

Occurrence of *Schistosoma mansoni* in Puerto Ricans

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DATA FROM diagnostic surveys on the extent of *Schistosoma mansoni* infections in Puerto Rico have been available since the disease was first detected in Mayagüez in 1904 (1). These data, valuable in epidemiologic studies and control planning, are evaluated in this paper as a means of estimating the current status of the disease in Puerto Rico.

Information available for this evaluation includes (a) stool examination data derived from the direct saline smear technique (used until about 1938) and data derived from a variety of egg concentrating methods (used during the past 25 years), (b) rectal biopsy data, (c) autopsy data, and (d) serologic and intradermal test data. The advantages or disadvantages of these diagnostic techniques are only briefly mentioned. A definitive summary has been published by Kagan and Pellegrino (2). There is a growing need for a diagnostic method that is readily adaptable to procedures for evaluating schistosomiasis control programs.

Data from tests on fecal samples taken from 1904 to 1955 were summarized in May 1955. At this time a total of 127 such diagnostic investigations had been performed in Puerto Rico. Of 82,212 single fecal tests, 3,764 (5 percent) were positive for *S. mansoni* (3). Kagan and associates noted that approximately 50 to 60 percent of the true incidence is detected on examination of a single stool sample from each subject (4). Significantly, current infection can be proved only by demonstrated passage of

viable fecal eggs or by detection of eggs in rectal biopsy material. Survey data were derived from both simple saline fecal smear and egg concentration techniques.

Additional surveys conducted since 1955 brought the total to 139 in 1963 (personal data). At this time 9,047 (7 percent) of 126,244 fecal specimens were positive. A total of 120 fecal surveys have been made by the Puerto Rico Department of Health in 9 experimental control projects, which were started during the period of 1952-58 in nearby Vieques Island and 8 valleys in Puerto Rico. Selection of these areas was based on the kind of *Australorbis glabratus* habitat. Primary surveys in these control projects were made on single fecal samples from the majority of the first-grade school children (aged 6 to 10 years) in each watershed. The highest infection rates reported in each project development period are shown in table 1. In the Lajas Valley project an attempt is being made to prevent the spread of the disease in an irrigated basin.

Data from principal studies which used a single fecal examination are summarized for the years from 1904 to 1959 in table 2. Both simple and refined test methods were reported by the authors. Of 240,605 single fecal tests, 10 percent were positive for *S. mansoni*.

Repeated fecal testing of persons suspected of being infected is known to raise the index. For example, 74 percent of 430 such patients showed positive results when tested from 1 to 12 times at hospitals in San Juan (5). The overall percentage of persons with positive results (table 2) is relatively low in comparison with data obtained by other techniques cited below. The range of percent positive was 7 to 30. Kop-

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pisch (6) used random samples of postmortem material, and he did not use an egg concentrating technique. His total of 27 percent positive represented both sexes and the many ages encountered during studies of autopsy material.

Dr. Thomas H. Weller, School of Tropical Public Health, Harvard University, stated in a 1963 personal communication regarding his 1945 survey data: "Examinations were made on candidates for military service after all rejects had been weeded out because of physical and mental disorders. The group sampled therefore consisted of overtly healthy individuals except for the bilharzial findings." Rodriguez-Molina and associates (7) examined relatively healthy males who were receiving care at the U.S. Veterans Administration San Patricio Hospital. Pons and Reyes (8) examined U.S. Army selectees. The diagnostic surveys of Ferguson and associates (9) were concerned with the extent of bilharziasis in areas chosen for investigation of control.

The data of White and associates (10) were obtained during 1953 studies carried out in several watersheds to determine appropriate areas for health department demonstration control projects. Children aged from 6 through 16 years were examined. The following rates of infection were reported from primary schools

Table 1. Schistosoma mansoni infection rates among school children in Puerto Rican control projects, based on examination of single stools for worm eggs, selected years

Place	Year	Number children	Number infected	Percent infected
Arroyo and Guayama-----	1954	1, 588	329	21
Patillas-----	1954	608	60	10
Vieques Island----	1955	222	21	10
Caguas Valley----	1955	1, 113	175	15
Mariana and Daguao-----	1957	91	22	32
Lajas Valley-----	1957	6, 607	19	-1
Aibonito-----	1958	504	13	3

of randomly selected communities: Quebradillas and Vega Baja, 0 percent; Ponce, 0.4 percent; San Germán, 0.6 percent; Añasco and Rincón, 1.8 percent; Gurabo, 3.2 percent; Carolina, 4.4 percent; Jayuya, 5.8 percent; San Lorenzo, 8.3 percent; Juncos, 9.8 percent; Barranquitas, 11 through 16 percent; Caguas, 12 through 40 percent; Patillas, 16 through 31 percent; Arroyo, 16.2 percent; Comerío, 18 percent; Ceiba, 27 percent; Guayama, 20 through 40 percent; and Daguao, 59 percent.

A 3-year study reported by Maldonado and Oliver-Gonzalez (12) indicated that the inci-

Table 2. Schistosoma mansoni in Puerto Ricans, based on single fecal examinations, selected studies, 1904-59

Study groups	Number persons	Positive		Source
		Number	Percent	
All ages, both sexes, postmortem ¹ -----	1, 009	273	27	(6).
U.S. Army selectees, aged 18-35 years ² -----	19, 139	2, 048	11	(11).
Do. ² -----	15, 831	2, 326	15	(7).
Do. ² -----	31, 523	3, 152	10	(8).
All ages, both sexes ³ -----	⁴ 126, 244	9, 047	7	(3).
All ages, both sexes, Patillas, Guayama, Arroyo, P.R. ² -----	5, 609	1, 233	22	(9).
All ages, both sexes, Caguas Valley, P.R. ² -----	4, 298	859	20	(9).
Children aged 6-16 years ² -----	11, 690	1, 169	10	(10).
All ages, both sexes ² -----	23, 262	2, 559	11	(12).
Migrants in Philadelphia, Pa., all ages, both sexes ² -----	⁵ 2, 000	600	30	Personal communication, F. Febles and M. Brooke, 1961.

¹ Saline smears.

² Egg concentration.

³ Various egg detection tests.

⁴ Represents all data from fecal test surveys through 1959, including data summarized in 1955; reference 3.

⁵ Tests duplicated on each fecal sample by separate U.S. Public Health Service laboratories. Samples primarily from migratory workers and families.

dence of schistosomiasis was possibly declining in six endemic communities. However, their more recent studies indicated higher indices in some communities (13). Dr. F. Febles, Teaching Hospital, Medical Center, Rio Piedras, P.R., and Dr. M. Brooke, Communicable Disease Center (personal communication, 1961), stated that they “. . . worked with outpatients in a public health clinic and with children in selected schools in low socioeconomic areas of Philadelphia. The primary purpose of these studies was demonstration of the effects of chemotherapy on intestinal parasites, and stool specimens were examined as part of the protocol.”

Unevaluated diagnostic data have been accumulated in a few public health clinics in the continental United States. For example, Dr. Harry Most, College of Medicine, New York University, stated in a 1961 personal communication: “It has been estimated that approximately 100,000 single fecal tests had been made of Puerto Ricans at the Tropical Disease Laboratory of the Department of Health of the City of New York during the past decade.” Analysis of such data would strengthen any general estimate on the extent of occurrence of the disease.

The status of bilharzial infection in New York City residents of Puerto Rican origin is of special interest. Dr. Howard Shookhoff, New York City Department of Health, estimated that there are at least 40,500 infected Puerto Ricans in this city (personal communication, 1963). He said that although prevalence rates from 17 to 20 percent were noted in population samples of Puerto Rican transmigrants, these rates were biased because fecal samples were obtained from patients who came to clinics for treatment of gastrointestinal disorders or who were from families who had a member infected with bilharziasis. However, he stated that in a 1956-57 survey a prevalence rate of 13 percent was obtained by fecal examination of 187 hospital patients selected at random. Also, three additional surveys between 1957 and 1961 showed a prevalence of more than 10 percent, and the samples for these surveys were obtained from presumably healthy persons.

In a group of New York City elementary school children born in Puerto Rico, most of whom had left the island before the age of 5,

only 1 percent was positive. In 226 junior high school children, however, an infection rate of 7.5 percent was observed. Among two samples of adults tested recently, 58 (13 percent) of 422 were infected. Friedman and Shookhoff have estimated that a minimum of 10 percent of the Puerto Ricans in New York City harbor *S. mansoni* (14); but, *S. mansoni* is not endemic in any part of the continental United States and *A. glabratus* does not occur here at present.

Data on rectal biopsy studies are sparse (table 3), although this technique is reported to be more efficient than either fecal tests or autopsy methods as a clinical tool in the diagnosis of *S. mansoni* infection (15-17). The percentage of positive results among groups of persons tested ranged from 28 to 93. Dr. Irving G. Kagan, Communicable Disease Center, Public Health Service, who supplied the references presented in table 3, stated: “With the exception of the work by Pons and Reyes (8) the rectal biopsy studies reported were made on Puerto Rican individuals residing in the continental United States. Careful perusal reveals that, although the number of cases is small, in

Table 3. Schistosoma mansoni in Puerto Ricans, based on rectal biopsy, selected studies

Study groups	Number persons	Positive		Source
		Number	Per cent	
Unselected U.S. soldiers..	26	20	77	(18)
Unselected clinic patients.	22	9	41	(19)
U.S. Army selectees, aged 18-35 years.....	34	15	44	(8)
Asymptomatic U.S. soldiers.....	¹ 107	36	34	(20)
Clinic patients of Puerto Rican origin, Jefferson Hospital, Philadelphia, Pa.....	62	23	37	(21)
Puerto Ricans with confirmed chronic cases, New York City.....	106	99	² 93	(22)
Male prisoners in United States, asymptomatic and healthy.....	103	29	³ 28	(4)

¹ Six had positive stools but negative biopsies.

² 83 percent had positive stools with an average of 3 examinations.

³ Only 14 percent proved positive by a single fecal examination, but 44 percent were positive by skin test.

each instance the sample was an unselected one, and consisted of soldiers, prisoners, and patients who presented themselves at clinics with diseases other than schistosomiasis. In almost every instance the sample represented the chronic asymptomatic individual."

Little information on postmortem materials is currently available (table 4). There is a consensus that the large numbers of pathologic specimens formerly seen at autopsy are now relatively reduced, compared with pathology reported 35 or more years ago (23). In the groups studied, the range of percent positive was 7 to 42.

A small body of intradermal skin test and serologic test data exists on patients with rectal biopsy findings (4). A general disadvantage of these intradermal-serologic techniques is that infection cannot be determined as specifically past or present. Of 13,345 intradermal tests performed, 2,673 (20 percent) persons had positive results (table 5). Skin tests among unselected clinic patients residing in the United States for several years detected 27 percent posi-

Table 4. Schistosoma mansoni in Puerto Ricans, based on postmortem data

Number examined for schistosomal pathology	Positive		Source
	Number	Percent	
225-----	30	13	(24)
33-----	14	42	(8)
144-----	10	7	(23)
1,009-----	147	15	(6)
100-----	11	11	(25)
150-----	19	9	(26)
35-----	7	20	(27)
1,520-----	¹ 248	16	(28)

¹ Pulmonary lesions were seen in 161 (65 percent).

tive, in contrast to 52 percent among school children in Aibonito, Puerto Rico, where the risk of infection is high. Higher rates (28, 62, and 75 percent) were obtained in a hospitalized group in San Juan suspected of infection based only on clinical findings. Usually, intradermal tests show considerably higher rates of infection than stool examinations.

With reference to serologic test data (table 6), 44 percent of males (18 to 35 years of age)

Table 5. Schistosoma mansoni in Puerto Ricans, based on intradermal tests, selected studies

Study groups	Intradermal test antigen	Number in sample	Positive		Source
			Number	Percent	
Healthy U.S. soldiers, random sample-----	Adult worm-----	¹ 276	124	45	(29).
Children in Philadelphia, Pa., aged 6-15 years-----	.....do-----	² 217	11	5	Personal communication, I. G. Kagan, 1960.
Children aged 10-13 years, islandwide random sample-----	.....do-----	10, 726	1, 445	13	I. G. Kagan, unpublished data.
Children aged 6-15 years, Aibonito, P.R.-----	.....do-----	³ 406	210	52	Personal communication, I. G. Kagan, 1961.
Male prisoners in United States, asymptomatic and healthy-----	.....do-----	⁴ 103	45	44	(4).
Patients at Philadelphia, Pa., Parasitosis Clinic, random sample-----	.....do-----	⁵ 204	56	27	Personal communications, I. G. Kagan, 1959, 1960.
Hospitalized patients in Puerto Rico, suspected clinically-----	.....do-----	480	296	62	(5).
Do-----	Cercarial-----	483	360	75	(5).
Do-----	Egg-----	450	126	28	(5).

¹ 19 percent had positive stools for *S. mansoni* eggs by concentration methods.

² 182 native Philadelphians were used as controls. 5 to 6 stools from each subject were examined for *S. mansoni* eggs; 5 Puerto Ricans were passing eggs when examined.

³ Of 372 selected persons from this group, 132 had positive results by a different technique.

⁴ 27 percent had positive results when stools were examined for eggs.

⁵ 34 of 38 persons with positive stools also had positive skin tests. Higher rates of infection were detected with intradermal tests than with single stool tests (27 percent in contrast to 20 percent).

selected for military duty as physically fit were positive by complement fixation test. In suspected hospital patients, tested by a variety of serologic methods by Jachowski and Anderson (5), 81 to 93 percent were positive, indicating the high sensitivity of serologic procedures.

Since it is clearly indicated that significantly higher prevalence rates accrue when serologic and intradermal tests are employed in contrast to either simple saline smear or egg concentration fecal examination, emphasis should be placed on stimulating wider use of these tests in investigations of Puerto Rican schistosomiasis. Obviously, the origin of the test population and whether it is from areas in which transmission is probable should be considered. Also, the test method, its determination of current infection, and its relative efficiency should be evaluated before generalizing on the current status of the disease.

Discussion

Analysis of various kinds of diagnostic surveys performed since 1904 indicates that the infection rate of Puerto Rican schistosomiasis may be estimated as 10 percent when based on the large number of single stool test data and 15 percent when based on autopsy data. Previously reported rates based on a limited amount of rectal biopsy data appear to be comparatively high (37 percent). When intradermal test data are considered, a rate of 15 percent is indicated. Scarcity of serologic test data precludes any valid estimation. A valid general estimate of the current infection rate for this disease in

Puerto Ricans must fall between 10 and 37 percent, based on unselected sampling of the general population.

Considering the approximately 1 million Puerto Ricans who live in the nonendemic continental United States and the probable natural self-limitation of infections, a 15 percent rate might be estimated. However, in the endemic sectors of the island homeland, I believe that a rate of 20 percent reflects the current status of infection. At present a "bilharzial line" may be drawn from Arecibo to Ponce (including Utuado). West of this line, which includes about one-third of the island, only three strictly limited foci are known in suburban areas of Mayagüez, Añasco, and Guánica. East of this line, infections may be generally encountered.

Historically, in 1904 two major fecal testing projects revealed bilharziasis to be confined mostly to agricultural groups working in the sugarcane areas. The Anemia Commission of Puerto Rico (30) determined that 21 of 1,408 patients with anemia were positive for bilharziasis. Gonzalez-Martinez determined that 59 of 1,321 unselected patients at his clinic were positive. In 1905 he estimated that about 8 percent of rural Puerto Ricans were infected. A general historical background has been reported by Faust (31).

Hopefully, from current research in the broad field of serologic and skin reactions (circumoval precipitin reaction, cercarial agglutination reaction, cercarial tagging by fluorescent antibody, cercarienhullen reaction, miracidial immobilization, complement fixation, flocculation, and skin tests) a practical diagnostic tool or tools

Table 6. Schistosoma mansoni in Puerto Ricans, based on serologic tests, selected studies

Study groups	Test and antigen	Number in sample	Positive		Source
			Number	Percent	
Healthy U.S. soldiers, random sample...	Complement fixation, adult worm.	276	121	44	(29)
Hospitalized patients in Puerto Rico, suspected clinically.	do-----	485	444	92	(5)
Do-----	Complement fixation, cercarial.	485	431	89	(5)
Do-----	Slide flocculation, cercarial.	485	435	90	(5)
Do-----	Cercarial agglutination	485	451	93	(5)
Do-----	Circumoval precipitin, egg.	485	388	80	(5)

will be sufficiently evaluated and will replace the burdensome stool examination technique now used in general surveys for the detection of *S. mansoni* eggs.

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Education Notes

Water Resources Development. The University of North Carolina at Chapel Hill will expand its curriculum in water resources development in the fall of 1965. Courses will be offered jointly by the department of environmental sciences and engineering and the department of city and regional planning and resources of the Institute of Government will be used. Professor Daniel A. Okun, head, Department of Environmental Sciences and Engineering, School of Public Health, will supply additional information.

Community Safety. The department of public health administration, University of North Carolina, will enlarge its community safety program, begun 3 years ago, at both graduate and continued education levels. The department will enroll 6 masters degree candidates in September 1965 and accept 30 students for a short course on program techniques in accident control, to be held from May 31 to June 4, 1965.

For information write to Accident Control Program, Department of Public Health Administration, UNC School of Public Health, Drawer 229, Chapel Hill, N.C.

Hospital Administrators Development Program. A short course of lectures, readings, and discussions dealing with the economic, social, and medical issues which affect the professional responsibilities of the medical care administrator will be held at Cornell University from June 27 to July 23, 1965. Twenty-five \$500 scholarships are available for experienced administrators. Information can be obtained from

the director, Hospital Administrator's Development Program, Sloan Institute of Hospital Administration, Malott Hall, Cornell University, Ithaca, N.Y.

Center for Hospital Administration. The University of Chicago has established a center to coordinate the interdisciplinary efforts of medical, social, and behavioral scientists working toward improved medical care.

The Center for Hospital Administration Studies functions as a part of the graduate school of business and incorporates two agencies affiliated with that school, the Health Information Foundation and the graduate program in hospital administration. It is not a degree granting agency of the university, but contributes resources for the education of M.B.A.-degree candidates in hospital administration and for doctoral candidates in the business school, having a special interest in research on health problems.

George P. Shultz, dean of the graduate school of business, is chairman of the center's administrative council and George Bugbee, professor of hospital administration, is the director of the center.

Clinical Psychology. Predoctoral internships and postdoctoral fellowships are available for 12 months of intensive training at the Devereux Schools in suburban Philadelphia, a group of residential treatment, remedial education, and rehabilitation centers. The training program, partly supported by a grant from the National Institute of Mental Health, Public Health Service, emphasizes work with mentally retarded or emotionally disturbed children, adolescents, and young adults presenting problems of learning and personal adjustment.

For information write to Dr. Henry Platt, Director of Training, the Devereux Foundation Institute for Research and Training, Devon, Pa.

Publication Announcements

Address inquiries to publisher or sponsoring agency.

Personnel Administration in Hospitals and Related Health Care Facilities. November 1964; 106 pages; \$3.50. American Hospital Association, 840 North Lake Shore Drive, Chicago, Ill., 60611.

Your Career in Pediatrics. 1964; 14 pages. The American Academy of Pediatrics, Inc., 1801 Hinman Ave., Evanston, Ill., 60204.

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How to Get Good Medical Care. Public Affairs Pamphlet No. 368. By Irvin Block. January 1965; 28 pages; 25 cents. Public Affairs Pamphlets, 381 Park Ave. South, New York, N.Y., 10016.

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The Cost of Social Security, 1958-60. 1964; 296 pages. International Labor Office, Washington Branch, 917 15th St. NW., Washington, D.C., 20005.

World Health Organization

WHO publications may be obtained from the Columbia University Press, International Documents Service, 2960 Broadway, New York, N.Y., 10027.

Enteric Infections. Report of a WHO Expert Committee. WHO Technical Report Series No. 288. 1964; 35 pages; \$1; Geneva.

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Protection Against Ionizing Radiations. A survey of existing legislation. 1964; 170 pages; \$2; Geneva.

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