

FACTORS ASSOCIATED WITH DEVELOPMENT OF TYPHOID FEVER AT KAZIWIZIWI COAL MINING AREA IN RUMPHI DISTRICT, MALAWI: A Retrospective Case Control Study

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Abstract

Introduction: Kaziwiziwi is a coal mine situated in the eastern and mountainous area, 60km from Rumphi Boma in Malawi. The mine has a population of about 350 workers. Outbreak of typhoid occurred from 21st May to 15th June, 2012, at the mining area. Therefore the investigation of the outbreak was instituted to establish risk factors associated with the development of typhoid.

Methodology: An unmatched 1:1 case-control study design was used to establish the relationships between the risk factors and the development of typhoid. Anyone who suffered from typhoid in the month of May and June 2012 and living within the area was regarded as a case. A control was any participant who had the same characteristics like the cases except for the contraction of typhoid during the same period, in the area. An interviewer administered questionnaire was used to collect data.

Results: A total of 50 cases and 50 controls consented to participate in the study. Risk factors such as use of untreated water from a nearby river, drinking locally prepared thobwa (sweet mild beer) and not having a facility for hand washing after toilet use were associated with contracting typhoid with OR [2.7(95%CI 1.2, 6.3) p=0.0176], [OR, 1.8(95% CI 0.8, 3.96)p=0.1127] and [OR, 2.6(CI 1.1,6.1) p=0.0236] respectively.

Discussion and Conclusion: Like some previous studies, use of water from the river and not washing hands after using toilet were the main risk factors associated with contracting typhoid. The water from the river needs to be treated before use and health education campaigns with targeted health promotion messaging should be conducted in the area to avoid recurrence of

the outbreak.

Keywords: Typhoid Outbreak, Kaziwiziwi Coal Mine, Malawi

Background

Typhoid fever is a bacterial disease, commonly caused by *Salmonella typhi*. It is transmitted through ingestion of food or drink water contaminated by faeces or urine of infected people (faecal-oral-route). So far, literature review has revealed that the most common source is contaminated water. For example a typhoid outbreak that occurred in Dzivaresekwa Suburb of Harare City in Zimbabwe was found that drinking contaminated water from a well was an independent risk factors for contracting typhoid (AOR = 5.8; 95% CI 1.90-17.78). (Muti et al 2011). Similarly in another study done in Karachi Pakistan, laboratory investigations confirmed the presence of multidrug resistant strain of *Salmonella enterica* serovar Typhi in 100% well water, 65% household water samples and 2% food items. 22% of clinical stool samples were tested positive with *Salmonella enterica* serover Typhi (Khan & Kazmi 2009). Typhoid fever can be treated with antibiotics. However, resistance to common antimicrobials is widespread. (WHO, 2012)

One of the major outbreaks of typhoid in Malawi, occurred in March to November 2009 in Mwanza district, where 303 cases were identified from 18 villages. Of these, 214 were suspected, 43 were probable, and 46 were confirmed cases. (Lutterlo, 2012)

Another outbreak of typhoid occurred in Rumphi District from 21st May, 2012 to 15th June, 2012, at Kaziwiziwi coal mining area. Kaziwiziwi is a local coal mine situated in the eastern and mountainous part of the district, 60km from Rumphi Boma. The mine has a population of about 350 coal mine workers. The common public health problems in the area include endemic malaria, irregular events of diarrhoea and respiratory tract infections throughout the year. (Unpublished report by Rumphi District Health Office Typhoid Fever Outbreak Report, July 2012).

On 21st May, 2012, the District Health Office received reports from the coal mine of a relatively large number of cases of fever with severe headache and abdominal pains and that three cases had already been admitted at David Gordon Memorial Hospital (DGMH), and others were being treated at Rumphi District Hospital. This prompted the District Health Office Rapid Response Team (clinicians, environmental health officer, health promotion officers and laboratory scientist) to be dispatched on 23rd May, 2012 to establish and confirm the outbreak. The Clinical Officer manning the coal mine clinic had line listed twenty-one suspected cases with no deaths at that time. Case notes and health profiles of the suspected cases were reviewed in order to initiate investigations. Specimens were collected from

cases and sent to Mzuzu Central Hospital Laboratory for analysis. Patients' temperatures ranged from 38 - 40°C and were subjected to Malarial Rapid Diagnostic Tests (MRDTs) to rule out malaria.

All tests performed on CSF and urine samples were normal except for a blood culture which on day two grew **Salmonella enteritidis** which was sensitive to *Gentamycin, Ceftriaxone and Ciproflaxin* but was resistant to Metronidazole, Chloramphenical, and Erythromycin. Remarkable findings on the Full blood count done were; low White blood cell count of $1.9 \times 10^3 / \mu\text{l}$, low platelets count of $55 \times 10^3 / \mu\text{l}$, low lymphocyte count of $0.5 \times 10^3 / \mu\text{l}$. Hemoglobin count of 13.8 g/dl. (Rumphi District Health Office Typhoid Fever Outbreak Report, July 2012).

An outbreak of typhoid fever was then declared at Kaziwiziwi by the Malawi MoH, after lab confirmation and an increased number of infected clients within a short period of time. By the sixth week, 108 people were already suffering from the disease. Therefore, this retrospective case control study was conducted to determine specific factors associated with the outbreak of typhoid in Kaziwiziwi Coal Mine area. The specific objectives were; To determine socio demographic factors of participants; To establish personal, social, environmental, facility and other health related factors correlated with typhoid; To determine the level of knowledge of the participants on typhoid fever.

Methods and measurements

An unmatched 1:1 Case Control Study was conducted to establish the relationships between the risk factors and the development of typhoid in Kaziwiziwi coal mining area in Rumphi District. A total of 100 participants were recruited in the study. It consisted of mine workers and their wives/husbands and children, and other individuals living around Kaziwiziwi Coal mine which were within the epidemic declared zone. A simple random sampling technique was used to select 50 cases and 50 controls. A number was allocated to each case on the line list and written on a paper. These pieces of paper with numbers were folded and mixed in a bowl. A qualified clinician working at the mining clinic was requested to pick from the bowl pieces of paper one at a time until the required number of cases was achieved. The same process was followed for the selection of controls. However, a different list was used. Instead, a company employment list was used. Where the selected control was not available, any relative first met in the home was requested to participate. A case was any resident/worker of Kaziwiziwi coal mining area and surrounding villages that serve as a catchment area for Kaziwiziwi coal mine, who presented with signs and symptoms of typhoid in the month of May and June, 2012. A control was any participant who had the same characteristics like the cases except for the

contraction of typhoid (did not contract typhoid) during the same period. A structured questionnaire was administered to the cases and controls by the researcher/interviewer. Analysis of descriptive statistics and associations was done using Epi info v.3.5.1. The proposal was approved by Africa University Faculty of Health Sciences research committee. Permission was also granted from the District Health Office (DHO) of Rumpi where the study was conducted. Potential participants were informed on the nature of the study, the purpose and the objectives. Consent was obtained before participants were enrolled. In addition, clearance was also obtained from the manager of Kaziwiziwi Coal mine. Privacy and confidentiality was ensured through one to one interview away from other people by using a questionnaire and numbers were used instead of names. Furthermore, participants were told that they had the right to participate or not and that they could withdraw at any time during the study.

Results

Table 1 presents the breakdown of the sex of the study participants who were recruited into the study while Table 2 reflects the age ranges of the cases and the controls.

Table 1. Gender distribution of study cases and controls (N=100)

	Cases (n=50)		Controls (n=50)	
	Frequency	Percent	Frequency	Percent
Males	44	88.0%	34	68.0%
Females	6	12.0%	16	32.0%
Total	50	100.0%	50	100.0%

Table 2: Age distribution of the study cases and controls

Age group	Cases (n=50)		Controls (n=50)	
	Frequency	Percent	Frequency	Percent
>10 - 20	6	12.0%	4	8.0%
>20 - 30	27	54.0%	23	46.0%
>30 - 40	13	26.0%	15	30.0%
>40 - 50	3	6.0%	6	12.0%
>50 - 60	1	2.0%	2	4.0%
Total	50	100.0%	50	100.0%

Socio-Demographic Characteristics of Cases and Controls

The level of education was classified as follows: those who never went to school; primary; secondary and tertiary. The majority among the cases had primary education (49%; n=50), while among the controls the majority had secondary education (48.9%; n=47).

Most of the participants (94% were employed, 2% were house wives and 4% were not employed (n=100). The majority of interviewed participants had 4 people living in one house (19 households) followed by

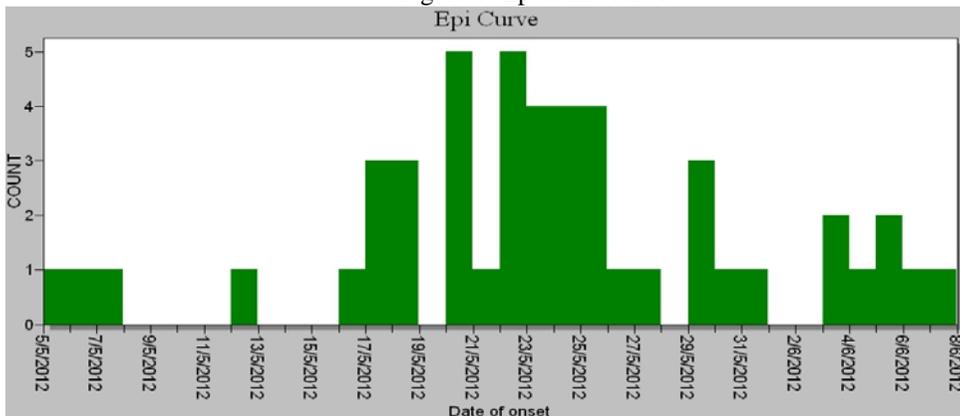
those that had 6 people living in one house (17 households). The study also revealed extreme cases in which up to 12 people could live in one house.

Many participants (58%) lived within Kaziwiziwi Mine compound, seconded by the participants who lived in the villages surrounding the mine such as Kajoni, Mpeta, Phoka, and Thunda. All these villages fall within the outbreak declared area.

Description of the Outbreak by Time
Interpretation of epidemic curve

The general shape of the epidemic curve is that of the intermittent common source. This means that the exposure of the cases to the causative organism of typhoid was sporadic over time within the same Kaziwiziwi Mining Compound. This type of exposure produces an irregular epidemic curve due to the intermittent and prolonged duration of exposure as seen in Epi curve below (figure 1). The peak of the outbreak was reached twice (on two different days), that is on 20th May, 2012 and on 22nd May 2012 when five cases were report on each day. Based on the first peak that occurred on 20th May, 2012, and the incubation period of typhoid which is 7 to 14 days (two weeks), we could suggest that the likely date of exposure prior to the peak of typhoid outbreak was on 5th May, 2012. It is however difficult to know when the beginning of the outbreak earliest case occurred, because the epidemic curve is not clear on that, since on the 5th of May when it is assumed that there was an exposure based on the peak, one client was reported sick. This client may also be dated back to 21st April as his/her date of exposure; hence it is difficult to know the index client or source. Based on the cut off dates (21/05/12 to 15/06/12) declared by the Malawi Ministry of Health as an outbreak period, is not fully supported by this epidemic curve. This is because some clients started suffering as early as 5th May, 2012 and that the 21st May, 2012 indicates the peak of the epidemic and not the onset.

Figure 1: Epidemic curve



Analysis of Risk factors

Association of many risk factors and development of typhoid among participants at Kaziwiziwi Coal mining Compound was done using Odds Ratio (OR) and Confidence Interval (CI) at 95%.

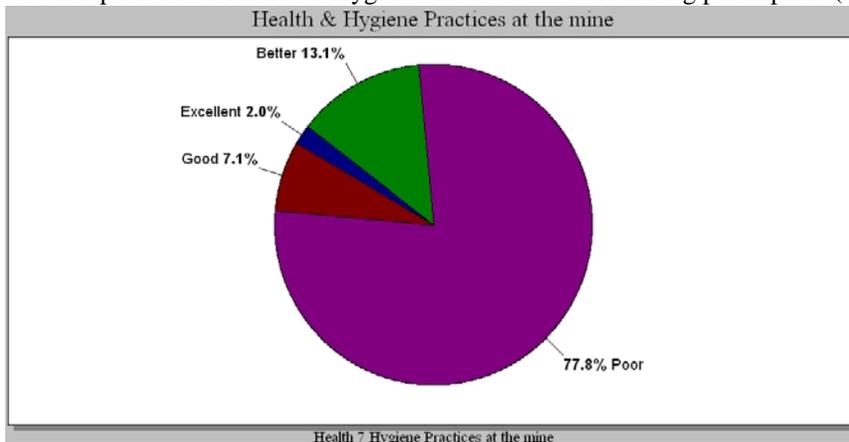
Table 3: Factors associated with contracting typhoid at the mine.

Variables		Cases N=50 (%)	Controls N=50 (%)	OR (95%CI)	P-value (0.05)
Hand wash After toilet	Yes	12 (24.0%)	22 (44.9%)	2.6 (1.1-6.1)	0.0236
	No	38 (76.0%)	27 (55.1%)		
Availability Of latrine	Yes	49 (98.0%)	49 (98.0%)	1.0(0.06-16.44)	0.7525
	No	1 (2.0%)	1 (2.0%)		
Thobwa	Yes	32 (64.0%)	25 (50.0%)	1.8 (0.80-3.96)	0.1127
	No	18 (36.0%)	25 (50.0%)		
Use of river Water	Yes	23 (46.0%)	12 (24.0%)	2.7 (1.15-6.34)	0.0176
	No	27 (54.0%)	38 (76.0%)		
Use of well water	Yes	7 (14.0%)	14 (28.0%)	0.42 (0.15-.15)	0.0698
	No	43 (86.0%)	36 (72.0%)		
Use of piped water	Yes	20 (40.0%)	24 (48.0%)	0.72 (0.33-.60)	0.2729
	No	30 (60.0%)	26 (52.0%)		

Level of knowledge on typhoid and hygiene practices

The participants were requested to indicate if they had undergone health education on typhoid prior to the year 2012, the majority (91%; n=100) declined to have attended any. Participants were also asked to comment on their perception about the health and hygiene practices at the mine. As shown in chart 1 below, the majority (77.8%; n=100) rated the health and hygiene practices at the mine as poor. The main reason given by participants for rating it poor were; Inadequate and dirty toilets hence people use bush system; Inadequate rubbish pit hence there is poor disposal of waste; Water not clean/not treated and most workers drink untreated water direct from a river; Drinking Thobwa at the work place which is not covered and locally prepared from untreated water.

Chart 1: Perception about Health & Hygienic Practices at mine among participants (n=100)



Most participants (63%;n=100) managed to mention how typhoid is transmitted. Others indicated that they were not sure, while others got it right by giving the following responses:

- Drinking unsafe/untreated water;
- Eating contaminated food;
- Not using the toilets and general poor hygiene.

However, another group of the participants gave wrong responses as follows:

- Through air/wind;
- Sharing clothes;
- Through visitors;
- Due to malaria;
- Wearing bad clothes.

Discussion

The findings of the study revealed an association between several risk factors and the development of typhoid fever in Kaziwiziwi and surrounding areas at 95% CI. P-value = 0.05.

Not having a facility for hand washing after toilet use, and using water from the river for home use had a higher association for contracting typhoid than other risk factors with an OR of 2.6 and 2.7 respectively. The association established was statistically significant (P= 0.0236 and 0.0176) respectively. The other risk factor was drinking thobwa at the workplace with an OR of 1.8. Although the finding established an association on the above mentioned risk, it was not statistically significant (P=0.1127). These findings may imply that the river which people used as a source of water for home use including preparation of thobwa at work place was contaminated. These findings are in agreement with the study done by King, (1983) in Chu

– Tung Township, Taiwan where the findings revealed that contaminated streams were a source of the outbreak. Therefore policy makers should intensify water treatment and environmental sanitation measures in communities whose main source of water is the river and unprotected wells. This would help to reduce the fecal-oral route of transmission of diseases such as typhoid.

There was no association between having a pit latrine and development of typhoid at the compound. (OR 1.0000; 95% CI 0.0608-16.4446) P-value 0.7525. This could possibly be due to the common exposure such as lack of hand washing after toileting, drinking thobwa, and using water from the river which seem to have been contaminated, to which most people at the mine were exposed regardless of having a pit latrine or not. However, emphasis should be made by the relevant authority on construction and use of pit latrine in the area, which was found to be very low in this study. Using water from the well and piped water for domestic purpose was found to be protective, with an OR 0.4186; 95% CI 0.1525-1.1488 P value 0.0698 and 0.7222; 95% CI 0.3270-1.5952 P value 0.2729 respectively (see table 3). These findings however are contradicting with the findings of the study done by Muti et al 2011 in Dzivaresekwa Suburb of Harare City in Zimbabwe where it was found that water from a well was associated with typhoid (OR 6.2). The difference could be due to rural set up of Kaziwiziwi versus urban set up of Dzivaresekwa Suburb of Harare City. Since there was shortage of water in Harare suburb of Dzivaresekwa, people relied on water from shallow wells which were down stream from sewer flows when there were sewer blockages, and water was contaminated with faecal coli forms and E. Coli as revealed by laboratory tests (Muti et al, 2011). Unlike in rural set up of Kaziwiziwi where people relied on water from the contaminated river.

The majority (91%; n=100) denied to have attended health education on typhoid before 2012. Lack of health education in any set up could result in serious disease burdens and outbreaks. Basic information of any disease such as definition, aetiology, transmission and prevention is important to reduce the incidence and prevalence of diseases. Lack of education was also reflected through rating of the health and hygiene practices at the mine, where the majority (77.8%; n=100) indicated it as poor. The reasons raised by workers for rating the health situation as poor (see results above), could justify the existence of typhoid in the compound since they provide conducive environment for the propagation of the microorganism that cause typhoid.

The participants outlined several responses on how typhoid is transmitted as outline in the results above. These responses are typical of inadequate information among participants in relation to good health

practices, which can be achieved through health education promotion. Even those who provided right information, possibly it was due to education campaigns that were conducted in the area soon after the outbreak had occurred. This being a retrospective study, education had an influence on the findings on this question, because these are the very same participants who indicated that they had never had any health education on typhoid prior to the outbreak as discussed above.

Limitations

Water and food (thobwa) samples were not collected for microbiological analysis. Instead, only human samples were collected such as blood, urine, CSF and stool. Recall bias was likely to have affected the finding since participants were required to give some of the information on issues that had happened a month or two prior to this study.

Conclusion

The most important risk factors associated with contraction of typhoid were using water from a river, drinking thobwa at the work place and lack of hand washing facility after toilet use (hygiene). Health education was found to be one of the major deficient services at the mining area. This study therefore has a big implication to policy makers and service providers to emphasize on targeted health education promotion on typhoid and the general hygienic measures in the area. A follow-up post-outbreak study need to be carried out to evaluate the public health status of the area.

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