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STUDIES ON THE PREVALENCE OF *GIARDIA* CYSTS AND *CRYPTOSPORIDIUM* OOCYSTS IN SOUTH AFRICAN WATER

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ABSTRACT

The levels of *Giardia* cysts and *Cryptosporidium* oocysts in 650 environmental water samples were investigated. Cysts and oocysts were found in all types of water tested. The presence of *Giardia* cysts exceeded *Cryptosporidium* oocysts both in the number per sample and the number of positive samples. Almost 50% of sewage samples studied contained *Giardia* cysts and 30% contained both *Giardia* cysts and *Cryptosporidium* oocysts. Treatment of sewage resulted in a reduction in the percentage of samples containing cysts and/or oocysts (30% of treated effluent samples were positive for *Giardia* and 25% had both cysts and oocysts). Higher numbers of *Giardia* cysts were found in surface water samples than in either sewage or treated effluents (55% of surface water samples were positive). However, the number of cysts isolated per surface water sample was lower on average. Most water purification plants showed effective removal of cysts and oocysts. However, 13% of potable water samples contained protozoan parasites, indicating occasional failure of the purification processes and the need for monitoring final treated water.

KEYWORDS

Giardia cysts; *Cryptosporidium* oocysts; raw sewage; treated effluents; surface water; drinking water; guidelines; purification processes.

INTRODUCTION

The protozoan parasites *Giardia* and *Cryptosporidium* are recognised causes of diarrhoea in man. *Cryptosporidium* has been found to be responsible for 23% of cases of diarrhoea worldwide while *Giardia* prevalence in the population has been indicated to be as high as 24%, depending on the lifestyle, socio-economic level and the general health of the community (Fayer and Ungar, 1986; Feachem *et al.,* 1983). In recent years the incidence of giardiasis and cryptosporidiosis has reached epidemic proportions throughout the world and at present *Giardia* and *Cryptosporidium* are implicated as the main causes of waterborne parasitic epidemic disease (Erlandsen and Bemrick, 1988). Both cysts and oocysts are known to be highly resistant to environmental stress and can withstand extreme environmental conditions. Cysts and oocysts have also been found to be more resistant to certain water purification processes than other bacterial indicators (Hibler and Hancock, 1990; Rose, 1990).

In recent years urban and rural settlements along South Africa's rivers and dams have been increasing. Such settlements are often informal and have no infrastructure, resulting in increased levels of pollution of drinking water sources. Studies in other parts of the world indicate that contamination of surface water by domestic sewage coincides with increased levels of parasites. In South Africa, although limited clinical data indicate the prevalence of these protozoan parasites in the population, little is known about the spread of cysts or oocysts in the country's waterways and drinking water supplies.

In this study the occurrence of *Giardia* cysts and *Cryptosporidium* oocysts in raw sewage, treated effluent, surface water and drinking water was investigated. The efficacy of sewage treatment facilities and drinking water purification plants in the removal of cysts and oocysts of protozoan parasites was also addressed.

MATERIALS AND METHODS

Sample Collection

Samples of 10l each were collected for the analysis of surface water and drinking water, while 4.2l of raw and treated effluent were studied. A total of 650 raw sewage, treated effluent, surface and drinking water samples were investigated over a 3-year period.

Concentration and Identification Techniques

Sewage and treated effluent samples were concentrated using a settling technique. Surface and drinking water samples were concentrated using a flat-bed membrane filtration system (Millipore filters, pore size 1.2 µm). After filtration the sediment collected on the membrane was sonicated in 10ml of the original sample for 10 min and thereafter removed from the membrane filter using a rubber policeman and centrifuged for 3 min at 500xg. The Hydrofluor Combo kit (Meridian Diagnostics) was used for identifying presumptive *Giardia* cysts and *Cryptosporidium* oocysts.

Table 1. The ranges of *Giardia* cyst and *Cryptosporidium* oocyst numbers in South African waters

	Water sample	*Giardia* cysts/10ℓ	*Cryptosporidium* oocysts/10ℓ
Raw sewage	Minimum	0	0
	Maximum	1790	500
	Average	130	30
Treated effluents	Minimum	0	0
	Maximum	3910	450
	Average	120	30
Surface water	Minimum	0	0
	Maximum	460	250
	Average	30	6
Drinking water	Minimum	0	0
	Maximum	4	1
	Average	2	0

RESULTS AND DISCUSSION

Giardia cysts and *Cryptosporidium* oocysts were isolated from all the types of water studied despite relatively small volume water samples having been tested (Table 1). In other studies 100-1000l of water samples were concentrated prior to the enumeration of protozoan cysts and oocysts (LeChevallier *et al.*, 1991).

The presence of *Giardia* cysts exceeded *Cryptosporidium* oocysts in South Africa's surface water, both in numbers and percentages of positive samples (Table 1, Fig. 1c). This indicates a different trend than that reported in other parts of the world where *Cryptosporidium* oocysts often outnumbered *Giardia* cysts (Stetzenbach *et al.*, 1988). It can be explained by possible contamination of the surface water with *Giardia* cysts of non-human origin as the identification kit used is pan specific. However, the relatively high levels of *Giardia* cysts in the raw sewage samples (Fig. 1a) may indicate a high prevalence of giardiasis in the South African population with the possibility of a high carrier rate. The occurrence of both protozoan parasites in the same water sample was limited, with the highest percentage (2,9%) of combined occurrence having been found in surface water and the lowest in the raw sewage samples. This contrasts with results of other studies showing that the two protozoan parasites often co-exist in polluted water (Madore *et al.*, 1987).

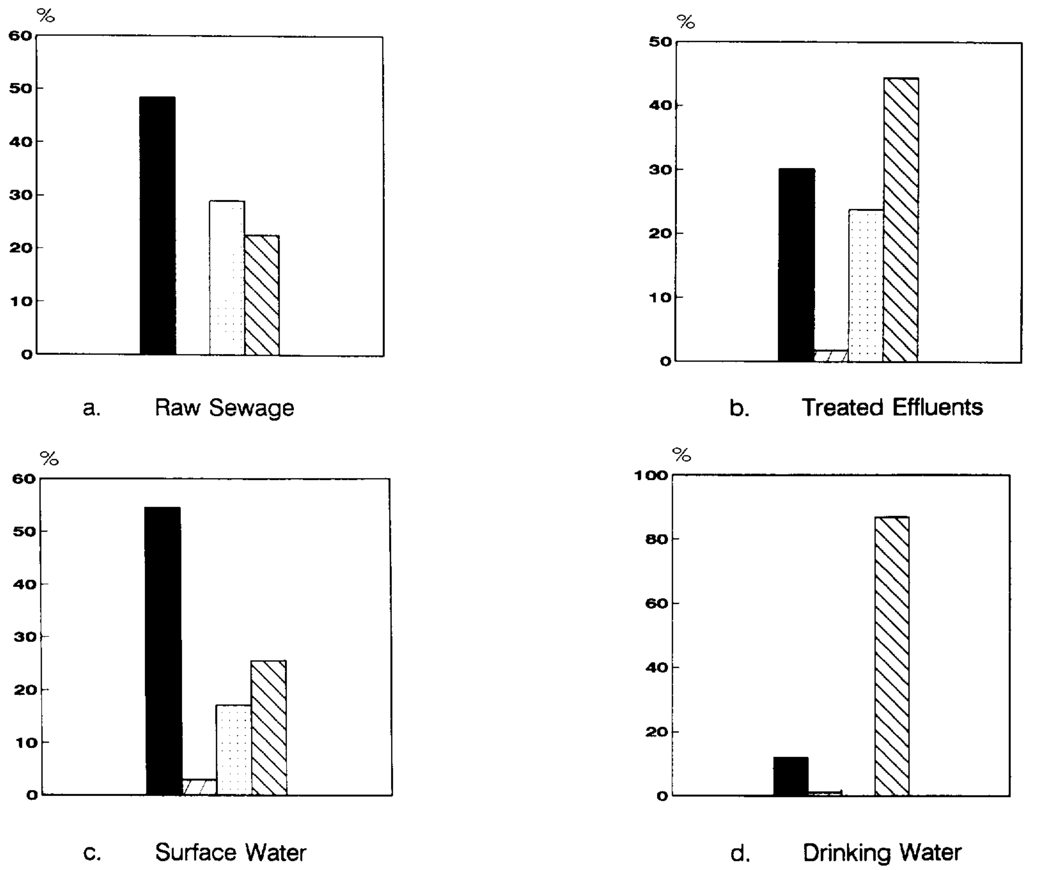

Figure 1. The occurrence of protozoan parasite cysts and oocysts in water G = *Giardia*, C = *Cryptosporidium*.

The percentage of treated effluent samples polluted by *Giardia* cysts was lower than that found for raw sewage, while the average number of cysts per sample was similar (Fig. 1a, b). The range, average counts and percentage of samples polluted with *Cryptosporidium* oocysts were similar for raw sewage and treated effluents (Fig. 1a, b). Some elimination of the protozoan parasite cysts due to sewage treatment was indicated, however, as 44.3% of the treated effluent samples were free of cysts and oocysts compared with 22.6% of raw sewage samples (Fig. 1a, b). Only 25.5 % of the surface water samples tested were free of protozoan parasites. However, the cyst or oocyst counts of the surface water were markedly lower than for the raw sewage (Table 1).

About 87% of the final treated water samples tested were free of protozoan parasites with only 1.1% of the samples being positive for *Cryptosporidium* oocysts and 12.1% for *Giardia* cysts. However, a very low number of cysts or oocysts were found (Table 1).

CONCLUSIONS

The results of this study highlight the great importance of formulating water quality guidelines incorporating limits for protozoan parasite cysts and oocysts and recommended procedures to be followed in treatment facilities for the successful removal or inactivation of these parasites, especially in developing countries where the risk of surface water contamination by protozoan parasites may be very high.

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