Cholera Outbreak at Haibatpur Village, Purba Medinipur District, West Bengal, India. *Journal of Tropical Medicine*, **2014**, e764530.

[18] Otshudiema, J., Shamavu, R., Masimango, M., Burhole, M., Kabongo, M. and Kokolomami, J. (2009) Epidémie de choléra à Bukavu (R.D.Congo) de 2006-2007: Données épidémiologiques et de contrôle.

[19] Koski-Karell, V., *et al.* (2016) Haiti's Progress in Achieving Its 10-Year Plan to Eliminate Cholera: Hidden Sickness Cannot Be Cured. *Risk Management and Healthcare Policy*, **9**, 87-100.

[20] Lilje, J., Kessely, H. and Mosler, H.-J. (2015) Factors Determining Water Treatment Behavior for the Prevention of Cholera in Chad. *The American Journal of Tropical Medicine and Hygiene*, **93**, 57-65. https://doi.org/10.4269/ajtmh.14-0613

[21] Rosewell, A., Addy, B., Komnapi, L., Makanda, F., Ropa, B., Posanai, E., Dutta, S., Mola, G., Man, W.Y., Zwi, A. and MacIntyre, C.R. (2012) Cholera Risk Factors, Papua New Guinea, 2010. *BMC Infectious Diseases*, **12**, 287.

[22] Colombara, D.V., Cowgill, K.D. and Faruque, A.S.G. (2013) Risk Factors for Severe Cholera among Children under Five in Rural and Urban Bangladesh, 2000-2008: A Hospital-Based Surveillance Study. *PLoS ONE*, **8**, e54395. https://doi.org/10.1371/journal.pone.0054395

[23] Izadi, S., Shakeri, H., Roham, P. and Sheikhzadeh, K. (2006) Cholera Outbreak in

Southeast of Iran: Routes of Transmission in the Situation of Good Primary Health Care Services and Poor Individual Hygienic Practices. *Japanese Journal of Infectious Diseases*, **59**, 174-178.

[24] Uthappa, C.K., *et al.* (2015) An Outbreak of Cholera in Medipally Village, Andhra Pradesh, India, 2013. *Journal of Health*, *Population and Nutrition*, **33**, 7. https://doi.org/10.1186/s41043-015-0021-1

[25] De Guzman, A., de los Reyes, V.C., Sucaldito, M.N. and Tayag, E. (2015) Availability of Safe Drinking-Water: The Answer to Cholera Outbreak? Nabua, Camarines Sur, Philippines, 2012. *Western Pacific Surveillance and Response Journal*, **6**, 1-5.

[26] Talavera, A. and Perez, E.M. (2009) Is Cholera Disease Associated with Poverty? *The Journal of Infection in Developing Countries*, **3**, 408-411. https://doi.org/10.3855/jidc.410

[27] El-Bassiony, G.M., Luizzi, V., Nguyen, D., Stoffolano, J.G. and Purdy, A.E. (2016) *Vibrio Cholerae* Laboratory Infection of the Adult House Fly *Musca domestica*. *Medical and Veterinary Entomology*, **30**, 392-402. https://doi.org/10.1111/mve.12183

[28] Merten, S., *et al.* (2013) Local Perceptions of Cholera and Anticipated Vaccine Acceptance in Katanga Province, Democratic Republic of Congo. *BMC Public Health*, **13**, 12. https://doi.org/10.1186/1471-2458-13-60

[29] Rosewell, A., *et al.* (2012) Cholera Risk Factors, Papua New Guinea, 2010. *BMC Infectious Diseases*, **12**, 287. https://doi.org/10.1186/1471-2334-12-287

[30] Fatiregun, A.A., Ajayi, I.O. and Isere, E.E. (2013) Cholera Outbreak in a Southwest Community of Nigeria: Investigation of Risk Factors and Evaluation of a District Surveillance System. *West African Journal of Medicine*, **32**, 173-179.

[31] Moradi, G., Rasouli, M.A., Mohammadi, P., Elahi, E. and Barati, H. (2016) A Cholera Outbreak Investigation in Alborz Province, Iran: Matched Case-Control Study. *Epidemiology and Health*, **38**, e2016018. https://doi.org/10.4178/epih.e2016018

[32] Frerichs, R.R., Keim, P.S., Barrais, R. and Piarroux, R. (2012) Nepalese Origin of Cholera Epidemic in Haiti. *Clinical Microbiology and Infection*, **18**, E158-E163. https://doi.org/10.1111/j.1469-0691.2012.03841.x

[33] UNICEF (2013) Guide pratique de lutte contre le choléra.

[34] Koto, T., Ahoyo, A., Akpovij, J., Mensah, M. and Binazon, O. (2013) P152: Reduction of the Prevalence of Cholera by Observation of Hand Hygiene. *Antimicrobial Resistance & Infection Control*, **2**, 1. https://doi.org/10.1186/2047-2994-2-S1-P152

[35] Osei-Tutu, B. and Anto, F. (2016) Trends of Reported Foodborne Diseases at the Ridge Hospital, Accra, Ghana: A Retrospective Review of Routine Data from 2009-2013. *BMC Infectious Diseases*, **16**, 139. https://doi.org/10.1186/s12879-016-1472-8