Water availability and trachoma

S. West,[1] M. Lynch,[1] V. Turner,[2] B. Munoz,[1]
P. Rapoza,[2] B.B.O. Mmbaga,[3] & H.R. Taylor[1]

As part of an epidemiological survey of risk factors for trachoma in 20 villages in the United Republic of Tanzania, we investigated the relationship of village water pumps, distance to water source, and quantity of household water to the risk of inflammatory trachoma. We also evaluated whether there was an association between the cleanliness of children's faces and these water variables.

No association was found between the presence of a village water supply and the prevalence of trachoma. However, the risk of trachoma in the household increased with the distance to a water source—although there was no association with the estimated daily amount of water brought into the house. Likewise, children were more likely to have unclean faces if they lived more than 30 minutes from a water source, but whether they had clean faces was not associated with the daily quantity of water brought into the household. The effect of the distance to water supply on trachoma may well reflect the value placed on water within the family, and this determines the priority for its use for hygiene purposes.

The results of the study suggest that changing the access to water per se *may be insufficient to alter the prevalence of trachoma without also a concomitant effort to change the perception of how water should be utilized in the home.*

Introduction

Trachoma, a disease caused by repeated reinfection with *Chlamydia trachomatis*, is a major cause of blindness (*1*). Although at one time global in its distribution, trachoma is now mostly confined to developing countries where community and family living conditions continue to foster its transmission (*2*).

The disease was long held to be associated with lack of water; indeed, hyperendemic areas are often dusty, dry regions with insufficient water. However, before simply promoting increased water supplies as an effective method for the prevention of trachoma, it is important to understand the epidemiology of the disease as it relates to water.

There are very few rigorous, scientific data on the relationship between trachoma and water availability. Former studies have focused on the source of water supply (*3–4*) but methodological problems make their results difficult to interpret (*5*); others have suffered from poor assessment of trachoma (*6*) or insufficient attention to confounding factors that might explain the observed results (*7*). An increasing prevalence of active trachoma in children has been reported with increasing distance from the house to the water source (*8–10*). The assumption is that less water is used for hygiene purposes as the distance to source increases (*11*); this assumption is not entirely borne out by the results of another study, which suggested that, at least for distances up to one kilometre (30 minutes), the volume of water used remained constant (*12*). Also, a study in Morocco indicated that distance to water was not associated with the amounts of water used per capita (*9*).

The purpose of the current study was to investigate the impact of distance to water and water availability on the prevalence of trachoma and on water use habits.

Methods

A risk-factor survey for trachoma was carried out in a random sample of 20 villages in Kongwa, United Republic of Tanzania, from July to September 1986. Random samples of clusters of households in each village were selected, and the mothers were interviewed by trained local women. Data were collected for over 3800 children in more than 2000 households, a response rate of over 92%, as described elsewhere (*13*). We investigated the relationship between three water-related variables and trachoma as well as hygiene behaviour.

The presence or absence of a constructed water supply in the village was determined by interviewing

[1] The International Center for Epidemiologic and Preventive Ophthalmology, The Dana Center of the Wilmer Institute and the School of Public Health, The Johns Hopkins University, Baltimore, MD, USA. Requests for reprints should be sent to Dr West at this address.

[2] Helen Keller International, Inc., New York, NY, USA.

[3] Kongwa Primary Eye Health Care Project, Kongwa, United Republic of Tanzania.

the village chairman. The distance to the usual water source for each household was assessed by questioning mothers about the time necessary to travel from the house to the source. The time needed to walk one way to the source was a difficult concept in the interview. In order to provide a locally appropriate reference, a series of common household tasks were timed and these were used as examples by the interviewer. For example, "less than 30 minutes" was the time necessary to build a fire and boil water. Responses to the travel time generally matched our knowledge of available water sources for each village. In addition, because households were often widely dispersed in the villages, the responses within a village were not necessarily similar and reflected the differential distances to the water source.

The quantity of household water available was measured as the number of person-trips per day made for collection. Fewer than 3% of households reported going for water less than once per day. For each trip, we assumed that the person carried one water gourd of 15 litres (*12*). The reported number of trips was multiplied by an estimate of the number of persons carrying water per trip, either the mother or the mother and a helper. Households were classified into the following three groups according to the quantity of household water: "low" (<25 l per day), "medium" (25–45 l per day), and "high" (>45 l per day).

Active, inflammatory trachoma was assessed in children aged 1–7 years using the WHO simplified grading scheme (*14*). For this purpose, children with disease were classified as having active, follicular trachoma (TF) and/or intense trachoma (TI); children with neither of these signs were considered free of active, inflammatory trachoma. Interviewers also noted whether children had clean faces.

The data were analysed using a χ^2 test for contingency tables and a logistic regression analysis to estimate the risk of trachoma in the households. A polychotomous regression analysis was used to adjust simultaneously for household and child variables while modelling the probability of clean faces in children (*15*).

Results

The presence of a constructed water supply was not associated with any differences in the prevalence of trachoma in the villages surveyed (average prevalence of TF/TI in the nine villages with constructed water supplies was 60.6% versus 58.5% in the eleven without, and that of TI alone was 8.6% and 11.5%, respectively).

Because the distance to the water source varied greatly for houses within a given village, we examined the relationship between water availability and trachoma at the household level. The distance to the water source was associated with the prevalence of trachoma (Table 1). The proportion of households in which all children had trachoma increased with the time to the source from 37% among those living within 30 minutes, to 49% for those who lived 0.5–2 hours, to 50% among those living more than 2 hours away from the source.

Table 1: **Percentage of households that had children aged 1–7 years with trachoma, according to the time (distance) to the nearest water source**

Time to water source	Trachoma status of household (%)[a]		
	No children affected	Some children affected	All children affected
<30 minutes (389)[b]	38	25	37
0.5–2 hours (844)	27	24	49
>2 hours (705)	29	21	50

[a] $\chi^2 = 25.14$; $P < 0.001$.
[b] Figures in parentheses are the number of households investigated.

Concomitantly, the proportion of households in which no children had trachoma decreased as the distance to the water source increased. The proportion of households in which some but not all the children were infected with trachoma also declined as the distance to the source increased. There appeared to be little difference in the risk of trachoma once the households were greater than 30 minutes from the water source.

The risk of trachoma in the household as a function of distance to water, irrespective of the amount of water consumed and other confounding factors, was assessed using a logistic regression analysis (Table 2). The results suggest that, although the distance to the water source was associated with an increased risk of trachoma, the risk did not vary with the amount of water brought into the house (odds ratios of 1.01 and 0.84 for medium and large quantities, respectively). Again, the risk was similar for all households that were more than 30 minutes from the water source.

The distance travelled to water was itself probably not the determining factor in altering the risk of trachoma, but rather how the water was used within the household. We therefore investigated the relationship between the water variables and the observation of children with clean faces, under the assumption that if either the water source was closer or a greater amount of water was brought into the household, personal hygiene might improve, leading to a decreased risk of trachoma.

The distance to the water source was significantly associated with the presence of children with

Table 2: **Results of logistic regression analysis of the association between trachoma in the household by time (distance) to water source, quantity of household water, and other factors**

Variable	Odds ratio	95% Confidence interval
Time to water source:		
0.5–2 hours	1.45	1.08, 1.95
>2 hours	1.37	1.01, 1.87
Quantity of water:		
Medium	1.01	0.76, 1.35
High	0.84	0.61, 1.15
No. of children:		
2	2.49	1.93, 3.23
⩾3	5.16	3.63, 7.37
Herding cows	1.85	1.35, 2.56
House with a metal roof (versus flat or thatched)	0.63	0.47, 0.86
Traditional religion (versus Christian or Muslim)	1.71	1.28, 2.30
Sleeping next to a cooking fire	1.48	1.14, 19.2
Presence of unclean faces:		
Some children	1.30	0.82, 2.08
All children	1.70	1.22, 2.35

clean faces in households (Table 3). However, the decrease in cleanliness with increasing distance was not large; in 70% of households within 30 minutes of a water source all children had dirty faces, compared with 81% of households that were more than 2 hours away. The relationship between the presence of children with clean faces and the quantity of water brought into the house was even less marked (Table 3). Essentially the proportion of households in which all the children had clean faces, was the same, regardless of the amount of water that was brought into the house daily.

Modelling the water availability variables for children with clean faces indicates that only the distance to the water source was significantly associated with the presence of children with unclean faces (Table 4). In addition, children's faces were less likely to be clean if they were male, aged over 4 years, and if there was another child in the house whose face was also unclean. This clustering of children with unclean faces in households suggests further that hygiene behaviour is governed by family attitudes. The occurrence of families in which all the children had clean or all had unclean faces reinforces the understanding that decisions on child cleanliness are not likely to be made at the level of an individual child, but rather for all the children in the household together.

Table 3: **Distribution of children with clean faces, according to the time (distance) to the water source and the quantity of household water**

		Percentage of households with children		
	n	All clean	Some clean	All not clean
Time to water source:[a]				
<30 minutes	386	15	16	70
0.5–2 hours	831	11	14	75
>2 hours	691	10	9	81
Quantity of water:				
High	577	10	16	74
Medium	815	12	12	76
Low	516	12	10	78

[a] $\chi^2 = 21.85$; $P = 0.01$.

Table 4: **Results of polychotomous regression analyses of association of unclean faces in children aged 1–7 years by time (distance) to water source, quantity of household water, and other factors**

Variable	Odds ratio	*P*-value for logarithm of likelihood statistic
Time to water source:		
0.5–2 hours	1.14	
>2 hours	1.55	
Quantity of water:		
Low	1.12	0.20[a]
Medium	1.19	
Age of children[b]	—	0.001
Female children	0.82	0.001
Traditional religion (versus Christian and Muslim)	1.35	0.001
House with a metal roof (versus flat or thatched roof)	0.59	0.001
>1 child with an unclean face	8.27	0.001

[a] Not significant.
[b] Regression coefficient for continuous data = 0.199.

When the mothers were asked why their children's faces were not washed more frequently, almost half indicated lack of water as the reason (Table 5). Interestingly, this response did not vary markedly with the observed cleanliness of the children, suggesting that although mothers whose children had clean faces may have perceived that lack of water was a constraint to face washing, in practice they did manage to keep their children clean.

Discussion

These findings suggest that while access to water may be associated with trachoma, increased risk of the disease is probably not a simple, direct function of water availability. Simply providing each village with a functioning water supply will not reduce the prevalence of inflammatory trachoma in children in these villages since the prevalence was no different in

Table 5: **Distribution of mother's stated reasons for not washing their children's faces according to observed cleanliness**

Observed facial cleanliness of children	*n*	Reported reasons (%)				Frequency considered adequate by mother
		Insufficient water	Insufficient time	Child dislikes being washed	Forgetfulness	
Unclean	3081	51	12	7	4	27
Clean	643	45	7	2	2	43

villages with and without a constructed water supply.

One reason for the similar prevalences of trachoma may be that the households in the study villages were geographically quite dispersed, such that a bore hole may have been several miles from some families. Thus, a better measure of household access to water may be the distance to the water source rather than the presence of a village water supply. Our results suggest that households situated more than 30 minutes (one way) from the water source were at an increased risk for trachoma and were more likely to have children with unclean faces.

It is tempting to assume that the further the family is from a water source the less water is available and the less likely that the children's faces will be washed, leading to increased risk of transmission of trachoma within the family. However, our results show that the effect of distance to the water source is independent of the estimated daily amount of water brought into the household. Thus, children from families who live further away from the water source were less likely to have clean faces, regardless of the amount of water brought into the house. In fact, the daily quantity of household water was unrelated either to the prevalence of trachoma or the presence of children with clean faces.

These findings suggest that an important determinant of water use for hygiene purposes is the value placed on the water that is collected (*16*). For example, mothers who must travel long distances for water may be less likely to use it for face washing, regardless of the actual amount of water in the home. Thus, the mother's perception that there is insufficient water for face washing must be interpreted within the context of the utilization priorities she places on the water available in the home, and not as an absolute pronouncement on the unavailability of water.

Such findings have important implications for the design of trachoma intervention strategies. First, even if it were theoretically possible to have a water source within 30 minutes of each home, there is no evidence that this would alter water usage patterns. In fact, the results of other studies indicate that even when a water source is brought closer to the home, the amount of water brought into the house does not change dramatically (*17*), possibly because there has been no alteration of the allocation of the water within the home. Second, any intervention strategy must address the problem of the mothers' perception that lack of water is a major problem in changing hygiene behaviour, regardless of the amount of water brought into the house. In this respect, mothers' values regarding water usage and their priorities for its allocation must be further clarified and addressed within the context of an intervention strategy.

Further investigations are needed to determine how water is used by families with and without trachoma, what determines the priorities set by the mother for allocating water within the home, and how to work within these constraints on water use to effect change in personal hygiene behaviour.

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Résumé

Approvisionnement en eau et trachome

On a effectué une enquête épidémiologique sur les facteurs de risque liés au trachome inflammatoire afin d'étudier leur association avec plusieurs

paramètres de l'approvisionnement en eau. L'enquête a porté sur un échantillon aléatoire de vingt villages de la région de Kongwa, République-Unie de Tanzanie, de juillet à septembre 1986, et a couvert plus de 2000 foyers. On a recueilli des données relatives à la distance séparant les maisons des points d'eau, aux quantités d'eau rapportées quotidiennement dans chaque foyer et à la présence d'un point d'eau aménagé dans le village. On a répertorié le nombre de cas de trachome folliculaire et grave observés chez les enfants de 1 à 7 ans et les enquêteurs ont mentionné dans leurs fiches si les enfants avaient le visage propre ou non.

On n'a observé aucune différence dans la prévalence du trachome entre les villages possédant ou non un point d'eau aménagé. La fourniture d'un bon système d'approvisionnement en eau à un village ne devrait donc en elle-même pas avoir de répercussion importante sur la prévalence du trachome.

Le risque de contracter un trachome à domicile augmente avec la distance séparant la maison du point d'eau, même lorsqu'on maîtrise les autres facteurs de risque. Toutefois, le trachome n'a pas été associé à la quantité d'eau rapportée quotidiennement à la maison. D'après ces données, il semble que l'approvisionnement en eau n'ait pas une influence déterminante sur le risque de trachome, celui-ci dépendant pltôt des décisions prises à la maison sur la manière d'utiliser l'eau, en particulier en ce qui concerne la propreté.

Une analyse plus fine a indiqué que l'augmentation de la distance entre le foyer et le point d'eau était associée de façon significative à la malpropreté des enfants. Quelle que soit la quantité d'eau rapportée quotidiennement à la maison, 12% environ des foyers abritaient des enfants propres. Il semble que l'hygiène et la prévalence du trachome soient associées à la distance separant le foyer du point d'eau, mais pas à la quantité d'eau rapportée quotidiennement à la maison.

Les résultats de cette étude laissent à penser que l'approvisionnement en eau n'est peut-être pas le facteur le plus déterminant dans la prévalence du trachome, celle-ci dépendant plutôt des priorités observées au sein du foyer en ce qui concerne l'usage de l'eau. Ainsi, en matière de trachome, les stratégies d'intervention visant à modifier les comportements sur le plan de l'hygiène doivent porter sur la perception qu'ont les mères de famille de la valeur de l'eau et sur les priorités qui sont observées dans le ménage quant à son usage.

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