Intestinal Parasites among North Carolina Migrant Farmworkers

ABSTRACT

Objectives. The public health significance of intestinal parasitism among migrant farmworkers has been poorly defined. We report a three-part study in which we attempted to provide population-based estimates and identify risk factors for infection.

Methods. Parasite prevalence and incidence were estimated from two cross-sectional studies and a longitudinal study. We used questionnaires and clinical measurements such as hematocrits to examine risk factors and health effects.

Results. In the 1987 convenience sample (n = 265), parasite prevalence ranged from 28% among the US born to 86% among the Central American born, with no significant difference between the prevalence of pathogens among US-born (14%) and Mexican-born (24%) subjects ($P = .12$, χ^2 test). High prevalences were also found in the 1988 random sample. An annual incidence of 9.5% (n = 74) was demonstrated in 1988. Symptoms such as abdominal pain were associated with infection, and lower hematocrits were associated with hookworm infection ($P = .02$, t test).

Conclusions. Infection with intestinal parasites appears to be an occupational hazard of farmwork, necessitating improved working and living conditions and greater clinical awareness. (*Am J Public Health.* 1992;82:1258–1262)

Stephen D. Ciesielski, PhD, John R. Seed, PhD, Juan C. Ortiz, MSPH, and Jobe Metts, MD

Introduction

Migrant farmworkers work and live in substandard hygienic conditions,[1–4] often in areas of the United States formerly hyperendemic for hookworm and other intestinal parasites. Immigrants from developing regions often enter farmwork, increasing the potential for transmission of parasites. Discussions of the health of farmworkers usually cite intestinal parasites as a major problem.[1,4,5] However, previous research has focused on children, a small minority of the population, and made little attempt to quantify transmission and risk factors or to describe associated morbidity.[2,3] We report the results of a three-part study of intestinal parasites among farmworkers in North Carolina, conducted in 1987 and 1988.

Methods

The 1987 prevalence study used a convenience sample of migrant camps in eastern North Carolina, including a representative range of camp condition and size. All individuals living in selected camps were eligible subjects. In 1988 a clustered random sample was obtained by selecting a 10% probability sample from a pooled list of camps. Because of high nonresponse rates, US-born Blacks were excluded from the 1988 sample. Our 1988 longitudinal study included all subjects relocated from the 1987 prevalence study.

After obtaining informed consent, we used pretested, verbally administered questionnaires in English, Spanish, or Haitian Creole to obtain data on demographic, health, and occupational variables. Parents supplied information for children less than 16 years old.

Subjects were given transport kits containing poly-vinyl alcohol and 10% formalin (Trend Scientific, St. Paul, Minn.). After our formalin ethyl-acetate concentration (CON-Trate System, Trend) of the samples, we employed Lugol's iodine and Tri-Chrome stain (Trend) in our microscopic examination. We used Direct Fluorescent Antibody tests (Meridian Diagnostics, Inc., Cincinnati, Ohio) to screen for *Cryptosporidium,* with acid fast dimethyl-sulfoxide stain (Trend) for confirmation. Water from camps in the 1988 prevalence and incidence studies was tested for total and fecal coliforms (membrane filtration method) using standard methods.[6]

Our statistical analysis was performed with SAS and consisted of χ^2 tests, Fisher's Exact Tests, t tests, and logistic regression. The 95% confidence intervals (CI) are not test based.

Results

1987 and 1988 Cross-sectional Studies

In 1987, 265 subjects in 24 camps in three counties participated; 54% of subjects provided one stool sample, 39% provided two, and 7% provided three. Nonresponse was 5% among Haitians, 15%

Stephen D. Ciesielski, John R. Seed, and Juan C. Ortiz are with the Department of Parasitology and Laboratory Practice, School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC. Jobe Metts is with the University of North Carolina School of Medicine, Chapel Hill, NC.

Requests for reprints should be sent to Stephen D. Ciesielski, PhD, Department of Parasitology and Laboratory Practice, School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599.

This paper was submitted to the Journal April 4, 1991, and accepted with revisions March 24, 1992.

among Central Americans, 35% among Mexicans, and 55% among US-born Blacks. The 1988 random sample included 181 subjects from 20 camps in four counties; 47% provided two samples, and 53% one. The 1988 nonresponse was similar to 1987, but higher among Central Americans (50%).

Most subjects in 1988 were young adult males from rural backgrounds with little education (Table 1). Demographics of the 1987 convenience sample were similar, except that US-born Blacks were included. Parasite prevalence was high in both years and usually varied little between years (Table 2). In 1987, 52% of all subjects were positive vs 58% in 1988. Most infections were with pathogens (defined in Table 2). In 1987 hookworm was the most prevalent pathogen among the foreign born, with a prevalence of 58% among Central Americans (28% in 1988) and 20% (24% in 1988) among Haitians (Table 2). The 1988 pathogen prevalence among both Haitians and Central Americans was significantly greater than among Mexicans ($P = .023$, relative risk (RR) = 2.7, 95% CI 1.3, 5.6; and $P = .030$, RR = 2.48, 95% CI 1.1, 5.7, χ^2 tests, respectively). One Central American subject had a *Taenia* infection.

In 1987, parasite prevalence was 28% and pathogen prevalence was 14% among the US born (50% of infected subjects were Hispanic and 50% US-born Blacks). The US-born subjects' prevalence of *Giardia* exceeded that of the Haitian born (RR = 7.2, 95% CI 1.0, 51, χ^2 test) and Mexican born (RR = 3.6, 95% CI .44, 29, χ^2 test); their *H. nana* prevalence exceeded that of the Mexican born; and their prevalence of *E. histolytica* and *E. coli* was comparable to foreign-born subjects. There was no significant difference in pathogen prevalence between the US and Mexican born ($P = .120$, χ^2 test).

In both years of the study, foreign-born subjects' return visits to their countries of origin were not associated with infection ($P > .05$, χ^2 tests). Measures of previous exposure in country of origin (age, sex, educational level, rural upbringing, previous agricultural work) were not associated with infection among foreign-born subjects in 1987 ($P > .05$, logistic regression). Among subjects in the 1988 sample, rural upbringing and previous farmwork were associated with all classes of parasite except protozoa ($P < .05$, logistic regression). Among foreign-born subjects of both years, grouped by birthplace, there were no differences in years of US residence between infected and uninfected subjects ($P = .24$–$.81$, t tests).

TABLE 1—Demographics of Subjects in 1988 Cross-sectional Study of Intestinal Parasites in Migrant Farmworkers

	All Subjects (n)[a]	Haitians (n)[a]	Hispanics (n)[a]
Male, %	80 (181)	74 (50)	83 (129)
Over 16 years of age, %	90 (181)	100 (50)	86 (129)
Mean age	29 (181)	39 (50)	25 (129)
Mean years in farmwork	4.8 (134)	5.5 (48)	3.9 (96)
Mean years in US	4.9 (145)	5.6 (48)	4.6 (97)
Mean exits from US	1.2 (145)	0.5 (48)	1.6 (97)
6 or fewer years of school, %	65 (145)	80 (48)	54 (97)
Rural upbringing, %	61 (145)	62 (48)	61 (97)
Previously in agriculture, %	38 (134)	60 (48)	24 (86)

[a]Number of subjects varies because some variables were not applicable to all subjects (particularly children).

In 1987, prevalence of intestinal parasites in Haitian camps ranged from 22 to 70%, in Mexican camps 0 to 60%, and in Black American camps 0 to 30%. This variation was not associated with years in the United States, age, gender, previous risk factors, or condition of camps.

Many subjects reported workplace conditions or behaviors with risk for infection (Table 3), but these variables were not associated with infection ($P > .05$, logistic regression). Among US-born children, day-care attendance was not associated with infection ($P = .574$, χ^2 test), but infection was associated with children accompanying parents to harvest fields ($P = .032$, RR = 2.4, 95% CI 1.3, 4.6, χ^2 test).

Reported symptoms had many significant associations with parasitic infections of different classes (Table 4). Symptoms were consistently associated with pathogenic parasites but not with nonpathogens (not shown).

The mean hematocrit of subjects (in 1988) with hookworm infection was 39.4% and that of the uninfected was 43.0%, a significant difference ($P = .02$, t test). The difference was most pronounced among Hispanic subjects (uninfected = 43.3%, infected = 37.1%, $P = .02$).

1988 Longitudinal Study

In 1988, 74 of 265 subjects (28%) were relocated in 11 camps, without nonresponse. Seven subjects (9.5%) without evidence of infection in 1987 were infected in 1988 with *G. lamblia, T. trichiura,* or *Entamoeba coli.* Latrines rather than flush toilets in camps were associated with incidence ($P = .008$, RR = 13.1, Fisher's Exact Test), as was the presence of coliforms in drinking water ($P = .011$, RR = 7.6, Fisher's Exact Test). Total coliforms were demonstrated in 44% and fecal coliforms in 26% of 27 camps (results published separately[7]).

Discussion

This study provides the first estimates of parasite prevalence among adult farmworkers, the first population-based estimates, and limited data on risk factors for infection. The results indicate that intestinal parasitism is a public health problem among farmworkers. The predominance of hookworm infection—which exceeded that of earlier studies by 6 to 20 times—is especially significant because of its pathogenic potential. However, the results also demonstrate the difficulties in applying standard epidemiologic methods to the study of migrant health. Logistical problems are partly responsible: one example is the more than 30 000 miles driven by field workers in the two years of study.

The estimates of prevalence are substantially higher than previous studies.[2–3] Although prevalence may vary among sub-populations and geographically, a population-based sampling design should provide more valid estimates. However, the majority of subjects were obtained by convenience sampling, and efforts to achieve representativeness can never avoid bias. The often close agreement in prevalence between years may suggest that the 1987 sample is reasonably representative. Nonresponse in field studies of intestinal parasites is always a problem, and the relatively high rate among some groups limits the certainty of these estimates. Nonresponse was lowest among the high-prevalence groups, which would tend to overestimate prevalence. Other

TABLE 2—Parasite Prevalence in 1987 Convenience and 1988 Random Samples of North Carolina Migrant Farmworkers (Percentage Positive)

	Birthplace									
	US		Haiti		Mexico		Central America		Total Sample	
	1987 (n = 108)	1988 (n = 11)	1987 (n = 80)	1988 [n = 50)	1987 (n = 41)	1988 (n = 87)	1987 (n = 36)	1988 (n = 32)	1987 (n = 265)	1988 (n = 181)
All parasites	28	36	66	64	56	53	86	69	52	58
All pathogens	14	0	49	52	24	29	81	50	35	37
Individual pathogens										
Hookworm	0	0	20	24	6	8	58	28	15	16
Trichuris trichiura	2	0	21	20	6	6	50	25	15	13
Ascaris lumbricoides	0	0	4	0	3	0	8	13	3	2
Strongyloides stercoralis	0	0	4	6	2	5	3	0	2	4
Taenia sp.	0	0	0	0	0	0	3	0	0.4	0
Hymenolopis nana	2	0	3	0	0	3	8	0	3	2
Giardia lamblia	8	0	1	10	3	6	11	3	6	6
Entamoeba histolytica	3	0	14	3	9	5	6	9	7	4
Cryptosporidium	0	0	2	2	2	1	3	3	2	2
Nonpathogens										
Entamoeba coli	17	36	24	12	29	26	17	25	21	22
Endolimax nana	0	0	16	10	15	8	17	9	9	8
Iodamoeba butschlii	1	0	4	0	7	3	11	0	4	2
Blastocystis hominis	3	0	1	2	2	1	6	0	3	1

TABLE 3—Percentage of Subjects Reporting Risk in Occupational Factors for Transmission of Intestinal Parasites, 1987 Convenience and 1988 Random Samples

	US-born Blacks		Mexicans		Central Americans		Haitians		All Subjects	
	1987 (n = 56)	1988*	1987 (n = 58)	1988 (n = 61)	1987 (n = 31)	1988 (n = 20)	1987 (n = 69)	1988 (n = 47)	1987 (n = 214)	1988 (n = 131)
Presence of field sanitation, sometimes or never	85	...	88	88	88	75	100	55	91	75
Presence of hand-washing water in fields, sometimes or never	64	...	75	77	72	85	62	21	58	58
Availability of toilet paper in fields, sometimes or never	61	...	45	36	37	20	81	89	60	57
Common drinking cup used in fields, always or sometimes	60	...	71	75	80	95	50	53	63	69
Frequency of working without shoes (or with sandals), always or sometimes	53	...	22	20	30	55	15	8	29	30

*No Black Americans were included in the 1988 sample.

factors (such as often obtaining only one stool sample) tend towards underestimation.

Transmission of parasites in the migrant population is indicated by several results:

1. The parasite prevalence of 28% among US-born subjects in 1987. Although the source of infection cannot be determined with confidence in a cross-sectional study, it is a reasonable assumption that most infections among the US born were acquired in farmwork, especially because most children had lived in this environment their entire lives.
2. The absence of a significant difference between the prevalence of pathogenic parasites among the US and Mexican born in the 1987 sample.
3. The prevalence of several parasite species among the US-born subjects that equaled or exceeded that of the foreign born.
4. The absence of any difference in years of US residence between infected and uninfected subjects. Parasite prevalence among nonfarmworker immigrants to the United

TABLE 4—Reported Symptoms and Infection with Intestinal Parasites

Year of Study	Parasite	Group	Symptom	P*	RR	95% CI
1987	Pathogens	All subjects	Nausea	.05	2.2	1.0, 4.8
		All subjects	Appetite loss	.002	3.2	1.7, 5.9
1987	Hookworm	All subjects	Appetite loss	.021	2.5	1.3, 4.9
		All subjects	Abdominal pain	.034	2.6	1.5, 5.0
1988	All parasites	All subjects	Abdominal pain	.0009	3.5	2.9, 4.0
		Hispanics	Abdominal pain	.017	2.7	2.0, 3.9
1988	Pathogens	All subjects	Abdominal pain	.0009	2.8	2.2, 3.4
		Haitians	Abdominal pain	.014	2.6	1.5, 3.8
		Hispanics	Abdominal pain	.002	3.0	1.9, 4.3

*From chi-square tests.

States decreases with increasing years of US residence.[8]

5. The annual incidence rate of 9.5%.

Use of a control group could have demonstrated more conclusively that the prevalence among US-born farmworkers exceeds the nonmigrant population. However, only longitudinal study can prove that infections are acquired in farmwork. Identification of a suitable control group would be difficult; in North Carolina there is no demographically similar group of working adults with such a low socioeconomic status. Future studies should employ one if conducted in Florida or California, where demographics make construction of a control group more feasible.

A cross-sectional design limits assessment of risk factors. Permission to directly inspect workplace conditions was denied; subjects reported conditions for the month prior to study, but working conditions may change weekly or daily. A sample size several times larger than described here would be needed to demonstrate an association between infection and risk factors cross-sectionally. Nevertheless, the potential for transmission is evident in the lack of field sanitation and other workplace conditions. The association between infection and children accompanying parents to the fields indicates occupational risk.

Obstacles to conducting longitudinal study are also substantial, given the transience of farmworkers. The incidence rate of 9.5% reported here is the first attempt to quantify transmission. However, problems include the small sample size (74 subjects) and the possibility of false negatives in 1987. The associations between infections counted as incidence and camp conditions such as latrines and coliforms in drinking water support the classification of these as new infections. However, because all three incident parasites (especially *Trichuris*) can be transmitted via nonwater routes, the importance of water as a means of transmission remains undefined.

The clinical significance of intestinal parasitism among farmworkers has been inconclusively addressed in previous studies. In this study, hematocrits and reported symptoms indicate that parasitism causes morbidity among farmworkers, although many infections may be asymptomatic. Although only one *Taenia* infection was demonstrated, it suggests the possible spread of cysticercosis among farmworkers. The seroprevalence of cysticercosis was 10% in a random sample of NC farmworkers.[9]

Descriptions of the health of farmworkers usually cite intestinal parasites as a paramount problem. Yet no one would maintain that parasitic infections are of greater significance than hypertension, diabetes, or the human immunodeficiency virus. The shock value of parasites is obviously one reason for this emphasis. But it is also true that parasitic infections are a sentinel health event. Their transmission indicates that working and living conditions place workers at risk for a variety of other enteric infectious diseases—both bacterial and viral—transmitted in a similar fashion. Farmworkers have rates of diarrhea 20 times that of the urban poor,[4] and such pathogens must contribute to this disparity.

We conclude that there is good evidence for the transmission of intestinal parasites within the conditions of migrant farmwork, and that infection with parasites is associated with some degree of morbidity. Workplace conditions present clear potential sources of infection. Farmworkers and their families are obviously at greatest risk. However, parasitic ova and cysts remain viable for long periods of time on produce,[10–12] creating some risk for the general public. In 1991 a North Carolina man who lived on a family farm employing migrant farmworkers (from areas endemic for cysticercosis) was diagnosed as having cerebral cysticercosis, a potentially fatal disease.[13] This infection was almost certainly acquired from the farm's employees. On the basis of the results of this study, we make the following recommendations:

- Enforce more strictly the regulations concerning field sanitation and hygiene.
- Replace latrines in migrant camps with flush toilets.
- Improve the surveillance of the microbiologic quality of drinking water in migrant camps.
- Routinely include intestinal parasitism on differential diagnoses of gastrointestinal complaints of all groups of farmworkers, including US-born blacks.
- Routinely screen high-risk patients such as Haitians and Central Americans for intestinal parasites, even when they are presenting other complaints: treatment of asymptomatic individuals can have an important public health function. □

Acknowledgments

Funding for this study was provided by the Milbank Memorial Fund, New York, NY, the Rural Community Assistance Program, Leesburg, Va, and the Tri-County Community Health Center, Newton Grove, NC.

We thank Nora Selva-Sutter for her assistance in diagnostic microscopy and Gustavo Saldias, MPH, Kathy Sarri, MPH, Roland Dorancy, Michael Baker (TCCHC director), Cynthia Behler, RN, and Kathleen Stanley (director RCAP). Gratitude is also expressed to

Edward Wrenn, MD, Douglas Esposito, MD, MPH, Edwin Dimi Stephen, and Mary Sween.

References

1. Arbab DM, Weidner B. Infectious disease and field water supply and sanitation among migrant farm workers. *Am J Public Health.* 1986;76:694–695.
2. Ortiz J. The prevalence of intestinal parasites in Puerto Rican farm workers in Western Massachusetts. *Am J Public Health.* 1980;74:1103–1105.
3. Ungar B, Iscoe E, Cutler J, Bartlett JG. Intestinal parasites in a migrant farmworker population. *Arch Intern Med.* 1986; 146:513–515.
4. Wilk VA. *The Occupational Health of Migrant and Seasonal Farmworkers in the United States.* Washington, DC: Farmworker Justice Fund Inc.; 1986.
5. Pendergrass JA. Field sanitation; final rule. *Federal Register.* May 1, 1987;52:16050–16096.
6. Clesceri LS, Greenberg AE, Trussell RR, eds. *Standard Methods for the Examination of Water and Wastewater.* Washington, DC: American Public Health Association; 1981.
7. Ciesielski S, Handzel T, Sobsey M. The microbiologic quality of drinking water in North Carolina migrant labor camps. *Am J Public Health.* 1991;81:762–764.
8. Winsberg GR, Sonnenschein E, Dyer AR, Schnadig V, Bonilla E. Prevalence of intestinal parasites in Latino residents of Chicago. *Am J Epidemiol.* 1975;102:526–532.
9. Ciesielski SD, Estrada J, Seed JR, Wrenn E. The seroepidemiology of tropical disease among North Carolina migrant farmworkers. Unpublished manuscript.
10. Geldreich EE, Bordner RH. Fecal contamination of fruits and vegetables during cultivation and processing for market: a review. *J Milk Food Tech.* 1971;34:184–195.
11. Rudolfs W, Falk LL, Ragotzkie RA. Contamination of vegetables grown in polluted soil. II. Field and Laboratory studies on *Entamoeba* cysts. *Sewage Ind Waste.* 1951;23:478–485.
12. Rudolfs W, Falk LL, Ragotzkie RA. Contamination of vegetables grown in polluted soil. III. Field studies on *Ascaris* eggs. *Sewage Ind Waste.* 1951;23:656–660.
13. Centers for Disease Control. Locally acquired neurocysticercosis—North Carolina, Massachusetts, and South Carolina, 1989-1991. *MMWR.* 1992;41:1–4.

Seventh National Conference on Chronic Disease Prevention and Control

The Centers for Disease Control, the Association of State and Territorial Health Officials, and the Association of State and Territorial Chronic Disease Program Directors will cosponsor the Seventh National Conference on Chronic Disease Prevention and Control, October 21 to 23, 1992, in Salt Lake City, Utah. The conference is open to the public. This year's theme is "Prevention: Can It Be Marketed, Managed, and Make a Difference?"

The conference will emphasize interactions among federal, state, and local health departments, voluntary health agencies, and professional organizations. Presentations will be given in plenary, invited, abstract, poster, and workshop sessions. Topics will include: "Universal Access: Future Implications for Prevention and Public Health"; "Behavioral Research: What Have We Applied?"; "Prevention Effectiveness: Documenting Our Successes"; "The Tobacco Industry's Tactics and Their Implications for Public Health"; "The Family High Risk Program: The Ultimate in Targeted Interventions"; "Clinic-Based Interventions"; "Reaching Children and Adolescents"; "Smoking and Health"; "Nutrition and Chronic Disease Prevention"; "Reaching the Underserved"; "Using the Latest in Computer Software for Public Health"; "Enlisting Minority Health Organizations in Chronic Disease Advocacy"; and "International Chronic Disease Prevention and Control."

Additional information is available from Mr. Jack Friel, National Center for Chronic Disease Prevention and Health Promotion, Mailstop K-43, Centers for Disease Control, Atlanta, GA 30333; tel. (404) 488-5390, fax (404) 488-5962.