Research Paper

An association between water, sanitation, and hygiene (WASH) and prevalence of trachoma in Monze district of Southern Province, Zambia

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ABSTRACT

This study aims to determine the association between water, sanitation, and hygiene, and the prevalence of trachoma in Monze district, Zambia. The overall prevalence of trachoma among residents of Monze district is 2.0% disaggregated as 3.4% for 1–9 age group and 1.1% for ≥10 age group. The findings reveal an association between trachoma eye infection and drinking water source from protected well/spring, and piped water. After adjusting for other variables, there was an association of drinking water from a protected well/spring (AOR 8.343, CI 1.126–61.803), piped water (AOR 4.127, CI 1.088–15.648), and piped water for washing (AOR 0.172, 95% CI 0.031–0.944.439). The presence of a hand wash facility was very low at 2.9% while hand washing agents were even lower at 0.41%. The study concludes that children are at a higher risk of trachoma prevalence. Other WASH aspects, such as adequacy of water, might be more important than the presence of potable water. The prevalence of trachoma in Monze is WASH focused.

Key words | trachoma, water and sanitation

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HIGHLIGHTS

- The research showed a significant need for attention 1–9 age group. Children are at a higher risk of trachoma prevalence.
- The research reveals that having water from a protected water source if the water source is not easily accessible makes trachoma prevention difficult.
- The findings serve as a foundation for the Monze Municipal Council and the community to advocate for more resources allocation to access to quality water.

INTRODUCTION

According to Feasey *et al.* (2010), trachoma is a neglected tropical disease. It is the leading cause of blindness worldwide and remains a major public health problem in 42 countries and responsible for the blindness or visual impairment of about 1.9 million people. It causes about 1.4% of all blindness worldwide, with the global focus in sub-Saharan Africa, particularly its poorest and most isolated rural communities (Agarwal *et al.* 2016). In 2013,

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it was estimated that the African continent was host to 4 million cases of trichiasis (47% of all cases globally), with 33 of 56 African countries thought to be endemic (Smith *et al.* 2013). In Zambia, blindness approximately affects 1% of the population with about 105,000 people affected by the disease (Ministry of Health 2013). Trachoma is the most common infectious cause of blindness which is caused by ocular serovars of *Chlamydia trachomatis*. Repeated infection by *C. trachomatis* can cause follicular conjunctivitis that results in chronic inflammation, peripheral corneal vascularization, or pannus formation (Communicable Diseases Network Australia 2014). Repeated episodes of reinfection within the family cause chronic follicular or intense conjunctival inflammation, also known as active trachoma, which leads to tarsal conjunctival scarring (Burton & Solomon 2004). Scarring may ultimately lead to trachomatous trichiasis and irreversible visual impairment or blindness. Miller *et al.* (2004) reported that trachoma is spread by direct contact with eye, nose, and throat secretions from affected individuals. It can also be spread by contact with fomites such as handkerchiefs, towels, or washcloths contaminated with these secretions. Eye-seeking flies such as *Musca sorbents* can carry *C. trachomatis*, but there is no animal or insect reservoir.

Many factors contribute to trachoma infection. These include poor personal hygiene, lack of access to clean water and availability, and type of sanitary facility. To better understand the high trachoma prevalence, the 2018 Ministry of Health, Zambia conducted a Tropical Data Trachoma health survey in 47 districts (MoH 2013). Based on the high prevalence (52.3%) revealed from an earlier survey conducted from 2007 to 2012, data in Monze district were extracted to determine the association of water sanitation and hygiene with the prevalence of trachoma. The study aims to determine the association between water, sanitation, and hygiene, and the prevalence of trachoma in Monze.

METHODS

This study uses secondary data from the Ministry of Health Tropical Trachoma Data Survey. The study used cluster sampling methods. The sampling was done by the Ministry of Health for a baseline survey conducted in 2018. The World Health Organization (WHO) recommendations for the planned sample size for each evaluation unit (EU) were followed (Mwale *et al.* 2018), to estimate the trachomatous inflammation follicular (TF) prevalence of 4%, a 95% confidence interval, and set an absolute precision of 2%. The study took into account variation of the sample and size of clusters and used a design effect of 2.63 and inflated the results by 20% to take care of non-responders. With the aid of OpenEpi, a sample size of 593 households and 2,710 individuals was calculated. Taking into account a non-response rate of 20%, the sample size was adjusted to 741 for households and 3,388 for individuals.

Data were extracted using a data extraction tool and analyzed using Stata version 14. The full and cleaned dataset responses consisted of 736 households and 3,148 individuals. Independent variables extracted included age, sex, source of washing water, source of drinking water, type of sanitary facility, type of latrine, and availability of wash facility) and matched with the dependent variable (prevalence of trachoma).

STATISTICAL ANALYSIS

Data were analyzed using Stata 14. Descriptive results were presented as percentages and means (with 95% confidence intervals). Univariate analysis of independent variables was used to describe the variables (age, sex, households, type of sanitary facility, and water source). Cross-tabulations were done to see if there was any association between the dependent variable trachoma and dependent variables (age, sex, type sanitary, source of drinking water, etc.). Later, multivariate logistic regression was done to check for confounding variables. Any variable with a p-value of >0.100 in the simple regression was not included in the logistic regression model.

All variables with a p-value of less than >0.05 in the multivariate logistic regression model were significant. The backward logistic regression method was used. The method was used to remove variables one at a time beginning with the largest p-value and continuing until all remaining effects were significant at a specified level.

RESULTS

Table 1 shows that most of the respondents who are heads of households were ≥50 years old (29.6%). The youngest age of heads of households (≤21 years) was 3%. Furthermore, more males are heads of households as compared to females. For the household size, the study revealed that houses that had 1–5 individuals was 512 (69.6%), with the lowest being 11–20 individuals in six households covering 0.8%.

For the type of sanitary facility, the most used sanitary facility by households is pit latrines, which account for 431 (58.6%) and the least used is a pour water to flush toilet (29, 39%). The rest of the participants used the bush to answer the call of nature. Households in Monze use private latrines as compared to shared or communal latrines.

Table 1 | Characteristics of households in Monze district

Variable	Number (n)	Percentage (%)
Age of household heads		
<21	22	3.0
21–30	188	25.5
31–40	175	23.8
41–50	133	18.1
>50	218	29.6
Sex of household heads		
Male	405	55.0
Female	331	45.0
Household size		
1–5	512	69.6
6–10	218	29.6
11–20	6	0.8
Type of toilet		
Flush/Pour flush	29	3.9
Pit latrine	431	58.6
No facilities or bush	276	37.5
Use and mode of toilet		
Shared or public latrine	152	20.6
Private latrine	300	40.8
No structure (other)	284	38.6
Availability of water		
Present	21	2.9
Absent	715	97.2
Washing agent		
Present	3	0.4
Absent	733	99.6

Table 1 shows that more families do not have any form of washing agent after using the toilet. The study revealed that only 21 (2.9%) houses had water for washing and 715 (97.2%) had no water. For those who had a washing agent to wash their hands, it was discovered that only three (0.4%) houses either had soap, ash, or any other wash agent to clean their hands after defecating. 733 (99.6%) had nothing.

Table 2 shows that out of 3,148 tested, 1,254 (37.0%) were 1–9 years old 37.0%, while 2,134 (63.3% were in the age group of 9 years and older). The results also show more women as compared to males were tested; males 1,600 (47.2%) and females 1,788 (52.8%), respectively.

Table 3 shows that participants aged between 1 and 9 years had a higher prevalence for the presence of trachoma (42, 65.6%) and it was lower for the ≥9 age group (22, 34.4%). The research also revealed that females had a higher prevalence (38, 59.4%) as compared to males (26, 40.6%). Children from 1 to 9 years are at a higher risk of contracting trachoma, which simply means there was a significant difference between age and trachoma ($p = 0.001$). However, there was no significant difference between sex and trachoma ($p = 0.444$). There was a significant difference in water for washing in the dry season and the presence of trachoma ($p = 0.019$). There was also a significant difference between drinking water source and trachoma ($p = 0.022$).

Table 4 shows that there was significant association between modes of toilet use and trachoma ($p = 0.043$). It also shows there was a significant difference for the type of toilet used with trachoma ($p = 0.037$).

Table 5 shows the odds of having active trachoma among households who had a water source from a protected

Table 2 | Individual demographics and trachoma eye tests ($N = 3,388$)

Variable	Number	Percentage
Age		
1–9	1,254	37.0
≥10	2,134	63.0
Sex		
Female	1,788	52.8
Male	1,600	47.2

Note: 3,148 only were tested.

Table 3 | Bivariate analysis

	Had trachoma				
	Yes		No		
Variable	**Number**	**Percentage**	**Number**	**Percentage**	***p***
Age					<0.001
1–9	42	65.6%	1,186	38.5%	
≥9	22	34.4%	1,898	61.5%	
Sex					0.444
Male	26	40.6%	1,426	46.2%	
Female	38	59.4%	1,658	53.8%	
Drinking water source in the dry season					0.019
Borehole	32	50.0%	1,717	55.7%	
Protected well/spring	17	26.6%	417	13.5%	
Unprotected well/spring	9	14.1%	431	14.0%	
Surface (rivers)	0	0.0%	176	5.7%	
Piped	6	9.4%	343	11.1%	
Time it took to get water for drinking					0.293
Water source in yard	2	3.1%	276	8.9%	
Less than 30 minutes	44	68.8%	1,926	62.5%	
Between 30 minutes and 1 hour	15	23.4%	793	25.7%	
More than one hour	3	4.7%	89	2.9%	
Water for washing in dry season source					0.022
Borehole	32	50.0%	1,684	54.6%	
Protected well/spring	15	23.4%	429	13.9%	
Unprotected well/spring	14	21.9%	478	15.5%	
Surface (rivers)	0	0.0%	176	5.7%	
Piped	3	4.7%	317	10.3%	
The time it took to get water for washing					0.072
All face washing is done at the water source	3	4.7%	66	2.1%	
Water source in yard	0	0.0%	260	8.4%	
Less than 30 minutes	43	67.2%	1,893	61.4%	
Between 30 minutes and 1 hour	15	23.4%	781	25.3%	
More than 1 hour	3	4.7%	84	2.7%	

well was eight times higher than households who had piped water, who are four times more likely to have active trachoma (AOR = 8.3: 95% CI 1.1–16.8). The analysis revealed that households whose source of drinking water was a protected well had an association with having trachoma of $p = 0.038$ and for piped water the association with having trachoma was $p = 0.037$. For washing water source, piped water had an association of $p = 0.043$. Also, time to fetch water and where people defecated were independently associated with the presence of trachoma ($p = 0.044$).

DISCUSSION

The study made an association of water, sanitation, and hygiene with the prevalence of trachoma in Monze district.

Table 4 | Bivariate analysis of sanitary facility by trachoma

	Had trachoma				
	Yes		No		
	N	%	N	%	p
Mode of toilet use					0.043
Shared or public latrine	19	29.7%	644	20.9%	
Private latrine	31	48.4%	1,228	39.8%	
No structure, outside somewhere	14	21.9%	1,183	38.4%	
Other	0	0.0%	29	0.9%	
Type of toilet					0.037
Flush/Pour flush	2	3.1%	137	4.4%	
Latrine	49	76.6.%	1,756	55.8.%	
Bush	13	20.3%	1,191	38.6%	
Had water for handwashing					0.403
Absent	64	100.0%	3,012	97.7%	
Present	0	0.0%	72	2.3%	
Had hand wash chemical in the toilet					1.000
Absent	64	100.0%	3,072	99.6%	
Present – ash, mud, or sand	0	0.0%	12	0.4%	

It determined the proportion of households using improved sanitation facilities in Monze district in 2018. It also assessed the prevalence of trachoma among residents of Monze district. Lastly, it determined the relationship between water access and trachoma and the relationship between sanitary facilities and trachoma among residents of Monze district. The overall prevalence of trachoma among residents of Monze is higher in the age group of 19 years as compared to that of $\geq$10 years.

Similarly, Mariotti *et al.* (2009) found that the main age group affected by trachoma includes children aged 1–5 years. Even though this study has a higher age group category of 1–9 years, it can be concluded that children are at a higher risk of getting trachoma. A survey done in 2013 showed that the prevalence of trachoma in Monze district was 52.3% (MoH 2013). The drastic decrease in the prevalence of trachoma in selected districts in Zambia can be attributed to disease control and prevention measures taken by the government and SAFE strategy supporting partners. According to Muma (2018) 'Zambia has embarked on programs to eliminate trachoma by the year 2025. The government and the cooperating partners are strongly focused on implementing the SAFE strategy through a comprehensive and multi-sectoral strategy'. Markle *et al.* (2017) further explained how close community intervention programs such as Community Led Total Sanitation (CLTS) in the Southern Province of Zambia have allowed district health officials, teachers, traditional leaders, community leaders, parents, and children to receive educational talks with the distribution of folders and banners regarding the disease and ways to prevent it, including the maintenance of clean faces to avoid bacterial transmission.

The significant drop of Trachoma prevalence in the Southern province of Zambia, particularly Monze, can be attributed to the extensive trachoma program. In a study done by Astle *et al.* (2006), in the Southern Province of Zambia, it explains that trachoma programs, attempts to alter hygiene practices, including latrines, face washing, dish racks, rubbish pits, and hand wash stations, are both environmental and health education activities. These activities play a significant role in the prevention of trachoma and are attributed to the decrease.

The frequency of trachoma was high in females as compared to males but not statistically significant. Comparing similar findings from Brazil, Gambhir *et al.* (2007) elaborate that it is possible that the greater frequency of trachoma cases among females could be related to the more effective behavior among them, as direct person–person contact is an important form of infection transmission. It is evident that in developing countries women take the role of the first point of contact with the children from the time they are born. This makes them more susceptible to the disease as compared to men.

Furthermore, the factors that were associated with trachoma eye infection were drinking water sources, such as well water or spring water. This simply means that a household with a drinking water source from well or spring water is more likely to be infected by trachoma. Interestingly, households that had piped water were four times more likely to get trachoma. This contrasts with findings of most related studies which show that piped water supply reduces trachoma prevalence (Golovaty *et al.* 2009). According to Baggaley *et al.* (2006), trachoma prevalence and piped water is linked with the distance to water sources. This could be due to inadequate access to the water supply.

Table 5 | Logistic regression of source of drinking water, the time it took to fetch drinking water and type of toilet by trachoma

	OR	95% CI	*p*	AOR	95% CI	*p*
Drinking water source in the dry season						
Borehole (ref)						
Protected well/spring	2.187	1.203–3.977	0.010	8.343	1.126–61.803	0.038
Unprotected well/spring	1.120	0.531–2.375	0.765	0.556	0.137–2.250	0.411
Surface (rivers)	1.000			1.000		
Piped	0.939	0.389–2.262	0.888	4.127	1.088–15.648	0.037
The time it took to get water for drinking						
Water source in the yard (ref)						
Less than 30 minutes	3.153	0.760–13.078	0.114	2.992	0.677–13.230	0.148
Between 30 minutes and 1 hour	2.610	0.593–11.487	0.204	3.171	0.686–14.651	0.139
More than 1 hour	4.652	0.765–28.284	0.095	5.331	0.796–35.692	0.085
Washing water source in the dry season						
Borehole (ref)						
Protected well/spring	1.840	0.987–3.489	0.055	0.229	0.028–1.862	0.168
Unprotected well/spring	1.541	0.816–2.912	0.183	2.990	0.819–10.249	0.099
Surface (rivers)	1.000			1.000		
Piped	0.498	0.152–1.636	0.251	0.172	0.031–0.944	0.043
Where people defecated						
Shared or public latrine (ref)						
Private latrine	0.856	0.480–1.567	0.598	0.825	0.450–1.510	0.532
Bush	0.401	0.100–0.805	0.010	0.465	0.221–0.981	0.044
Other	1.000			1.000		

There was no association recorded for the time it took to get water for drinking. According to Cairncross (1999), the relationship between water supplies and trachoma is sometimes more complex than it might seem, and the proof that water supply improvement can help to reduce trachoma can sometimes be difficult. Zerihun (1997) further elaborates, in a study done in Ethiopia, that found that people living further than 15 minutes' walk from a water source had less active trachoma than those with a source of water closer.

For washing water sources in the dry season (piped) the study revealed that participants were less likely to have trachoma. Participants that defecated in the bush were less likely to have trachoma. According to the WHO/UNICEF (2013), transmission of trachoma in a population that practices open defecation is explained using indirect factors; these include how dense the population is. Depending on how dense the population is these 'fecal fields' potentially put the village and, consequently, water sources at risk and attract flies, a major vector in the transmission of trachoma (Howard *et al.* 2013). Furthermore, there was no association for participants that used private latrine. Monze is a densely populated area and even if people defecate in open fields there is a likelihood of having more flies working as a vector to transmit the disease.

Hand washing after the use of sanitary facilities is an important act in reducing infection with trachoma (Zimba *et al.* 2016). It is clear from the findings that there was no availability of hand washing agents in the majority of the households, only households that had ash, mud, or sand. According to a study by Fewtrell *et al.* (2005), handwashing with soap is an effective practice for reducing trachoma. It is therefore necessary to highlight the importance of face washing. Special focus should be on hygiene education for children as they are not usually taught the importance of keeping their faces clean.

Tadesse et al. (2017) shows a remarkable improvement in the status of trachoma prevalence because of adequate water supply, sanitation, and hygiene situation after the intervention period. To explain the magnitude and influence of trachoma prevalence on the type of sanitary facility, the research conducted a meaningful comparison of effect modification for the different age groups by comparing by type of sanitary facility and water source after adjusting for age and the presence of trachoma. Households without a sanitary facility showed no association with the significance of active trachoma compared with households that had piped water and a private sanitary facility that were eight times more likely to have trachoma.

CONCLUSIONS

The study determined the association of water, sanitation, and hygiene with the prevalence of trachoma in Monze district. Trachoma is a public health problem among children under nine years of age in Monze district. Children are at a higher risk of trachoma prevalence. Having water from a protected water source if the water source is not easily accessible makes trachoma prevention difficult. The use of the bush for defecation may not necessarily cause trachoma if the population is not dense. The major factors associated with the prevalence of trachoma in Monze are WASH focused.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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