ORIGINAL RESEARCH

INTESTINAL PARASITES IN ST LUCIA: A RETROSPECTIVE, LABORATORY-BASED STUDY

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ABSTRACT

Objective: To investigate the epidemiology of intestinal parasitic infections and the presence of Schistosomiasis in the island of St. Lucia. **Methods:** A retrospective survey was conducted using data from hospitals and diagnostic laboratories on the island. A total of 10,735 stool samples were recorded from 10,508 individual people during January 2002 to December 2005. **Results:** The study yielded an overall parasitic prevalence of 26.1% (n=2807) with 95%-confidence interval (95% CI) = 24.5 - 27.7. The overall prevalence of helminthes infection was 13.3% (n=1424; 95% CI = 11.5 – 15.1) with hookworm, *Ancylostoma duodenale* or *Necator americanus* contributing most to the prevalence with 4.8%, followed by *Strongyloides* 2.9%, *Ascaris lumbricoides* 2.5%, *Trichuris trichiura* 2.5%, *Schistosoma mansoni* 0.3% and *Taenia sp*. 0.1%. The prevalence for all intestinal protozoans was 12.9% (n=1383; 95% CI = 11.1 – 14.7) with *Entamoeba coli* contributing most to the protozoan prevalence with 5.6%, followed by *Endolimax nana* 4.1%, *Iodamoeba butschli* 1.1%, *Entamoeba histolytica/ E.dispar/ E. moshkovski* 1.1%, *Giardia lamblia* 0.6 % and *Entamoeba hartmanni* 0.2%. **Conclusion:** The study has provided important data on the epidemiology of intestinal parasitic infection present in the community of St Lucia and supports the need for a well designed community based intervention study.

KEYWORDS: Helminthes; Protozoa; St Lucia; Caribbean.

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INTRODUCTION

Helminthes and protozoan parasitic infections have been reported on most of the Caribbean islands, with hookworms, *Trichuris trichiura*, *Ascaris lumbricoides* and *Strongyloides stercoralis* reported as the most commonly occurring infections (Howard 2002; Junck 2003; Hotez 2003). Pan American Health Organization (PAHO)/World Health Organization (WHO) estimates that 20% to 30% of those living in Latin America and the Caribbean are infected with one of several intestinal helminthes and/or schistosomiasis (PAHO/ WHO 2007).

The transmission, occurrence and pathology of human parasitic infections have long been known to be associated with various socio-economic factors including specific occupations, household clustering, and behaviors. There is a strong association between poverty and prevalence and intensity of infection (Benthony 2001; Legesse & Erko 2004; Drake et al., 2005).

St Lucia is a Caribbean island of volcanic origin of 616 sq km with a total population of about 165,000. To date a systematic examination and investigation of the distributions of helminthes and protozoan has not been completed on this island. This study represents the first island wide study that attempted to identify the epidemiology of helminthes and protozoan infections in St. Lucia

METHODS

The study examined stool sample records contained in a computerized and a written log from hospitals and private testing laboratories on the island. The sampling data was collated from January 2002 to December 2005 representing 48 months of continuous data. The stool examination method was a direct smear, and 10% formalin concentration method (Ritchie 1948; Anonymous 1978; Garcia & Bruckner 1993). A total of 10,735 stool samples were recorded from 10,508 individual people.

All stool samples records were examined and positive results for helminthes eggs and larvae and/or protozoan infections were noted. Variations in distribution patterns of positive stool samples between males and females, age groups, and different geographical regions were determined. For the spatial analysis the eight health regions defined according to the Ministry of Health of St Lucia were considered: Region 1 Gros Islet; Region 2 Babonneau; Region 3 Dennery; Region 4 Micoud; Region 5 Vieux Fort; Region 6 Soufriere; Region 7 Anse-La-Ray; and Region 8 Castries (Figure 1). Prevalences were reported together with 95%-confidence intervals (95%-CI). Chi-square tests were used to compare between gender, age groups and geographical regions. Data analysis was conducted using SPSS version 9.0 (SPSS Inc, Chicago, Illinois).

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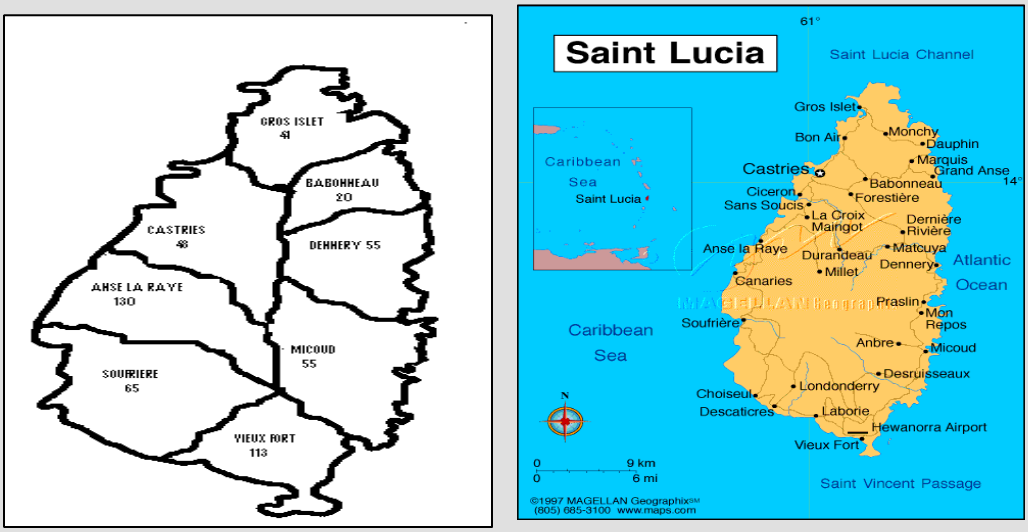
Figure 1: The Caribbean Island of St Lucia and its eight health regions.



RESULTS

A total of 10,735 stool samples were recorded between the year 2002 and 2005, of which 26.1% (n=2807; 95% CI = 24.5 – 27.7) of samples were positive for intestinal parasites. The total prevalence of helminthes infection, 13.3% (n=1424; 95% CI = 11.5 – 15.1) showed no difference when compared with the total prevalence in protozoan infection, 12.9% (n=1383; 95% CI = 11.1 – 14.7). Of the total number of helminthes infections recorded during the study a yearly increase was noted with n=272, n=332, n=382 and n=438 for the years 2002, 2003, 2004, and 2005 respectively (Table 1a). The overall helminthes prevalence against the total population of St Lucia showed a steady increase from 0.17% in 2002, 0.21% in 2003, 0.24% in 2004, to 0.27 % in 2005.

A total of six helminthes species were recorded over the four years and in all recorded years, the greatest proportional contribution of any one helminthes infection was that of the hookworm 4.8%. The second, third and fourth most common infections and subsequently their proportional contributions were *Strongyloides with* 2.9%, *Ascaris lumbricoides* with 2.5%, and *Trichuris trichiura* with 2.5%, respectively. *Taenia sp* (0.1%) and *Schistosoma mansoni* (0.3%) contributed least proportional to the total recorded infection on the island.

The prevalence of helminthes was higher in women (51.2%) compared to men (48.8%) ($p<0.05$). The male cohort showed a greater proportional contribution of hookworm and *Strongyloides* whereas the female cohort had a greater proportional contribution of *Ascaris lumbricoides, Trichuris trichiura* and *Schistosoma mansoni* in all recorded years (Table 1a). *Taenia solium* contributed to about 0.1% of the total helminthes infection though the prevalence was increased from marginally from 0 in 2002 to 8 in 2005 (Table 1a).

Table 1a: Prevalence (in percent) of helminthes stratified by year and host gender (n = number infected).

Parasite	2002			2003			2004			2005			Sample Total
	Male	Female	Year Total	Male	Female	Year Total	Male	Female	Year Total	Male	Female	Year Total	
Trichuris trichiura	2.3 (28)	1.3 (21)	1.7 (49)	1.8 (24)	2.0 (34)	1.9 (58)	2.2 (26)	2.6 (42)	2.4 (68)	3.2 (29)	5.2 (61)	4.3 (90)	2.5
Ascaris lumbricoides	0.7 (9)	2.0 (33)	1.5 (42)	2.3 (31)	1.9 (32)	2.1 (63)	2.3 (27)	3.2 (52)	2.8 (79)	3.3 (30)	4.5 (53)	4.0 (83)	2.5
Strongyloides	3.5 (42)	0.9 (15)	2.0 (57)	3.5 (47)	1.4 (23)	2.3 (70)	3.8 (45)	2.6 (41)	3.1 (86)	5.9 (53)	3.9 (46)	4.8 (99)	2.9
Hookworm	5.4 (64)	2.8 (46)	3.9 (110)	5.1 (69)	3.4 (58)	4.2 (127)	4.8 (56)	4.7 (76)	4.8 (132)	9.7 (88)	4.9 (58)	7.0 (146)	4.8
Schistosoma mansoni	0.2 (9)	0.2 (4)	0.2 (6)	0.4 (6)	0.4 (7)	0.4 (13)	0.2 (2)	0.4 (6)	0.3 (8)	0.2 (2)	0.4 (5)	0.3 (7)	0.3
Taenia solium	0	0	0	0.1 (1)	0	0.0 (1)	0.3 (3)	0.2 (3)	0.2 (6)	0.4 (4)	0.3 (4)	0.4 (8)	0.1
Sample size	1193	1637	2830	1354	1697	3051	1175	1602	2777	903	1174	2077	10735

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The total number of protozoan infections recorded over the four year time period showed no general trend, with n=281, n=353, n=414 and n=335 for the years 2002, 2003, 2004 and 2005, respectively (Table 1b). In total six species of protozoan were recorded with the greatest proportional contribution made by *Entamoeba coli* (5.6%). The second, third and fourth greatest contributors to the total infected population were *Endolimax nana* (4.1%), *Iodamoeba butschlii* (1.1%), and *Entamoeba histolytica/ E.dispar/ E. moshkovski* (1.1%). *Giardia lamblia* (0.2%), and *Entamoeba hartmanii sp.* (0.2%) contributed marginally to the total protozoan infection. The prevalence of protozoan was higher in females (53.7%) compared to males (46.3%)($p<0.05$). Examining the individual species of protozoan species showed no variation between the genders (Table 1b)

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Table 1b: Prevalence (in percent) of protozoan stratified by year and host gender (n = number infected).

Parasite	2002			2003			2004			2005			Sample Total
	Male	Female	Year Total	Male	Female	Year Total	Male	Female	Year Total	Male	Female	Year Total	
Entamoeba coli	4.3 (51)	4.2 (69)	4.2 (120)	5.5 (74)	4.1 (70)	4.7 (144)	6.7 (79)	6.0 (96)	6.3 (175)	7.5 (68)	7.8 (91)	7.7 (159)	5.6
Endolimax nana	3.4 (41)	2.6 (43)	3.0 (84)	4.8 (65)	3.6 (61)	4.1 (126)	5.5 (65)	4.6 (73)	5.0 (138)	4.1 (37)	5.0 (59)	4.6 (96)	4.1
Iodamoeba butschli	1.1 (13)	1.1 (18)	1.1 (31)	1.1 (15)	1.2 (20)	1.1 (35)	1.4 (17)	1.0 (16)	1.2 (33)	1.2 (11)	0.9 (11)	1.1 (22)	1.1
Giardia lamblia	1.0 (12)	0.2 (4)	0.6 (16)	0.8 (11)	0.5 (9)	0.7 (20)	0.4 (5)	0.7 (12)	0.6 (17)	0.4 (4)	0.5 (6)	0.5 (10)	0.6
Entamoeba histolytica/ E.dispar/ E. moshkovski	0.4 (5)	1.0 (16)	0.7 (21)	0.4 (6)	0.9 (15)	0.7 (21)	1.9 (22)	1.1 (17)	1.4 (39)	2.1 (19)	1.4 (16)	1.7 (35)	1.1
Entamoeba hartmani	0.3 (4)	0	0.1 (4)	0.1 (2)	0.2 (4)	0.2 (6)	0.3 (3)	0.2 (3)	0.2 (6)	0.6 (5)	0.3 (4)	0.4 (9)	0.2
Sample size	1193	1637	2830	1354	1697	3051	1175	1602	2777	903	1174	2077	10735

Age group specific prevalence of helminthes was lowest in the 40 to 49 year age group and highest in the 0 to 9 year age group. Examining the distribution of specific helminthes within the host age groups, *Ascaris lumbricoides, Trichuris trichiura* and *Strongyloides* showed highest prevalences in the 0 to 9 year age group. Whereas, hookworm and *Taenia solium* were more prevalent in the 10 to 19 year age group (Table 2a).

Table 2a: Prevalence (in percent) of helminthes stratified by host age (n = number infected).

Age group [in years]	0-9	10-19	20-29	30-39	40-49	50-59	60-69	>70
Trichuris trichiura	5.0 (16)	4.9 (53)	2.6 (85)	2.3 (60)	1.3 (23)	0.9 (8)	2.2 (11)	3.1 (9)
Ascaris lumbricoides	5.7 (18)	3.6 (39)	2.5 (83)	2.3 (59)	1.7 (31)	2.1 (19)	2.9 (14)	1.4 (4)
Strongyloides	7.9 (25)	5.1 (55)	2.4 (79)	2.0 (52)	2.1 (38)	3.3 (30)	5.1 (25)	2.7 (8)
Hookworm	7.9 (25)	8.5 (92)	4.3 (140)	3.7 (94)	3.9 (71)	6.2 (57)	4.1 (20)	5.5 (16)
Schistosoma mansoni	0	0.5 (5)	0.3 (10)	0.3 (7)	0.3 (6)	0.3 (3)	0.2 (1)	0.7 (2)
Taenia solium	0.3 (1)	0.4 (4)	1	0.2 (5)	0.2 (4)	0	0	0
Age group prevalence	26.8 (85)	23.0 (248)	12.2 (397)	10.8 (277)	9.6 (173)	19.2 (117)	14.5 (71)	13.4 (39)
Sample size	317	1079	3266	2570	1799	921	489	291

Age group specific prevalences for protozoan were lowest in the 30 to 39 year age group and highest in the 0 to 9 year age group (Table 2b). Examining the distribution of specific protozoa's, *Endolimax nana* and *Giardia lamblia* had the highest prevalence in the 0 to 9 year age group whereas *Entamoeba coli, Entamoeba histolytica/ E.dispar/ E. moshkovski,* and *Entamoeba hartmani* had the highest prevalence in the 10 to19 year age group. One protozoan *Iodamoeba butschli* was found to have an equal prevalence in the 10 to19 and the 60 to 69 year age groups.

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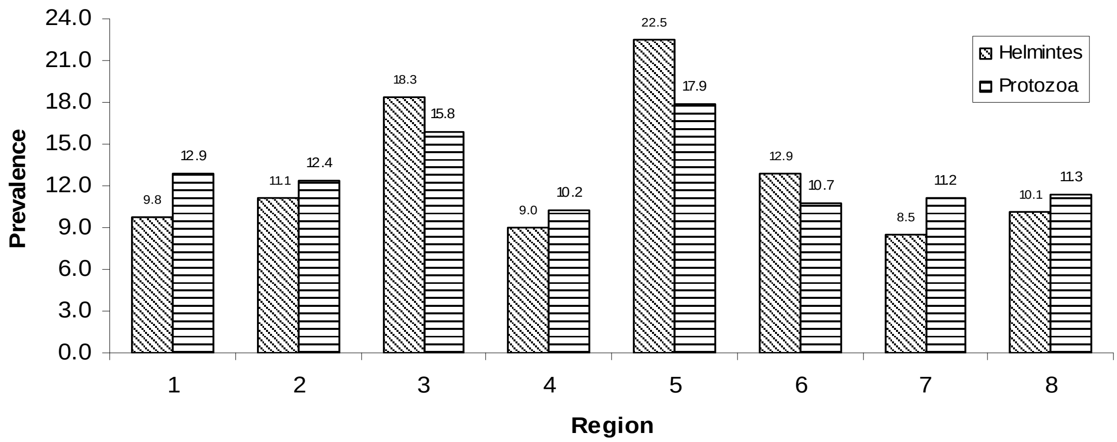
Table 2b: Prevalence (in percent) of protozoan stratified by host age (n = number infected).

Age group [in years]	0-9	10-19	20-29	30-39	40-49	50-59	60-69	>70
Entamoeba coli	7.3 (23)	8.7 (94)	5.0 (164)	4.6 (117)	5.2 (93)	6.3 (58)	5.9 (29)	6.9 (20)
Endolimax nana	8.8 (28)	5.7 (62)	4.1 (134)	3.8 (97)	3.5 (63)	3.4 (31)	3.3 (16)	4.5 (13)
Iodamoeba butschli	1.6 (5)	1.8 (19)	0.8 (26)	0.9 (23)	1.6 (28)	1.0 (9)	1.8 (9)	0.7 (2)
Giardia lamblia	0.9 (3)	0.7 (8)	0.7 (22)	0.5 (13)	0.4 (7)	0.8 (7)	0.2 (1)	0.7 (2)
Entamoeba histolytica/ E. dispar/ E. moshkovski	1.6 (5)	1.8 (19)	0.9 (29)	0.9 (22)	1.1 (19)	1.6 (15)	1.0 (5)	0.7 (2)
Entamoeba hartmani	0	0.6 (7)	0.1 (3)	0.2 (5)	0.3 (5)	0.3 (3)	0.2 (1)	0.3 (1)
Age group prevalence	20.2 (64)	19.4 (209)	11.6 (378)	10.8 (277)	12.0 (215)	13.4 (123)	13.7 (67)	13.8 (40)
Sample size	317	1079	3266	2570	1799	921	489	291

The regional distribution of helminthes infections showed the highest prevalence in region 5 with 22.5 % (n=522) followed by region 3 with a prevalence of 18.3% (n= 66), whereas regions 6 and 2 contributed with a prevalence of 12.9% (n=224) and 11.1% (n=105), respectively. Region 7 had the lowest prevalence of helminthes infection with 8.5% (n=97) (Figure 2). The regional distribution of protozoan infections showed a very similar pattern.

Figure 2: Prevalence (in percent) of helminthes and protozoan stratified by the eight health regions of St Lucia.



The prevalence of hookworms (4.8%; n=514) was the highest of all helminthes. The prevalence of hookworms was highest of all recorded helminthes (Figure 3) across all regions. The highest prevalence of hookworm was noted in region 5 with *Trichuris trichura, Ascaris lumbricoides* and *Strongyloides* infections also highest in region 5 (Figure 3). Across all the regions the second most prevalent helminthes was *Strongyloides* noted in regions 1, 2, 4, 6, 7, and 8 with Ascaris being the second most prevalent in region 3 and *Trichuris trichura* in region 5. Though the overall prevalence of Schistosoma infection (0.3%; n=34) was low compared to other helminthic infections, region 5 showing the highest incidence with 0.7% (n=16) (Figure 3)
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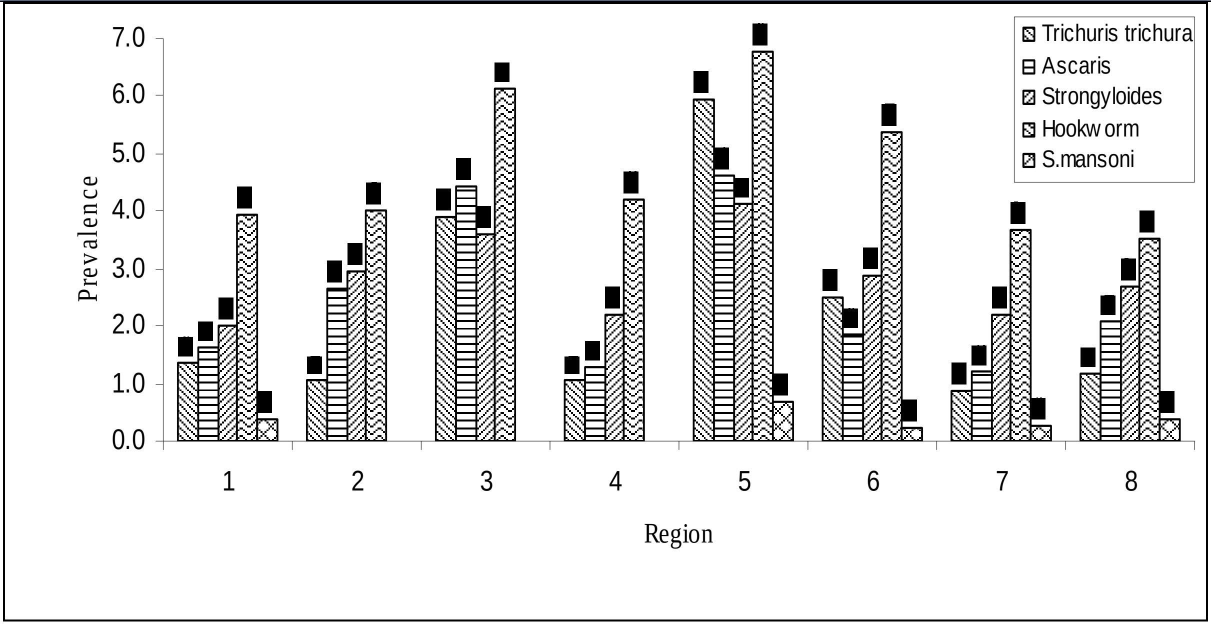
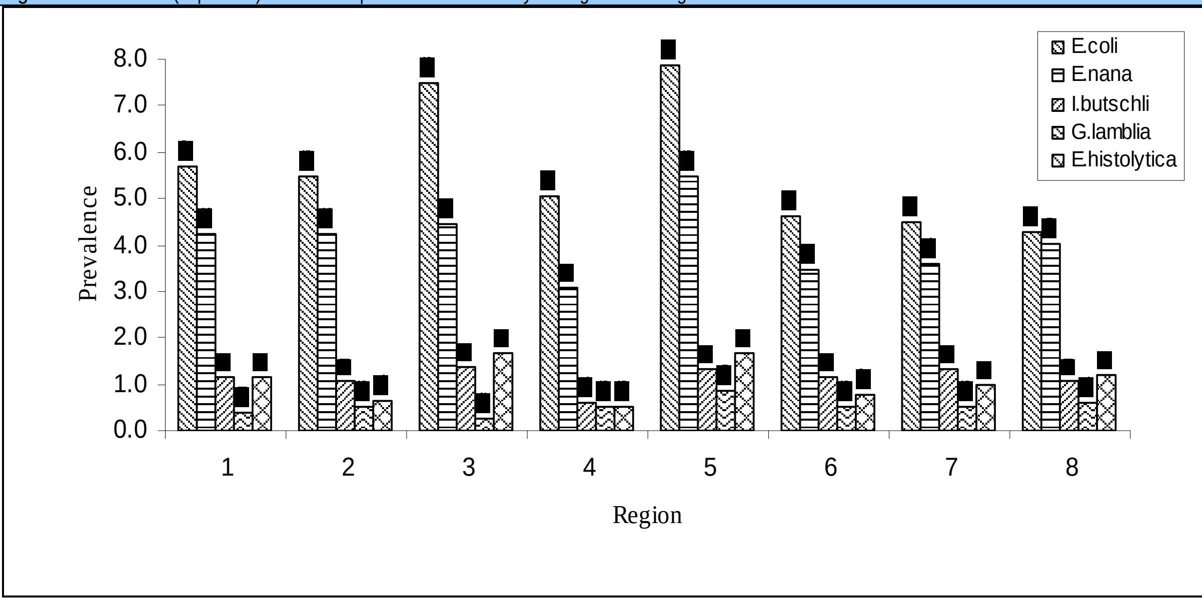
Figure 3: Prevalence (in percent) of intestinal helminthes stratified by the eight health regions of St Lucia.



The prevalence of protozoan infections with respect to region showed *Giardia lamblia, Entamoeba coli, Endolimax nana*, *Entamoeba hartmannii* and *Entamoeba histolytica/ E.dispar/ E. moshkovski* were the most frequent protozoan infections in region 5 (Figure 4). Across all eight health regions the most prevalent protozoan was *Entamoeba coli* with *Endolimax nana* coming second. All other protozoan infections were recorded with prevalence's ranging between 1.7 and 0.3% across the health regions, though specific contributions to the overall prevalence in any one region was limited (Figure 4).

Figure 4: Prevalence (in percent) of intestinal protozoan stratified by the eight health regions of St Lucia.



DISCUSSION

This study was the first island wide investigation on the frequency and distribution patterns of helminthes and protozoan parasitic infections on St Lucia. The infections noted are not unique to St Lucia rather many of the islands of the Caribbean have also been noted in harboring the common species of parasites (Grell 1981; Crompton1999). A sequential increase of helminthes infections was noted from January 2002 to December 2005. Variations in access due to transport or reductions in heath care provision were not observed during the study period suggesting that the increase in prevalence

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may be real. This result suggests that effective infection control measures are required for the most affected regions of St Lucia.

The present study found hookworm, *Ascaris lumbricoides, Trichuris trichura and Strongyloides* to be the most common soil transmitted helminthes; with hookworms showing highest the prevalence across the study period followed by *Strongyloides*. High transmission rates of hookworm has previously been noted in other areas with rural poverty in the tropics, including southern China, the Indian subcontinent, Sub Saharan Africa and the Americas (Hotez 2002; Yadla et al 2003; Hotez et al 2003; Aimpun & Hshieh 2004; Hotez et al 2006). Although *Ascaris lumbricoides* and *Trichuris trichura* were less frequent than hookworms and *Strongyloides* in the present study, they predominate in some parts of South East Asia, Africa and the Caribbean (Stephenson 2000).

Examining the protozoan data showed no general time trend suggesting a stable level of prevalence. *E. coli* was most frequent. *E. nana, I. butschlii* and *Entamoeba histolytica/ E.dispar/ E. moshkovski* contributed second, third and fourth towards the total protozoan infections. Similar findings were previously reported from studies conducted in other parts of the Americas (Bonilla & Chavez 2000; Aimpun & Hshieh 2004). The high prevalence of *E. coli* infection could be caused by water or food contamination or the general unsanitary conditions of daily living.

Analysis of helminths infections by sex showed that males had higher prevalence in hookworm and *Strongyloides* infections. Such predominance in infection rates may be a reflection of male behaviour (Collins & Edwards 1981; Albonico et al 1997). However, infections with *Ascaris lumbricoides, Trichuris trichura* and *Schistosoma mansoni* were more frequent in the female population and similar results were found in studies from New Guinea (Shield 1980; Kightlinger et al 1995). Individual protozoan infections did not show any significant differences.

Overall incidence of both helminthes and protozoan infection with respect to age showed a U-shape with higher prevalence in the 0 to 9 year age group whereas the 40 to 49 year age group had lowest prevalence. This finding suggests a typical high exposure in children (Brooker 2004; Bundy 1995). Individual analyses found that the prevalences of *A. lumbricoides, Trichuris trichura,* and *Strongyloides* infections were high in the young age group and declined thereafter. These findings were similar to results from previous studies showing for example, for *Ascaris* and *Trichuris* infections a peak in the young age group, but with a subsequent decline among adults (Bundy 1995; Bundy 1988); and for hookworm and *Schistosoma mansoni* high infection rates for the 10 to 19 year age group (Kabatereine 1999; Kabatereine 2005).

The regional differences in prevalences noted in this study do not reflect differences in the relative size of the populations living in each of the regions and are thus independent of the size of that region. The highest prevalence of all recorded helminthes and protozoan infections was found in health region 5 followed by region 3. Region 5 has the second largest hospital of the island and thus provides all health care needs of that region leading to the assumption that this may cause the data collection to be influencing the regional differences. However health region 2 has the largest hospital of the island as well as independent laboratories from which data were recovered. Thus no clear association exists between healthcare provision for a health region and infection levels recorded in that region.

Study of individual parasites showed hookworm, *Trichuris trichura, Ascaris lumbricoides* and *Strongyloides* infections to be high in health region 5 whereas among protozoans *Giardia lamblia, E. coli, E. nana, E. hartmanii* and *Entamoeba histolytica/ E.dispar/ E. moshkovski* infections were also high in region 5. Schistosomal infections were reduced after the successful conduct of the Rockefellers project in St Lucia between 1970 and 1975. This project reduced the incidence of *Schistosoma mansoni* from 22% to 4.3% (Barnish 1980; Morgan 2001). The low prevalence of Schistosomiasis noted in this study (0.3%) would reflect the effective nature of the control program which was based on the introduction of competitor snails in 1975. No other parasite control program than that conducted in 1975 has been implemented on St Lucia. Future investigations are needed to identify factors which influence the regional difference and the levels of infection. It is necessary to identify potentially controllable factors that contribute to the risk of infection in order to establish future effective control programs on the island.

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Declaration
Authors have no competing interests to declare.

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