# Occurrence of Helminths and Protozoan Parasites (*Giardia* and *Cryptosporidium*) in the Filling Vaults of Urine Diversion (UD) Toilets in the eThekwini Municipal Area (Durban, South Africa)

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*Abstract*

*The City Health Department of eThekwini Municipality and UKZN School of Medicince recently completed a large-scale epidemiological study aimed at comparing the health of rural communities within eThekwini Municipality which: (a) had been provided with water supply, sanitation by means of Urine Diversion (UD) toilets and health education, versus (b) had not yet been serviced. The major indicator of health status was taken to be diarrhoeal indicidence during the study period. The epidemiological project is in its final stages and has yielded a comprehensive database of information, which is potentially highly useful to the wider reseach community. Since the project was epidemiological in nature, no microbiological data regarding the possible agents of diarhoeal disease were gathered. A pilot project was therefore undertaken examining the incidence of helminthic and protozoan parasites in a sub-sample of the toilets of househlds included in the epidemiological study. Attention was focussed on these organisms because of the relative resistance of their reproductive structures to adverse environmental conditions, hence their relatively higher likelihood of surviving the standing phase of the UD toilet vaults. . Approximately 120 samples were collected over two weeks, with approximately equal numbers sampled from each of the two geographical areas. All samples were screened for presence of Giardia, Cryptosporidium and Ascaris. Results were analysed with respect to the frequency of parasite occurrence, correlation of incidences of the different parasites with each other, and of the overall occurrence of parasites with incidence of diarrhoeal disease as recorded in the epidemiological study.*

## Introduction

The Environmental Health Department and Water and Sanitation Section (EWS) from eThekwini Municipality (Durban, South Africa), in collaboration with the World Health Organisation (WHO-Geneva), Swedish Institute of Infectious Disease Control (Sweden), The Nelson R Mandela School of Medicine (UKZN – Durban) conducted an epidemiological study to evaluate the health outcomes of providing UD toilets, together with provision of water and hygiene programmes. The study took the form of an observational analytical cohort study, and compared health outcomes in intervention areas (receiving UD toilets, water and hygiene education) to those control areas of similar socioeconomic and demographic stratification, but without UD toilets (3).

The epidemiological project is in its final stages and has yielded a comprehensive database of information, which is potentially highly useful to the wider research community. Since the project was epidemiological in nature, no microbiological data regarding the possible agents of diarhoeal disease was gathered. A pilot project was therefore undertaken examining the incidence of helminthic (*Ascaris, Trichuris trichuria* and *Taenia* sp.) and protozoan parasites (*Giardia* and *Cryptosporidium*) in a sub-sample of the toilets of households included in the epidemiological study. *Ascaris* is the major pathogen of concern along the KwaZulu-Natal coastline, with incidence as high as 70% recorded in some communities. Attention was focused on these organisms because of the relative resistance of their reproductive structures to adverse environmental conditions, hence their relatively higher likelihood of surviving the standing phase of the UD toilet vaults.

The hypothesis tested in the pilot collaborative project was that households with high and low risks of diarrhoeal disease, as identified in the epidemiological study, would correlate with presence and numbers of parasites detectable in fresh waste from UD toilet. The research team of the epidemiological study identified high risk and low risk areas. The pilot project team was blinded to the nature of the households to be sampled, these being identified only by a reference number.

## Materials and Methods

Samples were collected from UD toilet vaults from two rural (Sawpitts and Mtamuntengayo) communities outside Durban. Approximately 120 samples were collected over two weeks, with approximately equal numbers sampled from each of the two geographical areas. All samples were screened for presence of helminthic and protozoan parasites. Initial screening for cysts and (oo)cysts of protozoan parasites was conducted using fluorescent-stained antibodies to the walls of these organisms (USEPA method 1623). The AMBIC protocol developed by the Pollution Research Group was used to screen for *Ascaris, Trichuris* and *Taenia* sp. Ova (2).

Results were analysed with respect to the frequency of parasite occurrence, correlation of incidences of the different parasites with each other, and of the overall occurrence of parasites with incidence of diarrhoeal disease as recorded in the epidemiological study.

## Results and Discussion

Only 13 (± 10%) of the 124 households sampled were found to be negative for the presence of both protozoan and helminth parasites. *Ascaris* infections were detected in 60% of the 124 samples (Figure 1). This was followed by *Giardia* (55%), *Trichuris* (50%), *Cryptosporidium* (21%) and *Taenia* sp. (11%). However, 60% of the samples contained either *Cryptosporidium* or *Giardia* (oo)cysts. A worrying aspect was the elevated prevalence of *Taenia* sp. in the communities.

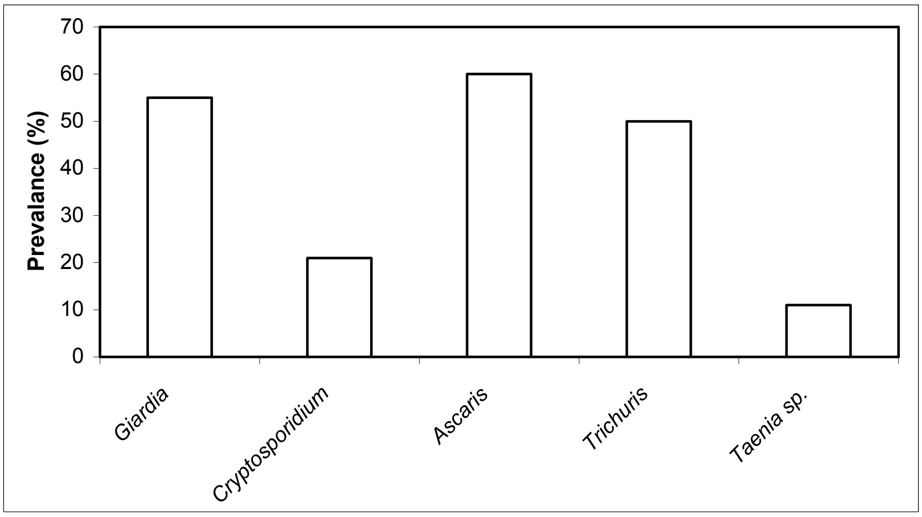


**Figure 1:** Prevalances of helminthic and protozoan parasitic infections for the 2 communities sampled, Sawpitts and Mtamuntengayo (n=124).

Sawpitts (n = 57) had higher prevalence of *Ascaris* (72%), *Trichuris* (55%) and *Taenia* (15%) in the vault currently in use than Mtamuntengayo (n=67) (Figure 2). One possible explanation for this could be the denser population in Sawpitts. It was also noted that although some households were supplied with UD toilets, they were not being used and therefore suggested that the community may in fact be practicing "open" defecation. Alternatively it is known that prevalence rates are higher at the coast and decrease gradually with increasing altitude (1).

Mtamuntengayo (n = 67) was positive for either *Cryptosporidium* or *Giardia* in 63% of the samples. In 39% of the samples only *Giardia* was found and 7% of the samples for *Cryptosporidium*. Both *Cryptosporidium* and *Giardia* were only found in 16% of the samples (results not shown). Sawpitts (n = 57) was positive for either *Cryptosporidium* or *Giardia* in 58% of the samples. In 40% of the samples only *Giardia* was found and 4% of the samples for *Cryptosporidium*. Both *Cryptosporidium* and *Giardia* were only found in 14% of the samples (results not shown).

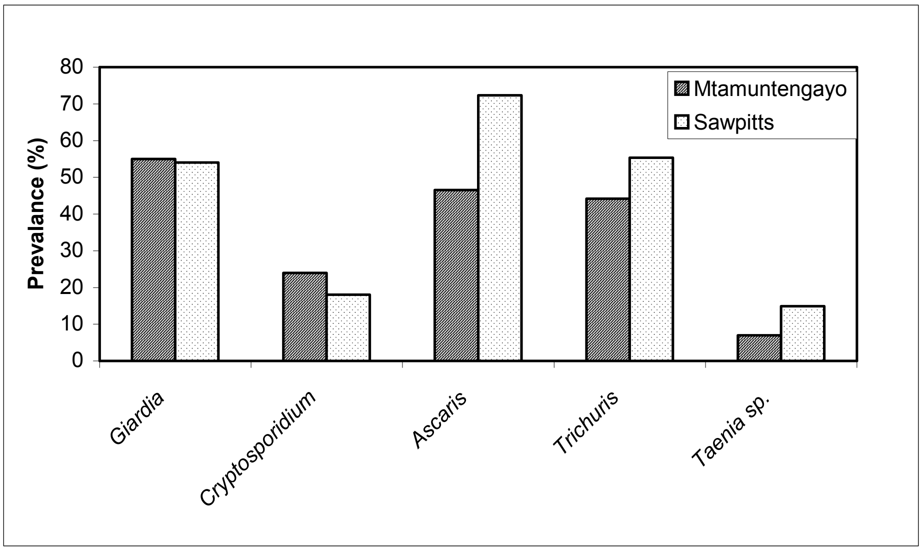


**Figure 2:** The difference in parasite prevalances between 2 peri -urban communities.

The data were further broken down into the number of parasite infections per vault (Figure 3) and then by individual community (Figure 4) for helminth infections. Single vault helminth infections (41%), most commonly *Ascaris*, dominate this category. Infection by 2 helminth parasites (28%) followed single infections in prevalence. *Ascaris* was in most cases accompanied by *Trichuris* in this category. When separating the two communities on the basis of number of infections per vault, a different pattern emerges: Sawpitts had elevated double infections and less negative samples compared to that of Mtamuntengayo. This again may be associated with the denser peri – urban settlement and its location within the coastal belt where prevalance rates can be greater then 80%.

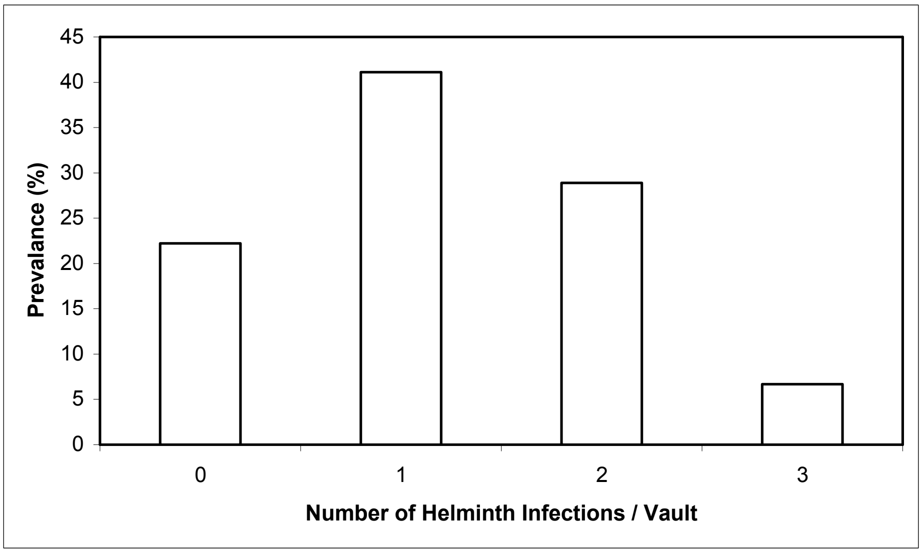


**Figure 3:** Prevalance of multiple helminth infections per vault taken from samples of the 2 peri-urban communities.

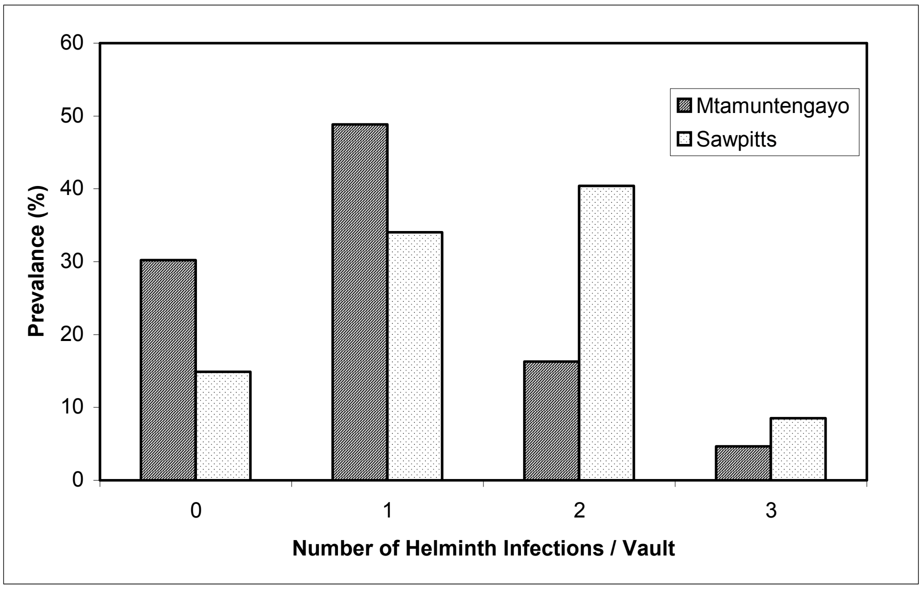


**Figure 4:** Prevalence of multiple helminth infections per UD vault reflected for individual communities sampled in the study.

One important question that should be raised before drawing any conclusions regarding prevalence of pathogens based on sampling from UD toilets, is how many people that are linked to one sample. For example (protozoan infections), of the 124 samples taken, 55% contained *Giardia* and 21% contained *Cryptosporidium* (Figure 5). If an average family contains five people, the resulting percentage figures could mean that as a maximum 341 individuals in the areas were infected with *Giardia* and 130 people were infected with *Cryptosporidium*. With the same line of reasoning, it would be possible to state that 372 individuals (60%) in the selected households can be infected with one or both of these two protozoa. It should however be noted that not all the family members need to have the infection. Especially in the lower categories (1000 – 10 000 [oo]cysts/g faeces) the numbers probably relate to a single infected individual, while in the high level range (100 000 – 1000 000[oo]cysts/g faeces) probably several household individuals are infected. It is not possible to link the results from a study such as this, which is based on sampling from family toilets, to prevalence on an individual level. However, the results show a hypothetical number of infected individuals, and it is not an unlikely figure. On the other hand, the prevalence could be expressed as number of families with one or several infected individuals instead. If extrapolating the results from this study to include all of the 1 337 households in the epidemiological study, the suggestion would be that 802 families have one or more members infected with one or both of the protozoan parasites (*Giardia* or *Cryoptosporidium*).

The results show a high level of infected households in the peri-urban areas that were subjects for the investigation. These results are consistent with another study with a similar approach, undertaken in 2002, in which 82% of the investigated households had Giardia, 70% had Cryptosporidium and 65% had both pathogens (4). These two studies both underscore the cause of concern that intestinal pathogenic protozoa are likely to be endemic in areas with limited hygiene resources and very low socio-economic standards.

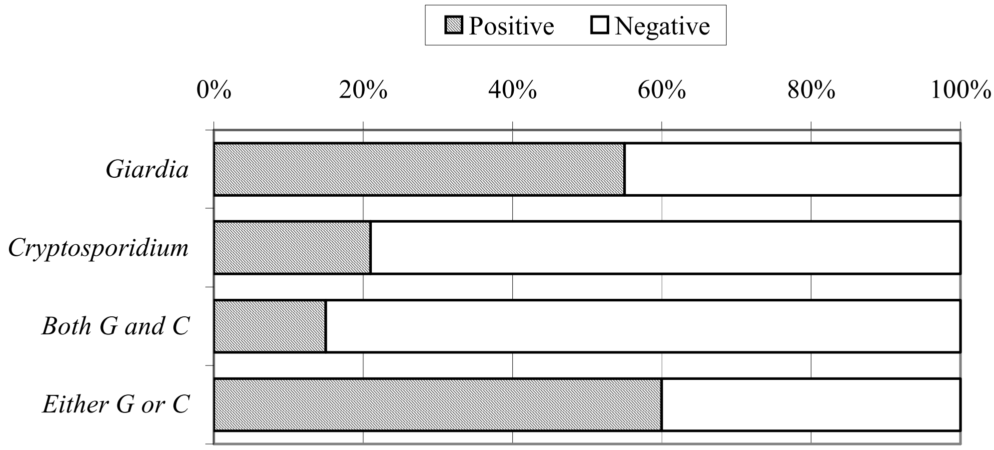


**Figure 5:** Prevalence of protozoan infections in the 2 communities sampled (n=124).

Initially, it was hypothesized that there should be a higher occurrence of (oo)cysts in Sawpitts than in Mtamuntengayo. Sawpitts was denser populated and the houses were often in a worse shape than in Mtamuntengayo, which was more remote and had, in some cases, vast stretches of land separating farms. The people in Sawpitts were living closer together and the differences in standard amongst the people were bigger in this area than in Mtamuntengayo. However, the occurrence of (oo)cysts was lower in Sawpitts than in Mtamuntengayo. The difference, however, was not significant (P>0.05).

Some households, especially in Sawpitts, that were visited did however not use their UD toilet and since samples only could be taken from those particular toilets, some households could not participate in this study. Hence, the households that have a conventional flush or "pour flush" system connected to a tank or soak pit might be carriers of *Giardia* or *Cryptosporidium* without contributing to the figures in this study. In addition, if the householders prefer "open defecation" in the bush instead of using their UD toilet, which was the case more often in Sawpitts than in Mtamuntengayo, this could also contribute to some problems with estimating the true occurrence. Therefore, the hypothesis might still be true even though it could not be shown here.

## Conclusions

- Sampling directly from the deposited faecal material is useful for both a screening assessment of family based prevalence and as a further base for environmental risk assessment of the material in urine diversion toilets.
- It can be concluded that a high prevalence of both protozoan and helminth parasite infections occur in the communities
- No correlation between the prevalances of both protozoan and helminthic parasites on diarrhoeal frequencies was found (p>0.05). It is however, reassuring that the material sampled is contained in UD vaults and not in an open environment.
- The information gathered can be incorporated into microbial risk assesments.
- The information gives a general idea of the general parasite load within individual communities.

## References

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