

Schistosomiasis among Recreational Users of Upper Nile River, Uganda, 2007

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After recreational exposure to river water in Uganda, 12 (17%) of 69 persons had evidence of schistosome infection. Eighteen percent self-medicated with praziquantel prophylaxis immediately after exposure, which was not appropriate. Travelers to schistosomiasis-endemic areas should consult a travel medicine physician.

Schistosomiasis, a parasitic infection caused by schistosome flukes, affects 207 million persons worldwide, mostly in sub-Saharan Africa (1). Schistosomiasis has been reported among travelers (2–12); 3 outbreaks have been reported among white-water rafters on the Omo River in Ethiopia (2,7,10). During September–November 2007, the Centers for Disease Control and Prevention (CDC) received reports of schistosome infection among travelers returning from white-water rafting on the Nile River, Jinja District, Uganda. Approximately 12,000 persons raft each year in Uganda, and local rafting companies believe that exposure to fast-moving white water during rafting and kayaking presents a low risk for schistosomiasis (C. McLeay, pers. comm.).

The Study

During November 30–December 5, 2007, we enrolled a convenience sample of competitors and spectators attending the international Nile Freestyle Festival kayaking event and tourists on commercial rafting trips in Jinja District, Uganda. We administered a questionnaire to collect information about participants' demographic characteristics,

use of praziquantel (the antiparasitic drug treatment for schistosome infection), and exposure to fresh water. Three months after enrollment, we asked study participants who had had a negative or indeterminate result from a blood test for schistosome antibodies at the time of enrollment to complete an Internet-based questionnaire about freshwater exposures, health symptoms, and medical tests or treatments for schistosomiasis since enrollment.

We measured infection by collecting two 5-mL blood samples 3 months apart and testing them for evidence of schistosome antibody seroconversion. We tested for presence of schistosome-specific antibodies using an ELISA assay screening test that is 99% sensitive for *Schistosoma mansoni* and 90% sensitive for *S. hematobium* (10). We confirmed FAST-ELISA-positive samples using an *S. mansoni*-specific immunoblot to detect species-specific antibody. We tested all samples using an *S. hematobium*-specific immunoblot, which is 95% sensitive and 99% specific for each species (13). We defined a positive test result as positive results by both tests, an indeterminate result as positive by FAST-ELISA but negative by immunoblot, and a negative result as negative by both tests.

We defined study participant exposures from 2 weeks before enrollment until second sample collection by 4 activity categories: no water-contact activity, swimming/wading only, kayaking/rafting only, and swimming/wading plus kayaking/rafting. We defined schistosome antibody seroconversion in participants as either being first-test-negative and second-test-positive, or being first-test-negative and second-test-indeterminate. We compared characteristics between groups using the χ^2 test for categorical data and the Mann-Whitney test for continuous variables (14). We expressed the risk for infection as the proportion of persons in each activity category who had evidence of schistosome antibody seroconversion and calculated the Mantel-Haenszel χ^2 test for trend (14). We performed all analyses using SAS version 9.1 (SAS Institute, Cary, NC, USA). The CDC Institutional Review Board and the Uganda Virus Research Institute approved this study.

We enrolled 150 study participants; 2 subsequently withdrew. Thirty-five (24%) participants were not followed up because their first blood test was positive; all of these persons reported previous exposure to fresh water in schistosomiasis-endemic countries. Of the remaining 113 persons eligible for follow-up, 69 (61%) provided a second blood sample. Persons who provided only 1 blood sample were more likely to be younger ($p = 0.005$) and female ($p = 0.03$) (Table 1).

Of 69 persons followed up, 23% had fever, 13% cough, 10% skin rash, and 10% abdominal pain; 8% reported prickling skin. None reported physician-diagnosed acute schistosomiasis. Twelve (17%) of the 69 persons with 2 blood samples had evidence of seroconversion. No

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Table 1. Characteristics of 113 recreational users of the upper Nile River who participated in a study to determine risk for schistosome infection, were eligible for study follow-up, and provided 1 or 2 blood samples, Uganda, 2007*

| Characteristic | Provided 1 blood sample, no. (%), n = 44 | Provided 2 blood samples, no. (%), n = 69 | p value† |
|-----------------------------------|---|--|----------|
| Male sex | 14 (32) | 34 (50) | 0.03 |
| Main reason for being at the Nile | | | |
| Raft | 20 (45) | 32 (46) | 0.4 |
| Spectator at the competition | 12 (27) | 18 (26) | |
| Kayak competitor | 9 (21) | 8 (12) | |
| Other | 3 (7) | 11 (16) | |
| Region of residence | | | |
| Africa | 6 (14) | 16 (23) | 0.6 |
| Americas | 12 (27) | 16 (23) | |
| Europe | 15 (34) | 17 (25) | |
| Australasia | 7 (16) | 12 (17) | |
| None given | 4 (9) | 8 (12) | |

*Median ages (ranges) of study participants were as follows: 1 blood sample provided: 25 y (18–41 y); 2 blood samples provided, 29 y (16–67 y); p = 0.005.

†p values estimated by using the Mann-Whitney test for age and a χ^2 test for all other variables.

seroconversions were identified among the 9 persons who reported no water-contact activities. Serologic data suggested that infection occurred in 1 (13%) of 8 reporting swimming/wading only; 4 (15%) of 26, kayaking/rafting only; and 7 (27%) of 26, swimming/wading plus kayaking/rafting (Table 2).

Of 106 persons for whom data were recorded, 19 (18%) reported self-medicating with praziquantel while at the kayaking competition. Of the 12 participants with evidence of seroconversion, 6 had data recorded about self-medication, none of whom took praziquantel.

Conclusions

Approximately one fifth of persons with recreational exposure to water on the upper Nile River in Jinja District showed evidence of schistosome antibody seroconversion. Infection occurred among persons who reported swimming/wading only, kayaking/rafting only, and both activities, which refutes the belief that exposure to fast-moving water presents a low risk for schistosomiasis.

Exposure to schistosomes is likely to be highest in slow-moving water near riverbanks; thus, persons who go rafting may be at highest risk while putting their kayaks/rafts into and taking them out of the river. Although we were unable to estimate the risk for infection attributable to fast-moving white-water exposure alone, we did find that persons who reported swimming/wading and kayaking/

rafting had the highest risk, possibly because of increased duration of exposure (4).

Eighteen percent of study participants reported self-medicating with praziquantel immediately or shortly after river water exposure. However, they would not have been protected against schistosomiasis because praziquantel acts against mature schistosome parasites and thus is most effective if taken after the parasite has developed to the adult stage, which is 4–6 weeks after infection. Local advice about using praziquantel to prevent schistosomiasis may not be appropriate; because indigenous populations have ongoing exposure, timing of treatment is not as critical. Travelers with discrete freshwater exposures in schistosomiasis-endemic countries should consult a travel medicine physician. In addition, information could be made available to pharmacies, rafting companies, and travelers about when to take praziquantel.

Our study had several limitations. The study cohort was a convenience sample, and participants might not have had equal chance of being enrolled. Use of this sample may have introduced bias, although whether any such bias would contribute to overestimation or underestimation of risk is unclear. Because schistosome antibody tests do not differentiate newly acquired infection, we excluded persons with first-test-positive results from the study follow-up. However, if these persons were more likely to have had a higher risk for infection, excluding them would have led us to underestimate risk for infection.

More than 12,000 persons take rafting trips in Uganda each year. Many travelers do not follow advice to avoid freshwater activities in schistosomiasis-endemic countries (15). Travelers should be made aware that white-water exposure presents a risk for schistosomiasis and that treatment with praziquantel should be at least 4–6 weeks after last exposure, preferably under the direction of a travel medicine physician.

Table 2. Proportion of recreational users of the upper Nile River who had schistosome infection, Uganda, 2007*

| Activity | No. infected/total (%) |
|--------------------------------------|------------------------|
| No water-contact activity | 0/9 |
| Swimming/wading only | 1/8 (13) |
| Kayaking/rafting only | 4/26 (15) |
| Kayaking/rafting and swimming/wading | 7/26 (27) |
| All study participants | 12/69 (17) |

*Activity categories are mutually exclusive. χ^2 test for trend p = 0.06

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References

1. Steinmann P, Keiser J, Bos R, Tanner M, Utzinger J. Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. *Lancet Infect Dis.* 2006;6:411–25. DOI: 10.1016/S1473-3099(06)70521-7
2. Centers for Disease Control and Prevention. Schistosomiasis among river rafters—Ethiopia. *MMWR Morb Mortal Wkly Rep.* 1983;32:585–6.
3. Centers for Disease Control and Prevention. Acute schistosomiasis in U.S. travelers returning from Africa. *MMWR Morb Mortal Wkly Rep.* 1990;39:141–2,147–8.
4. Cetron MS, Chitsulo L, Sullivan JJ, Pilcher J, Wilson M, Noh J, et al. Schistosomiasis in Lake Malawi. *Lancet.* 1996;348:1274–8. DOI: 10.1016/S0140-6736(96)01511-5
5. Chapman PJ, Wilkinson PR, Davidson RN. Acute schistosomiasis (Katayama fever) among British air crew. *BMJ.* 1988;297:1101. DOI: 10.1136/bmj.297.6656.1101
6. Colebunders R, Verstraeten T, Van Gompel A, Van den Ende J, De Roo A, Polderman A, et al. Acute schistosomiasis in travelers returning from Mali. *J Travel Med.* 1995;2:235–8. DOI: 10.1111/j.1708-8305.1995.tb00667.x
7. Istre GR, Fontaine RE, Tarr J, Hopkins RS. Acute schistosomiasis among Americans rafting the Omo River, Ethiopia. *JAMA.* 1984;251:508–10. DOI: 10.1001/jama.251.4.508
8. Leshem E, Maor Y, Meltzer E, Assous M, Schwartz E. Acute schistosomiasis outbreak: clinical features and economic impact. *Clin Infect Dis.* 2008;47:1499–506. DOI: 10.1086/593191
9. Pitkanen YT, Peltonen M, Lahdevirta J, Meri S, Evengard B, Linder E. Acute schistosomiasis mansoni in Finnish hunters visiting Africa: need for appropriate diagnostic serology. *Scand J Infect Dis.* 1990;22:597–600. DOI: 10.3109/00365549009027102
10. Schwartz E, Kozarsky P, Wilson M, Cetron M. Schistosome infection among river rafters on Omo River, Ethiopia. *J Travel Med.* 2005;12:3–8.
11. Trachtenberg JD, Jacobson M, Noh JC, Tsang VC, Ndoskoi J, Koster F. Schistosomiasis in expatriates in the Arusha region of Tanzania. *J Travel Med.* 2002;9:233–5.
12. Visser LG, Polderman AM, Stuijver PC. Outbreak of schistosomiasis among travelers returning from Mali, West Africa. *Clin Infect Dis.* 1995;20:280–5.
13. Tsang VC, Wilkins PP. Immunodiagnosis of schistosomiasis. *Immunol Invest.* 1997;26:175–88. DOI: 10.3109/08820139709048925
14. Altman D. *Practical statistics for medical research.* London: Chapman & Hall/CRC; 1999.
15. Centers for Disease Control and Prevention. CDC Health information for international travel, 2008 [cited 2010 Mar 24]. <http://wwwnc.cdc.gov/travel/yellowbook/2010/chapter-5/schistosomiasis.aspx>

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Appendix Table. Persons and public health agencies assisting with the collection of follow-up blood samples in a study of schistosome infection among recreational users of the upper Nile River, Uganda, 2007*

| Name | Public health agency |
|----------------------|--|
| United States | |
| Sue Jenkerson | Alaska Department of Health and Social Services |
| Jane Conard | Mat-Su Public Health Center |
| Kanta Sircar | Los Angeles County Department of Public Health |
| Amy Karon | California Department of Public Health |
| Duc Vugia | California Department of Public Health |
| Douglas Hatch | California Department of Public Health |
| Frank Alvarez | Santa Barbara County Public Health Department |
| Paige Batson | Santa Barbara County Public Health Department |
| Ken Gershman | Colorado Department of Public Health |
| Kate Lujan | Colorado Department of Public Health |
| Alice Guh | Connecticut Department of Health |
| Paul Melstrom | Georgia Department of Human Resources |
| Laurel Garrison | Georgia Department of Human Resources |
| Randy Nett | Idaho Department of Health and Welfare |
| Kathy Reynolds | Southeastern District Health Department |
| Alfreda DeMaria | Massachusetts Department of Public Health |
| Patricia Kludt | Massachusetts Department of Public Health |
| Kathleen Gilmore | Massachusetts Department of Public Health |
| Steven Helgersen | Montana Department of Public Health and Human Services |
| Ellen Leahy | Montana Department of Public Health and Human Services |
| Shelly Meyer | Montana Department of Public Health and Human Services |
| Vivian Mears | New Hanover County Health Department |
| Myra Brinson | Raleigh State Laboratory |
| Ning An | Oregon Department of Human Services |
| Emilio Debess | Oregon Department of Human Services |
| Susan Donnelly | Hood River Health Department |
| John Dunn | Tennessee Department of Health |
| John Su | Texas Department of State Health Services |
| Thi Dang | Texas Department of State Health Services |
| Canada | |
| Diane MacDonald | Public Health Agency of Canada |
| Denise Werker | Public Health Agency of Canada |
| Glennis Doiron | Calgary Laboratory Services |
| Muhammad Morshed | British Columbia Centre for Disease Control |
| Laura MacDougall | British Columbia Centre for Disease Control |
| James Aw | Medcan Clinic, Ontario |
| Beth Swift | Medcan Clinic, Ontario |
| Australia | |
| Anthony Moore | Health Protection Service, ACT Health |
| Riemke Kampen | Health Protection Service, ACT Health |
| Tiffany Savli | ACT Pathology, ACT Health |
| Jeremy McAnulty | Communicable Diseases Branch, New South Wales |
| Hanisah Corner | Center for Epidemiology and Research, New South Wales |
| Rogan Lee | Westmead Hospital, New South Wales |
| Christine Selvey | Communicable Diseases Branch, Queensland Health |
| Avner Misrachi | Department of Health and Human Services, Tasmania |
| David Coleman | Department of Health and Human Services, Tasmania |
| Margaret Hill | Department of Health and Human Services, Victoria |
| Megan Scully | Western Australia Department of Health |
| New Zealand | |
| Simon Baker | Auckland Regional Public Health Service |
| Don Bandaranayake | Population Health Directorate, Ministry of Health |
| Alistar Humphrey | Canterbury District Health Board |
| Ramon Pink | Canterbury District Health Board |
| Jill Geary | Canterbury District Health Board |
| Belinda Loring | Toi Te Ora Public Health Board |
| Anita Bell | Waikato District Health Board |
| Daphne Fairfood | Diagnostic Medlab Limited |
| Europe | |
| Tizza Zomer | Swedish Institute for Infectious Disease Control, Sweden |
| Esther Kissling | Institut Scientifique de Santé Publique, Belgium |
| Sabrina Bacci | Statens Serum Institut, Denmark |
| Kaisa Mäkinen | Lapland Central hospital, Finland |
| Laura Pakarinen | National Public Health Institute, Finland |
| Gudrun Bettge-Weller | Fachgebiet Infektiologische Diagnostik, Germany |

| | |
|-------------------------|--|
| Anja Hauri | Hesse State Health Office, Germany |
| Joan O'Donnell | HSE–Health Protection Surveillance Centre, Ireland |
| Tone Brunn | Norwegian Institute of Public Health, Norway |
| Christina Furtado | Instituto Nacional de Saúde Dr Ricardo Jorge, Portugal |
| Eugenio Cordeiro | Administração Regional de Saúde do Centro, Portugal |
| Kitty Smith | Health Protection Scotland, Scotland |
| Titia Kortbeek | Netherlands Laboratory for Infectious, Netherlands |
| Praveen Sebastianpillai | Health Protection Agency, England |
| Jane Jones | Health Protection Agency, England |
| Lorenzo Pezzoli | Health Protection Agency, England |
| Richard Pebody | European Programme for Intervention Epidemiology Training, European Centre for Disease Prevention and Control |
| Viviane Bremer | European Programme for Intervention Epidemiology Training, European Centre for Disease Prevention and Control |

*ACT, Australian Capital Territory; HSE, Health Service Executive.