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Kashin-Beck disease and drinking water in Central Tibet

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Abstract A cross-sectional survey was carried out in order to study the relationship between Kashin-Beck disease and drinking water. The average volume of the water containers was larger in families unaffected by the disease. Organic material was measured by ultraviolet (UV) spectroscopy. The UV absorbency was significantly lower in drinking water of unaffected families. Thus, the organic material in drinking water may play a role in the pathogenesis of Kashin-Beck disease.

Résumé Une enquête a été effectuée afin d'étudier la relation entre la maladie de Kashin-Beck et l'eau de boisson. Le volume des containers de stockage d'eau était en moyenne plus élevé dans les familles non affectées par maladie. Les matières organiques ont été mesurées par spectroscopie ultra-violet (UV). L'absorption UV était plus basse, de façon significative, dans l'eau de boisson des familles non affectées par la KBD. Les résultats de cette enquête, confirment que les matières organiques dans l'eau peuvent jouer un rôle dans la pathogenèse de la maladie Kashin-Beck.

Introduction

High levels of organic material in drinking water are generally believed to be a risk factor for Kashin-Beck disease (KBD), in addition to selenium deficiency and mycotoxins on grain [2, 3].

Materials and methods

From May to August 1998, a cross-sectional survey was carried out in three prefectures of Tibet (Lhoka, Shigatse and Lhasa). The survey was carried out on 401 families (316 KBD families and 85 non-KBD families) grouped in 22 villages in the endemic regions. There were 901 children, aged from 5 to 15 years. A family was considered to be a "KBD family" when at least one of the children had clinical signs of the disease. In addition, 27 families from a non-endemic region were included in the survey.

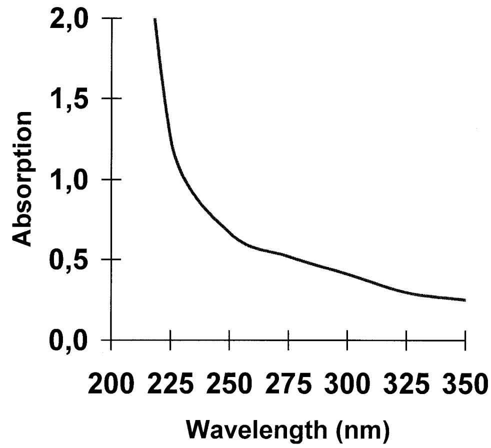

Fig. 1 Typical ultraviolet absorption spectrum for natural waters [1]

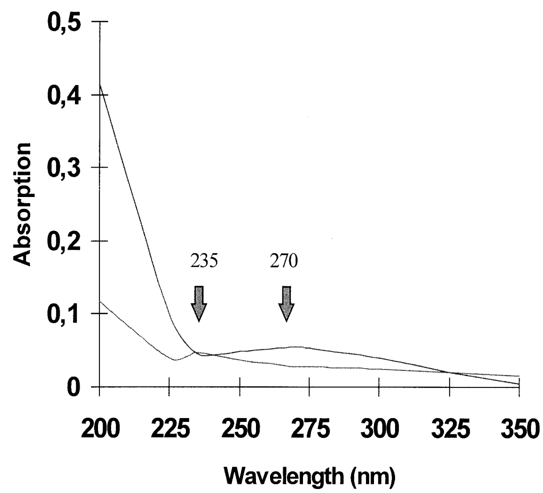

Fig. 2 Observed ultraviolet absorption spectra, when scanning water samples from storage water containers

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Table 1 Factors associated with Kashin-Beck disease in endemic areas

Variable	Kashin-Beck disease (*n*=316)	Non-Kashin-Beck disease (*n*=85)	Measure	*P*-value
Family water source (%)				<0.001
Concrete canal	3.9	1	b	
Earth canal	22.8	47	b	
River	54.7	37	b	
Spring	8.5	10	b	
Well	4.7	2	b	
Other	5.4	3	b	
Cleaning of transport container	84.2	94.0	b	0.017
Cleaning frequency of transport container (per month)	10	30	a	0.001
Type of storage container (%)				0013
Drum	9.8	10.0	b	
Jar	1.8	0.00	b	
Pot	15.6	5.0	b	
Standard	70.7	85.0	b	
Other	2.1	0.0	b	
Diameter of storage container (cm)	56.0	59.5	a	0.010
Volume of storage container (l)	98.5	108.0	a	0.001
Addition of products in storage container	13.2	3.0	b	0.007
>1 door in storage room	52.3	27.7	b	0.001
Presence of chimney in storage room	69.1	86.0	b	0.001
Location of ladle (%)			0.009	
On cover of storage container	29.8	16.0	b	
Hanging on wall	70.2	84.0	b	
Use of same ladle all year through	73.0	26.0	b	0.009

a, Median; b, percentage

Table 2 Factors associated with type of area (endemic versus non-endemic)

Variable	Endemic (*n*=401)	Non-endemic (*n*=27)	Measure	*P*-value
pH in storage container	7.485	7.710	a	0.003
Organic matter (absorbency at 254 nm)	0.078	0.041	a	<0.001
Organic matter (absorbency at 270 nm)	0.071	0.039	a	<0.001
Family water source (%)				<0.001
Concrete canal	3.2	0.0	b	
Earth canal	28.2	0.0	b	
River	51.2	51.8	b	
Spring	8.5	48.2	b	
Well	4.2	0.0	b	
Other	4.7	0.0	b	
Childrens' other water sources	96.6	56.4	b	<0.001
Cleaning of transport container	86.1	70.2	b	0.003
Transfer of water immediately	99.2	86.0	b	<0.001
Type of storage container (%)				0.001
Drum	10.3	5.2	b	
Jar	1.4	0.0	b	
Pot	12.9	3.5	b	
Standard	73.8	82.6	b	
Other	1.6	8.7	b	
Height of storage container (cm)	42.0	45.0	a	0.038
Diameter of opening in storage container (cm)	25.0	42.5	a	<0.001
Addition of products in storage container	11.1	50.9	b	<0.001
Fill frequency (per month)	35	14	a	<0.001
Emptying container	0.1	26.0	b	<0.001
>1 window in storage room	66.7	41.8	b	0.012

Water samples were collected from family storage containers. Organic matter was measured through ultraviolet (UV) spectrometry [4]. Full spectra from 200 to 500 nm were registered as well as the specific values at 254 nm and at 270 nm (Fig. 1 and Fig. 2).

Data were analyzed with Epi-Info 6.04 b and Stata 6.0 software. For categorical variables Pearson's chi-square test was used. Fisher's exact test was applied when appropriate and for continuous variables the Kruskal-Wallis test was used.

Results

Table 1 shows the parameters that were significantly associated with the presence of KBD in the families from villages where the disease was endemic. KBD families used the river as a drinking water source more frequently, while families without KBD more frequently took their drinking water from earth canals. Unaffected families cleaned their water container more frequently. In KBD families the volume of the containers was significantly smaller than that for non-KBD families.

In the endemic regions organic material, as measured by UV absorbency, was not significantly associated with the presence of KBD. However, the stratified analysis by type of UV peak appearing in the absorbency spectrum (peak at 235 nm, peak at 270 nm or no peak) showed that levels of UV absorbency were higher in KBD families when no peak was present (median 0.091 vs 0.061 $P<0.001$). When any peak was present, the UV absorbency was not associated with KBD (median 0.082 vs 0.097, $P=0.14$).

The variables significantly related to presence of KBD in the non-endemic region are shown in Table 2. Organic material in the storage containers, as measured by UV absorbency, was significantly lower in non-endemic regions, independently of the presence of UV peaks. In other respects the absence of peaks was more frequently found in the endemic region. Another important finding was that children in endemic areas more frequently used water from other sources than the family container when compared to children in non-endemic areas.

Discussion

As shown in previous studies the average size of the water container was smaller in KBD families. The possible mechanisms through which the size of the water container may influence the prevalence are hypothetical. First, organic material migrates to the walls of the container, lowering the intake of organic material. The greater the surface of the container wall, the less organic material remains suspended in the water. A second mechanism might be that a higher container would allow more sedimentation of suspended organic material and, hence, lower the intake.

The role of organic material has to be considered to be linked to the appearance of peaks in the absorbency spectra. In endemic regions, the UV absorbency was only higher in affected families when no peak was present. The meaning of these peaks with regard to specific substances remains to be clarified. However, in the non-endemic region, the values of organic material, were much lower than those in the endemic region, independently of the presence of UV peaks. The higher UV absorbency in drinking water of KBD families is compatible with earlier observations that drinking water of KBD families contained higher levels of humic (or more specifically fulvic) acids. However, analysis of the water sources and qualitative analysis of the water components should be carried out to further explore and understand the underlying processes of this association.

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