(RESEARCH ARTICLE)

Mortality risk factors for tuberculosis patients under treatment in the Kenya health zone, Lubumbashi, DRC

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Abstract

Context and objective of the study: Tuberculosis remains a major public health problem in the world and in the DRC in particular. Tuberculosis lethality is an important indicator of its control. The objectives of this study were to determine the lethality rate of tuberculosis and to identify the risk factors for death in tuberculosis patients. under treatment in Kenya Health Zone.

Methods: This is a case-control study from January 1, 2014 to December 31, 2016. The characteristics of patients aged at least 15 years and who died of tuberculosis during treatment were compared to those who had progressed well. We have exhaustively collected 59 deceased (Cases). The 177 controls were selected according to certain criteria of similarity among tuberculosis patients over 14 years of age who had progressed well. Chi-square tests, Fisher Exact, Wilcoxon, OR and its 95% CI as well as logistic regression were used to analyze our results. For all statistical tests, the significance level was set at 5%.

Results: From 2014 to 2016, the rate of overall lethality was 3.34% with a decreasing trend. Ihe socio-demographic and anthropometric characteristics: Follow-up care at CST Kalebuka [ORa1.33 (<0.001 - >1000.00), p=0.99],weight loss between the 1st and 2nd phase of treatment [ORa0.94, CI (0.018 - 48.48), p=0.97];clinical and therapeutic characteristics: The concept of counting [ORa1.68, CI (<0.001 - >1000.00), p=0.98],the therapeutic diet2SRHZE/RHZE/5RHE » [ORa>1000.00, CI (<0.001 - >1000.00), p=0.59], irregular compliance with treatment [ORa6.54, CI (<0.001 - >1000.00), p=0.95] did not were not significantly associated with tuberculosis mortality after logistic regression, and therefore constituted confounding factors

Conclusion: The decrease in lethality observed during the 3 years reflects a good evolution of the fight. Aprospective study investigating tuberculosis mortality taking into account all possible determinants and aspects will make it possible to identify the factors significantly linked to death and develop additional treatment and follow-up strategiesto further reduce lethality due to tuberculosis.

Keywords: Tuberculosis; Mortality; Risk factors; Lubumbashi; DR Congo

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1. Introduction

Tuberculosis remains a global scourge. However, from 1952, with the appearance of effective chemotherapy, the decline of tuberculosis was real. Since 1986, there has been a resurgence of Tuberculosis in the world and two factors were at the root of the resurgence: HIV/AIDS infection and resistance to anti-tuberculosis drugs(1) .

A major cause of ill health, tuberculosis is one of the top 10 causes of death worldwide and the leading cause of death from an infectious agent (before HIV/AIDS)(2). Still alarming figures are reported: 10 million people contracted this disease worldwide in 2019, a number that has been decreasing very slowly in recent years.(2) .

In 2019, the number of TB deaths was estimated at 1.2 million among HIV-negative people (down from 1.7 million deaths in 2000), plus an additional 208,000 deaths among HIV-positive people (down from 678,000 deaths in 2000(2).Over 95% of TB deaths occur in low- and middle-income countries.In 2015, the TB case fatality rate varied from less than 5% in some countries to more than 20% in most countries in the African Region(4).

Since 2000, TB treatment has averted more than 60 million deaths, although access is still far from the goal of universal health coverage (UHC) and millions of patients remain undiagnosed and untreated(2).

The DRC is ranked among the 22 countries most affected by tuberculosis in the world. Bearing 80% of the global tuberculosis burden, the country ranks second in Africa(5). With a population of 86 million inhabitants, the DRC notified in 2020 a total of 278,000 cases of tuberculosis, including 30,000 among HIV positive. A record figure that could be even higher given that the covid-19 pandemic vampirizes the resources needed to fight this disease. The number of deaths was 43,000 among HIV negative and 9600 HIV positive(6,7).

In 2014, the South Katanga PNLT recorded a total 7,358 new cases of tuberculosis, all forms combined, for a population of 4,689,564 inhabitants, i.e. an incidence of0.15%. The death rate among microcopy-positive tuberculosis patients was 5.7% for the 2013 cohort. In 2010, this death rate was estimated at 5% in the same group.(8,9).

In the Lubumbashi Health Zone (DRC),Ngama noteda prevalence of 530 cases of tuberculosis per 100,000 inhabitants and a mortality rate of 8.75%(10). This study, however, did not investigate factors related to this high mortality.

To reduce the number of deaths from tuberculosis in a region, it is important to identify the risk factors for mortality in order to act on these factors. Little research has addressed this subject in Lubumbashi. So to answer this concern, we chose to conduct this study.

2. Material and methods

2.1. Study environment

 Our study was conducted in the health zone of Kenya, which is one of 11 health zones in the city of Lubumbashi in the Provincial Health Division of Haut-Katanga in the Democratic Republic of Congo. It is an urban-rural Health Zone located in the Administrative Commune of Kenya.

2.2. Type of study

This is a case-control study among tuberculosis patients under treatment in the Kenya health zone of 1er January 2014 to December 31, 2016. The characteristics of patients who died of tuberculosis were compared to those who had progressed well.

2.3. Study population

The study population consists of tuberculosis patients living in Lubumbashi and treated in the Kenya health zone from January 1, 2014 to December 31, 2016, among which cases and controls were selected.

The cases were tuberculosis patients aged at least 15 years who died during treatment, while the controls were tuberculosis patients aged at least 15 years who survived the end of treatment. Controls with "treatment failure" or "lost to follow-up" status were excluded from the study.

2.4. Sampling

Sampling was exhaustive for cases. The 1 case for 3 controls approach was used. 59 cases were selected against 177 controls in the same registers as the cases based on the following criteria: To have as outcome of the treatment the mention "Cured" for TPM+, or the mention "treatment completed" for TPM- and PET; be registered in the register of the same year as the case and also in the period closest to it; come from the same municipality of residence as the case; belong to the same age group as the case (15-24 years, 25-34 years, 35-44 years, 45-55 years, 56-64 years, and ≥65 years).

2.5. Data collection, management and analysis

We collected patient information using a template from treatment registers, laboratory registers, and tuberculosis patient follow-up sheets. The data was encoded using Microsoft Excel 2016 software. The processing and analysis of our data were carried out with Epi Info 7.2.0.1., R version 3.4.1., SAS version 9.3 (SAS Institute Inc. Cary, NC, USA). Zotéro 5.0.96 allowed us to manage bibliographic references.

For the quantitative variables, we calculated the position and dispersion parameters, in particular the mean, the median, the standard deviation, and the extreme values.

Qualitative variables were presented as frequency.

Differences in proportions were analyzed using the Chi-square test and the Fisher Exact test. The test of Wilcoxon was used to compare the medians of the two groups. The odds ratio (odds ratio) and its 95% confidence interval were used to assess the magnitude of the association between the dependent variables and the independent variables. For all statistical tests, the significance level was set at 5%.

2.6. Ethical considerations

Note that this is a documentary review. Thus, for reasons of confidentiality, no identity of our patients has been revealed and the results of this work will only be used for scientific purposes. The study had the authorization of the chief medical officer of the Kenya health zone and the medical director of the hospital being the information managers of the health institutions

For patients under the age of 18, obtaining permission from parents or guardians.

The study received authorization from the Kisangani Research Ethics Committee of the University of Kisangani under number CER/002/GEAK/2013.

The patients gave their free and informed consent to participate in the study and the guidelines set out in the Declaration of Helsinki were followed.

3. Results

3.1. Evolution of lethality from 2014 to 2016

During the period from 1erJanuary 2014 to 31 December 2016, Kenya Health Zone recorded a case fatality rate of 3.34%. From 2014 to 2016 the lethality evolved in a decreasing way, 3.78% in 2014, 3.20% in 2015 and 3.09% in 2016.

3.2. Sociodemographic and anthropometric characteristics

Among the deceased, the median age is 33 years, the minimum age 16 years and the maximum age 72 years.

In the group of survivors, the median age is 34, the minimum is 15 and the maximum is 80. There are no statistically significant differences (Wilcoxon test, p=0.77) (Table II).

Gender has no relationship with the occurrence of death during anti-tuberculosis treatment (Chi-square test, p=0.53) although male subjects are apparently more vulnerable than female subjects during tuberculosis treatment (26.32 versus 22.62%) (Table I).

During their evolution the deceased lost weight. They showed a median loss of one kg between the first and second phase of treatment. This group of patients had a minimum difference of -7Kg and a maximum difference of 4Kg. The survivors, on the other hand, showed a weight gain. They had a median weight of +3 kg between the two treatment phases. This group showed a minimum difference of -9 Kg and a maximum difference of 16 Kg. There is therefore a significant difference between the dead and the living with regard to the evolution of weight (Wilcoxon test, p<0.0001) (Figure 1).

We observed a significant link between being followed in a treatment center and tuberculosis mortality (Chi-square test, p=0.02). 45.00% of patients followed at the CST Kalebuka died during treatment compared to 21.35% at HGR Kenya CSDT. Mortality is 3 times higher in patients followed at CST Kalebuka compared to those followed at HGR KENYA with a statistically significant difference [OR: 3.01; CI (1.17-7.76)] (Table 1).

No statistically significant association between occupation and death of tuberculosis patients (test of Chi-square, p=0.79) (Table 1).

3.3. Vaccination and therapeutic history

There is no link between BCG vaccination and the death of tuberculosis patients undergoing treatment (Chi-square test, p=0.09). We also see that unvaccinated subjects die more than vaccinated subjects, ie 30.61% against 21.01%. The risk of death is therefore 1.66 times in the unvaccinated compared to the vaccinated. [OR 1.66, CI (0.92-3.00)] (Table 3).

The mortality of patients under anti-tuberculosis treatment is significantly associated with the notion of tuberculosis count (Fisher Exact, p=0.01). 52.63% of patients who reported a case of tuberculosis in their environment died during treatment against 22.58% who did not report a case of tuberculosis in their environment. The concept of tuberculosis counting exposes 3.81 times to death than the absence of counting with a significant difference [OR 3.81 (1.47-9.90)] (Table 3).

There is a significant link between the history of antituberculosis treatment and mortality (Chi-square, $p<10-4$). 62.50% of patients who had been treated in the past died while only 19.12% died in the group of patients with no history of treatment antituberculosis. The risk of death is therefore 7.05 times higher in patients who have been treated in the past than in those who have never been treated [OR: 7.05; IC (3.18-15.63)] (Table 3).

The type of treatment history is statistically associated with mortality in tuberculosis patients undergoing treatment (Fisher exact, p= 6x10-07). The odds are 11.28 times higher for patients on "retreat" after treatment failure than for "new cases" [OR: 11.28; CI (2.86-44.49)] (Table 3).

3.4. Clinical and paraclinical characteristics

There is no statistically proven association between mortality and the type of tuberculosis (chi-square, p=0.47). 26.09% of patients with pulmonary tuberculosis died compared to 21.15% of those with extra pulmonary tuberculosis (Table 4).

We did not find a statistically significant association between site of extra pulmonary tuberculosis and death during tuberculosis treatment (Fisher exact, p=0.77). The analysis showed 33.33% death among patients with abdominal tuberculosis, 33.33% death in the group of patients with miliary tuberculosis and 20% death among pleural-tuberculose (Table 4).

No relationship between microscopy results and mortality of TB patients under treatment (Fisher exact, p=1.00). 26.67% of patients with smear-negative tuberculosis died compared to 26.04% of tuberculosis patients with positive microscopy (Table 4).

The number of bacteria found after staining of Zhiel-Nielsen has no influence on the death of patients under treatment for tuberculosis (Fisher exact, p=0.07) (Table IV).

During anti-TB treatment, HIV-positive patients seem to die slightly more than HIV-negative patients (36.00% versus 23.70%). However, the difference observed between the two groups is not statistically significant [OR 1.81; CI (0.75-4.35)]. There is therefore no association between positive HIV serology and the occurrence of death during antituberculosis treatment (Chi-square, p=0.18) (Table 4).

3.5. Therapeutic aspects

There is an association between the duration of treatment and the occurrence of death (Fisher Exact, p=2x10-16). It is during the first two months that more deaths occur (100%) followed by the period ranging from 3 to 6 months with 18.00% of deaths. No deaths were recorded beyond 6 months. Patients are 23 times more likely to die within 1 dayat 2 months compared to the interval beyond 9 months without significant statistical difference [OR: 23, CI (0.75-702.63)] (Table 5).

The median duration of treatment is 3 months in deceased patients. In this group, the minimum duration of treatment is 1 month and the maximum duration is 5 months. In survivors the median duration of treatment is 6 months. The minimum duration of treatment in this control group is 6 months and the maximum duration is 12 months. When comparing the two groups, we find that there is a statistically significant difference in raw treatment time (**Wilcoxon test,**p<0.0001) (Table 6).

Treatment compliance is associated with tuberculosis mortality (Fisher exact, p=<10-4). 90% of patients with non-regular compliance died during treatment while only 22.12% of patients with regular compliance died during treatment. The risk of death is 31.68 times higher in tuberculosis patients with irregular compliance than in those with regular compliance. This difference between the two groups is statistically significant [OR: 31.68; IC (3.91-256.07)] (Table 5).

We did not find a link between taking ARVs and mortality in patients on tuberculosis treatment (Fisher exact, p=0.60). 50% of HIV-positive patients not receiving ARVs died while only 33.33% of the group of patients receiving ARVs dieddice (Table V). 60% of tuberculosis patients under HIV care according to option A died and 20% under a plan of care according to option B died. (Fisher exact, p=0.09) (Table 5).

It emerged 38.10% of deaths among seropositive tuberculosis patients under cotrimoxazole against 33.33% of patients not subjected to cotrimoxazole (Fisher exact, p=1.00) (Table 5).

Resistance to anti-tuberculosis drugs has an influence on the mortality of patients under treatment for tuberculosis (Fisher exact, p=0.004). All our respondents resistant at least to Rifampicin and Izoniazid died during treatment compared to 23.71% of non-resistant patients. The difference between the two groups is statistically significant [OR: 0.08 (0.01-0.71)] (Table 5).

There is an association between treatment category and death during anti-tuberculosis treatment (Fisher Exact, p=6x10-07). 100% of patients with treatment resistance and 57.14% of retreatment cases died compared to only 19.12% of new patients. Resistance cases die 16.92 times more than new patients with a significant statistical difference [OR: 16.92; CI (1.84-155.65)] (Table 5).

Treatment regimen is related to TB mortality (Fisher exact, p=9x10-7). Patients subject to the "4 Km-Mfx-Pto-H-Cfz-EZ/5 Mfx-Cfz-EZ" are the most vulnerable during treatment with 100% mortality, and are 12 times more likely to die during treatment than patients on the "2RHZE" regimen /10RH". However, this observed difference is not statistically significant [OR: 12.00; CI (0.51-280.11)] (Table 5).

3.6. Multivariate analysis by logistic regression

The multivariate analysis (Table 7) showed us that all the variables taken into account in our study are confounding factors. None was retained as being significantly associated with the mortality of patients on therapy tuberculosis treatment in the Kenya health zone.

4. Discussion

The evolution of lethality is an important indicator in the fight against tuberculosis. From 2014 to 2016 the lethality evolved in a decreasing way, 3.78% in 2014, 3.20% in 2015 and 3.09% in 2016, achieving an average of 3.34%. This low rate as well as this regression of lethality are due to the improvement of care and treatment compliance. If this decline continues, Kenya Health Zone will soon reach the national vision of 0 TB-related deaths(11). In Kenya, Van't Hoog and colleagues (2012) also found a decline in tuberculosis-related mortality between 2006 and 2008(12). Heunis and collaborators (2017) found in their study carried out in a province of South Africa that case fatality increased from 15.1% in 2003 to 17.8% in 2009, before declining to 15.4% in 2012. Low and collaborators (2009), in a retrospective cohort study conducted in Singapore and involving 7433 tuberculosis patients from 2000 to 2006, found a case fatality rate of 2.70%(13), which is also low, as in our study. Shimazaki and collaborators (2013) during a cross-sectional study

carried out in 2009 in the city of Manila in the Philippines, found a case fatality rate of 37.50%(14). In this study, the authors justified these high death rates by the poor nutritional conditions of their patients. A study conducted in 1972 by the "National Tuberculosis Institute" in Bangalore, India for 3 years resulted in a case fatality rate of 18.94%.(15). This rate is also high. We believe that at that time there were no effective control strategies. With the DOT strategy of 1996, Stop Tuberculosis of 1999, the MDGs, currently the SDGs, there are considerable advances in the fight. Kattan and collaborators (2012) found in a study conducted in connecticut between 2007 and 2009, a lethality of 7%(16). This rate is slightly higher than that found in our study. We therefore see that the lethality varies from one region to another according to the realities linked to each environment and according to the study period.

Our study revealed during the analysis bivariate that sex has no link with mortality although male subjects are apparently more vulnerable than female subjects with respectively 26.32% versus 22.62% of deaths (Table N°, chi-square test, p= 0.53). This would be due to the fact that men and women live almost in the same conditions and are also treated under the same conditions in the Kenya Health Zone. Zerbini and collaborators (2017) found that in bivariate analyzes sex was associated with tuberculosis mortality and that male subjects were more at risk of death than female subjects [1.7, CI (1.1-2.5), p: 0.009]. Nevertheless, after multivariate analysis, they realized that gender was only a confounding factor [OR: 11.05, CI (0.79-154.40), p: 0.07)](17). Shimazak and collaborator (2013) also found after multivariate analysis that there was no significant link between sex and mortality although the male sex was apparently more exposed to death compared to the female sex [Adjusted OR 0.77; CI (0.43–1.37)](14).Low and Collaborators (2009), for their part, in a study conducted in Singapore on7433 tuberculous found after multivariate analysis that sex was a risk factor for tuberculosis and that male subjects were more exposed than female subjects [adjusted RR 1.9, CI (1.02–1.39), p: 0.03](13).

The model bivariate showed us that the structure of care was associated with death (Table N°I). Patients followed at CST Kalebuka were apparently more exposed than those followed at HGR Kenya [OR: 3.01 (1.17-7.76); p=0.02]. Patients followed at CST Kalebuka are screened at HGR Kenya, but HGR Kenya is about 12 km from CST Kalebuka, which may be the reason for the delay in screening these patients and therefore the exposed more at death

We found that the deceased had lost weight (-1 kg) while the survivors gained (+3 kg) between the 2 treatment phases (Wilcoxon test, p<0.0001) (Figure 1). When a patient loses weight, his immune system weakens further, which can expose him to death. Shimazaki et al found no significant link between weight loss in tuberculosis patients and mortality. [Adjusted OR 0.57 (0.27–1.19)](14).

It is observed in our study that there is no association between laboratory confirmation of tuberculosis and death (Table IV). 26.67% of patients with negative microscopy progressed to death and 26.04% of patients with positive microscopy died (Fisher exact test, p=1.00). Both groups died in almost the same proportions. Since the results of x-rays are not found on the forms, it is necessary to ask the question whether all the cases with negative microscopy are really of tuberculosis. We think that this result would be linked to diagnostic errors, to an unsuitable diagnostic tool for smear-negative pulmonary tuberculosis which can mistake other conditions for tuberculosis. Our results differ from those of Low et al. (2009) in a study conducted in Singapore. These authors confirmed, after multivariate analysis, the existence of a significant association between microscopy results and tuberculosis mortality. Patients with positive microscopy are 1.37 times more likely to die than patients with negative microscopy, with a significant statistical difference [Adjusted RR 1.37, CI (1.16–1.61), p<0.0005](13). Adamu et al also found a significant link between microbiological confirmation of tuberculosis and lethality. Contrary to previous authors, these authors noticed that patients with non-laboratory confirmed tuberculosis are more likely to die than patients with confirmed tuberculosis [Adjusted RR 4.96, CI (2.69–9.17)](19).

Our analysis did not reveal a relationship between HIV and the mortality of patients on anti-tuberculosis drugs in Kenya (Table IV). This can be explained by a good integration of the HIV control program with good management of HIV cases in the Kenya health zone. This may also be linked to the low prevalence of HIV infection in Lubumbashi. The study carried out by Zerbini et al found a statistically significant association between HIV/AIDS and tuberculosis mortality in Argentina. Patients with HIV/AIDS were 66.68 times more likely to die than HIV-negative subjects [adjusted OR 66.68, CI (5.48- 811.86), p= 0.001](17). HIV infection leads to a very extensive destruction of the body's defense mechanisms(11). If it is not properly taken care of, it risks hastening the death of a tuberculosis patient. Mathew et al found no association between HIV and mortality of tuberculosis patients on treatment in Tomsk Oblast in Russia [RR: 1.00, CI (0.00–3.07), p= 0.97](20). In a case-control study carried out in Ethiopia, Amante and collaborator (2015), confirmed after multivariate analysis, a statistically significant association between HIV infection and death/treatment failure [Adjusted OR: 2.53, CI(1.34-5.73), p=0.01](21).

A link between resistance and the death of tuberculosis patients was revealed during the analysis bivariate from our study (Table V). Patients with resistance to at least Rifampicin and Izoniazid apparently had a higher risk of death than those who did not show resistance to these two molecules [OR: 0.08 (0.01-0.71, p=0.004). This is because these patients sometimes become exhausted after this long treatment and become irregular in the treatment or else, the resistant germs weaken them to finally die. The study carried out by Kattan and collaborators (2012), did not prove the association between multi-drug resistance to anti-tuberculosis drugs and mortality because of the data not applicable(16). This variable was therefore excluded from the bivariate analysis. Santha et al. (2002) found in a study conducted in the Tiruvallur District in India that multidrug resistance was associated with death. [GOLD6.0, CI (0.9-33.1), p= 0.04](22).

An association between treatment category and mortality was found in the analysis bivariate (Table V). Re-treatment patients were 5.64 times more at risk of death than new patients [OR: 5.64, CI (2.47-12.88), p=6x10-7]. We believe that retired patients have a higher risk of death because they are more exposed to developing resistance, have experienced treatment failures, have sometimes abandoned treatment and the disease has had time to weaken their immune system, thus making them vulnerable. Mathew et al. (2006) found in the study conducted in Tomsk Oblast that retreatment tuberculosis was significantly related to tuberculosis mortality. (Adjusted RR: 1.77, CI (1.25–2.50), p=0.0012](20). In a retrospective cohort study, Adamu and collaborators (2017) demonstrated after multivariate analysis a significant statistical association between the notion of previous treatment and mortality. Patients in retreatment are 3.48 times more likely to die than patients with no history of treatment with a significant statistical difference [Adjusted RR: 3 48, CI (2 54–4 77)](19)

The median duration of treatment for deceased was 3 months and for survivors 6 months. Analysis bivariate revealed a statistically significant link between the median duration of treatment of our respondents and mortality (Table VI).

By categorizing this processing time, the analysis bivariate also pointed to a significant relationship between treatment duration and mortality. Our patients run 23 times the risk of dying in the interval from 1 day to 2 months compared to the interval beyond 9 months without statistically significant difference [OR: 23, CI (0.75-702.63)] (Table V).

Santha T. et al. (2002) found in a survey carried out in the Tiruvallur district in India that out of 39 patients who died of tuberculosis, 25 (64.1%) died during the first two months of treatment (at the intensive phase)(22).(23) Similar results were reported by Diallo S. and collaborators (2008) during a survey carried out in Bamako during which 53.6% of deaths attributed to tuberculosis occurred early in the first weeks following treatment. hospitalization(24). This high frequency of early deaths observed by these surveys reflects the situation in developing countries where patients come late to consult specialized centers because of the lack of information on the warning signs of tuberculosis, and the delay in diagnosis. of tuberculosis in non-specialized centers due to the lack of effective diagnostic tools. We also think that here the aggravation of the immune depression observed in tuberculosis patients because of the resurgence of HIV/AIDS infection increases the appearance of rapidly fatal forms such as tuberculous meningitis, etc. The early death of tuberculosis patients under treatment would also be attributed to the adverse effects of antituberculosis drugs or the interaction between antituberculosis drugs and antiretroviral.

5. Conclusion

Our study led to the following results: a lethality of3.34%, with a decreasing trend from 2014 to 2016. The bivariate analyzes demonstrated a relationship between the death of tuberculosis patients in the Kenya Health Zone and the following variables: The change in weight during treatment, the treatment center, the notion of tuberculosis count in the entourage, the patient's history of anti-tuberculosis treatment, the type of treatment history, the duration of treatment, compliance with treatment, resistance to anti-tuberculosis drugs, treatment category and treatment regimen. After analysis by logistic regression, these variables are only confounding factors.

Compliance with ethical standards

Disclosure of conflict of interest

We affirm that there is no conflict of interest.

Statement of ethical approval

The authors of this article declare that there is no conflict of interest *Statement of ethical approval*

The study received authorization from the Kisangani Research Ethics Committee of the University of Kisangani under number CER/002/GEAK/2013.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study".

Authors' contributions

All authors participated in the drafting and finalization of this study for publication.

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Appendices

Socio-demographic characteristic

Table 1 Socio-demographic characteristics of respondents

	Deceased Not (%)	Alive Not (%)	Total Not (%)	Gold (IC)	p*	Test
Structure	*N=59*	*N=177*	*N=236*			
Cst Kalebuka	9 (45.00%)	11 (55.00%)	20 (100%)	3.01 (1.17-7.76)	0.02	Chi-square
Cst Kenya1	9 (37.50%)	15 (62.50%)	24 (100%)	2.20 (0.90-5.41)		
Hgr Kenya	41 (21.35%)	151 (78.65)	192 (100)	1		
Occupation	N=59	N=177	N=236			
Student/Pupil	12 (29.27)	29 (70.73)	41 (100.00)	-	0.79	Chi-square
Official	9 (29.03)	22 (70.97)	31 (100.00)	-		
Liberal	18 (22.22)	63 (77.78)	81 (100.00)	-		
SP/housekeeper	20 (24.10)	63 (75.90)	83 (100.00)	-		
Sex	*N= 59*	*N=177*	*N=236*			
Feminine	19 (22.62)	65 (77.38)	84 (100.00)		0.53	Chi-square
Male	40 (26.32)	112 (73.68)	152 (100.00)			

Anthropometry

- Age of respondents

Table 2 Age of respondents

Status	NOT	Minimum	Q1	Median	Mean	Standard deviation	Q3	Max	p*	test
Deceased	59	16.00	27.00	33.00	35.49	12.08	44.00	72.00	0.77	Wilcoxon
Alive	177	15.00	28.00	34.00	35.77	11.97	42.00	80.00		

- Evolution of the weight of respondents
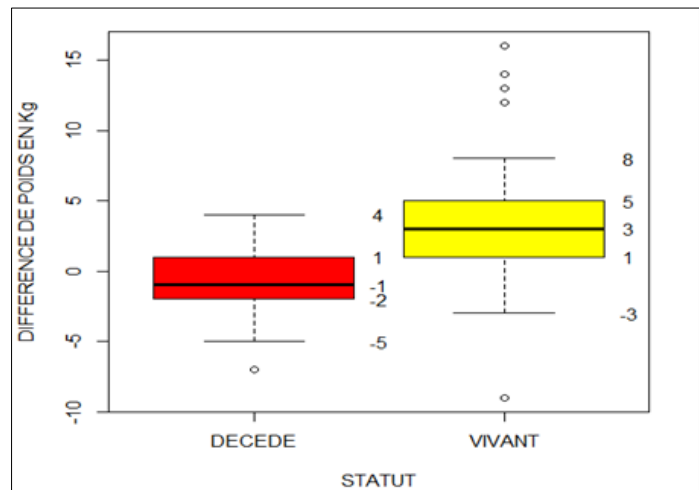
Figure 1 Distribution of respondents according to their change in weight from phase 1 to phase 2 of treatment

Vaccination and therapeutic history

Table 3 Vaccination and therapeutic history

	DECEASED Not (%)	ALIVE Not (%)	TOTAL Not (%)	GOLD (IC)	p*	Test
BCG vaccination	*N=59*	*N=177*				
NO	30 (30.61)	68 (69.39)	98 (100.00)		0.09	Chi-square
YES	29 (21.01)	109 (78.99)	138 (100.00)			
Tuberculosis count	*N=59*	*N=177*				
NO	49 (22.58)	168 (77.42)	217 (100)	1	0.01	Fisher exact
YES	10 (52.63)	9 (47.37)	19 (100)	3.81 (1.47-9.90)		
Treatment history	*N=59*	*N=177*				
NO	39 (19.12)	165 (80.88)	204 (100.00)	1	<0.0001	Chi-square
YES	20 (62.50)	12 (37.50)	32 (100.00)	7.05 (3.18-15.63)		
Type of treatment history	*N=59*	*N=177*				

new case	39 (19.12)	165 (80.88)	204 (100.00)	1		6x10-07	Fisher Exact
Relapse	8 (47.06)	9 (52.94)	17 (100.00)	3.76	(1.36-10.37)		
Reprocessing after failure	8 (72.73)	3 (27.27)	11 (100.00)	11.28	(2.86-44.49)		
Reprocessing after lost to follow-up	4 (100.00)	0 (0.00)	4 (100.00)	16.92	(1.84-155.65)		

Clinical and paraclinical characteristics

Table 4 Clinical and paraclinical characteristics

	Deceased Not (%)	Alive Not (%)	Total Not (%)	Gold (IC)	p*	Test
Type of tuberculosis	*N=59*	*N=177*				
Extra pulmonary	11 (21.15)	41 (78.85)	52 (100)	-	0.47	Chi-square
Pulmonary	48 (26.09)	136 (73.91)	184 (100)	-		
PET site	*N=11*	*N=41*				
Abdomen	2 (33.33)	4 (66.67)	6 (100.00)	-	0.77	Fisher Exact
Ganglion	0 (0.00)	1 (100.00)	1 (100.00)	-		
military	1 (33.33)	2 (66.67)	3 (100.00)	-		
Bone	0 (0.00)	2 (100.00)	2 (100.00)	-		
Pleura	8 (20.00)	32 (80.00)	40 (100.00)	-		
Microscopy	*N=48*	*N=136*				
negative	4 (26.67)	11 (73.33)	15 (100.00)		1.00	Fisher Exact
Positive	44 (26.04)	125 (73.96)	169 (100.00)			
Number of bacteria	*N=47*	*N=134*				
1 to 9 AFB	2 (13.33)	13 (86.67)	15 (100.00)		0.07	Fisher Exact
1 to 10 AFB /Field	11 (22.92)	37(77.08)	48 (100.00)			
10 to 99 AFB	9 (17.65)	42 (82.35)	51(100.00)			
ABSENCE	3 (25.00)	9 (75.00)	12 (100.00)			
>10 AFB/ Field	22 (40.00)	33 (60.00)	55 (100.00)			
HIV serology	*N=59*	*N=177*				Chi-square
negative	50 (23.70)	161 (76.30)	211 (100.00)		0.18	
Positive	9 (36.00)	16 (64.00)	25 (100.00)			

Therapeutic aspect

Table 5 Therapeutic aspects

	Deceased Not (%)	**Alive Not (%)**	**Total Not (%)**	**Gold (IC)**	**p***	**Test**
Duration of categorized treatment	*N=59*	*N=177*				
1d – 2 months	23(100.00)	0 (0.00)	23 (100.00)	23(0.75-702.63)	2x10-16	Fisher exact
3months – 6months	36 (18.00)	164(82.00)	200 (100.00)	0.22 (0.01-3.59)		
7months – 8months	0 (0.00)	12 (100.00)	12(100.00)	0.08 (0.002-2.60)		
9 months and over	0 (00.00)	1 (100.00)	1 (100.00)	1		
Compliance	*N=59*	*N=177*				
Irregular	9 (90.00)	1(10.00)	10 (100.00)	31.68 (3.91-256.07)	<10-4	Fisher Exact
Regular	50(22.12)	176 (77.88)	256 (100.00)	1		
Taking ARVs	*N=7*	*N=16*				
NO	2 (50.00)	2(50.00)	4 (100.00)		0.60	Fisher Exact
YES	7(33.33)	14 (66.67)	21 (100.00)			
ARV treatment option	*N=9*	*N=16*				
OPTION A	6 (60.00)	4(40.00)	10 (100.00)		0.09	*Fisher Exact*
OPTION B+	3(20.00)	12 (80.00)	15 (100.00)			
Taking cotrimoxazole	*N=9*	*N=15*				
NO	1 (33.33)	2(66.67)	3 (100.00)		1.00	Fisher Exact
YES	8(38.10)	13 (61.90)	21 (100.00)			
Drug resistance	*N=59*	*N=177*				
NO	55 (23.71)	177 (76.29)	232 (100.00)	1	0.004	Fisher Exact
YES	4(100.00)	0 (0.00)	4 (100.00)	0.08 (0.01-0.71)		
Treatment category	*N=59*	*N=177*				
new patient	39 (19.12)	165 (80.88)	204 (100.00)	1	6x10-7	Fisher Exact
Wearing	4 (100.00)	0 (0.00)	4 (100.00)	16.92 (1.84-155.65)		
Reprocessing	16(57.14)	12(42.86)	28 (100.00)	5.64 (2.47-12.88)		
Treatment plan	*N=59*	*N=177*				

2RHZE /10RH	0 (0.00)	3 (100.00)	3 (100.00)	1		9x10-7	Fisher Exact
2RHZE /4RH	39 (19.40)	162 (80.60)	201 (100.00)	0.72 (0.07-7.13)			
2SRHZE/RHZE/5RHE	16 (57.14)	12 (42.86)	28 (100.00)	4.00 (0.37-43.38)			
4 Km-Mfx-Pto-H-Cfz-EZ/ 5 Mfx-Cfz-EZ	4(100.00)	0(0.00)	4 (100.00)	12.00 (0.51-280.11)			

Table 6 Raw duration of treatment

Status	Variable	NOT	Minimum	Q1	Median	Mean	Standard Deviation	Q3	Max	p*	Test
Deceased	Duration in months	59	1.00	2.00	3.00	3.08	1.16	4.00	5.00	<0.0001	Wilcoxon
Alive	Duration in months	177	6.00	6.00	6.00	6.20	0.80	6.00	12.00		

Multivariate analysis

Table 7 Multivariate analysis by logistic regression of factors associated with tuberculosis mortality

Factors	Terms	Adjusted OR (CI)	p
Weight difference		0.94 (0.018 - 48.48)	0.97
Raw TTT duration		<0.001 (<0.001 - >1000.00)	0.21
Tt regime	2RHZE /10RH	1	
	2RHZE /4RH	>1000.00 (<0.001 - >1000.00)	0.66
	2SRHZE /RHZE/5RHE	>1000.00 (<0.001 - >1000.00)	0.59
	4 Km-Mfx-Pto-H-Cfz-EZ. 5 Mfx-Cfz-EZ	N / A*	N / A*
Category of TT	New patient	1	
	RTTT	N / A*	N / A*
	Resistance	N / A*	N / A*
Resistance	No	1	
	Yes	N / A*	N / A*
History of DTT	No	1	
	Yes	N / A*	N / A*
Concept of counting	No	1	
	Yes	1.68 (<0.001 - >1000.00)	0.98
Compliance	No	1	
	Yes	6.54 (<0.001 - >1000.00)	0.95
Structure	HGR kenya	1	

	CST kenya1	0.49 (<0.001 - >1000.00)	0.98
	CST kalebuka	1.33 (<0.001 - >1000.00)	0.99
TT ATCD type	New case	1	
	Relapse	>1000.00 (<0.001 - >1000.00)	0.86
	RTTT after failure	>1000.00 (<0.001 - >1000.00)	0.88
	RTTT after lost	N / A*	N / A*

*NA: Not Applicable