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THE EPIDEMIOLOGY OF SCHISTOSOMIASIS IN EGYPT: METHODS, TRAINING, AND QUALITY CONTROL OF CLINICAL AND ULTRASOUND EXAMINATIONS

M. FARID ABDEL-WAHAB, GAMAL ESMAT, YASER EL-BORAEY, IMAN RAMZY, EMAN MEDHAT, AND G. THOMAS STRICKLAND

Department of Tropical Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt; International Health Program and Department of Epidemiology and Preventive Medicine, School of Medicine, University of Maryland at Baltimore, Baltimore, Maryland

Abstract. Morbidity due to schistosomiasis was evaluated in a subpopulation of 14,000 of the randomized sample in the Epidemiology 1, 2, 3 Project. It was measured by using a standardized questionnaire for obtaining medical history and symptoms and by performing standardized physical and ultrasound examinations. Reported herein are descriptions of the methods and training and quality control efforts made to insure that the morbidity data was reliable and consistent when collected by 7 different teams in 9 different governorates.

The third objective of the Egyptian Ministry of Health/United States Agency for International Development (USAID)—sponsored Schistosomiasis Research Project Epidemiology 1, 2, 3 (EPI 1, 2, 3) Project was to assess morbidity due to schistosomiasis in a sample of rural population from 9 different Egyptian governorates.[1] The procedures used in this population-based estimation of morbidity were to take clinical histories and to perform physical and ultrasonographic examinations on all inhabitants > 5 years of age of every fifth household included in the survey. Approximately 14,000 subjects were in this subsample having clinical and ultrasound examinations, making this the world's largest investigation of community morbidity.

Examining such a large number of subjects in their communities posed numerous logistic problems. The purpose of this paper is to describe the methods used for these examinations, the training of ultrasonographers, and attempts at quality control.

METHODS AND RESULTS

During planning meetings the 7 Egyptian EPI 1, 2, 3 Project principal investigators and 3 American coinvestigators discussed the methods to be used in assessing morbidity in the communities. A standardized approach was selected.

Clinical examination. The Clinical Examination Form included demographic and symptom questions, height and weight, visual observations (e.g., the presence or absence of pallor or jaundice) and examination of the abdomen. Symptom questions were asked separately for present time, past year, and prior to one year and included the following: burning micturition, hematuria, bloody stools, tenesmus, jaundice, edema of the lower limbs, fever, hematemesis, passage of renal stones, abdominal pain, other symptoms, management of hematemesis and renal stones, site of abdominal pain (if currently present), previous operations, and physician visits and reason for the visit during the previous year. The abdominal examination consisted of measuring the hepatic span in the midclavicular line (MCL) by percussion and the distance the lower border of the liver descended below the subcostal border and below the xiphisternum by palpation, clinical impression of the liver size and consistency, and whether the surface was smooth or irregular or tenderness was present on palpatation. The spleen was searched for and, if palpated, the distance in centimeters below the left costal margin in the anterior axillary line was measured by palpation and/or percussion and recorded. The abdomen was also examined for ascites, palpable kidneys, or other masses, tenderness, and costovertebral or suprapubic tenderness.

Ultrasonographic examination. Eleven portable ultrasound machines (EUB-200; Hitachi, Tokyo, Japan) with linear 3.5 MHz probes (EZU-PL21; Hitachi) with video printers were purchased for the project and standardized and adapted for surveying subjects in communities. They all provided excellent resolution and high-quality visualization.

The methodology for ultrasound examinations was based upon recommendations proposed at a World Health Organization-sponsored workshop in Cairo.[2] Only the abdomen was examined. Measurements obtained following a strict protocol, rather than by using a diagnostic approach, were recorded on an Ultrasonography Examination Form.

The standardized form was used to guide the examiner and to record results of the examination (Table 1). Details of the examination have been published.[2] Specific measurements were selected as being 1) characteristic of schistosomiasis, e.g., bladder wall thickening; 2) indicative of severity of infection, e.g., grade of periportal fibrosis (PPF); 3) recognizable and relatively easily measurable; and 4) quantitative or precisely qualitative.

The examination methods and the form had extensive pretesting to determine whether it provided sufficient information to assess morbidity due to schistosomiasis. The ultrasound examination could be performed by an experienced ultrasonographer in 10 min if he or she had assistance in preparing the subjects and recording the data. Less experienced ultrasonographers needed 15–20 min to complete the examination.

Standardization of reporting. The same standardized forms were used by each of the 7 groups and the ultrasonographers were required to complete these forms, including measuring and recording height and weight of each subject. Height was used to adjust for variability in body size when testing for the presence of hepatic enlargement. Patients were generally examined 3–6 hr after their morning meal, not while fasting. All 7 groups performing the evaluations were taught that examination of the urinary bladder required full bladders and that all subjects should drink fluids and not void before the examination. Grading of PPF was performed following guidelines proposed by Abdel-Wahab and others

TABLE 1
Examinations performed during abdominal ultrasonography

1	Spans of the right lobe of the liver measured in the midcla vicular line and below the costal margin
2	Span of the hepatic left lobe measured in the midsternal line
3	Portal tract thickening (outer-to-outer wall diameter) measured in 3 portal tracts peripherally in liver
4	Assessment of attenuation or dilation of the hepatic veins
5	Portal vein diameter (inner-to-inner wall) midway between the portahepatis and the portal vein bifurcation
6	Liver texture (normal, bright, heterogenous, coarse)
7	Hepatic surface (smooth or irregular)
8	Hepatic focal lesions (presence or absence, number, site, echo-pattern and size)
9	Gall bladder (normal, distended, contacted or removed, wall thickness, presence or absence of stones and biliary mud)
10	Common bile duct (visualized, presence or absence of dilation, and diameter)
11	Spleen size (in longitudinal axis and below the costal margin), texture, and presence or absence of focal lesions
12	Splenic vein diameter at the hilum and midline and presence or absence of collateral veins (splenic hilum, periumbilical, and coronary veins)
13	Ascites (presence or absence)
14	Kidney appearance and size in longitudinal and transverse axis
15	Kidney parenchymal thickness, back pressure changes, stones, focal lesions or other abnormalities
16	Ureteral dilation or stones (nondilated ureters are not visualized)
17	Bladder appearance (normal or not, stones, sediment)
18	Bladder wall (irregular, calcification, posterior wall thickness, polyps and tumors (and measurements)
19	Prostate (normal, enlarged, calcified)
20	Other findings

TABLE 2
Some topics covered in the ultrasonography course

A. Theoretical (readings, lectures, and slide demonstrations)	
1	Background information on schistosomiasis
2	Epidemiology of schistosomiasis in Egypt
3	Pathology and pathogenesis of schistosomiasis
4	Collagen metabolism as it relates to schistosomal hepatic fibrosis
5	Clinical morbidity associated with schistosomiasis as is seen in hospitals and in communities
6	Diagnostic ultrasonography (e.g., theory, machines, and use in medicine)
7	Slide demonstrations of normal and abnormal, including in schistosomiasis, ultrasonographic findings in abdominal organs
8	Description of ultrasonographic methods to be used in the Epidemiology 1,2,3 Project.
B. Practical examinations of subjects	
1	Examination of abdominal organs in normal subjects
2	Demonstration of typical hepatosplenic and urinary lesions of schistosomiasis, mild and advanced
3	Demonstration of typical pathologic lesions due to other diseases, e.g., chronic hepatitis, cirrhosis of the liver, and comparison with schistosomal abnormalities
4	Complications of schistosomiasis, e.g., portal hypertension, ascites, hydronephrosis, cancer of the bladder
5	Other abnormalities detected by abdominal ultrasonography, e.g., gall stones
6	Examine patients in the Ultrasound Unit and during field studies in communities
C. Certification	
1	Written test
2	Practical examination of 10 patients

at the time the data was analyzed using the average of three measurements of portal tract thickness.[3]

Ultrasound standardization was accomplished by requiring all ultrasonographers working on the project to take a training course given by the University of Cairo's Tropical Medicine Department at the Kasr El Aini Hospital.

Training. Individual principal investigators trained members of their teams performing physical examinations. A 4–6 week ultrasound training course was organized by the Ultrasonography Unit of the Tropical Medicine Department at Kasr El Aini Hospital. The objectives of this course were 1) to train members of the 7 teams to perform the required examinations; 2) to teach them to collect and record information needed to measure morbidity of schistosomiasis; and 3) to provide experience required for performing ultrasound examinations of the abdomen. Most trainees in 5 of the 7 EPI 1, 2, 3 groups did not have prior ultrasound experience. The course was a mixture of didactic and practical sessions (Table 2). The students also had opportunities to examine patients in both the hospital and in the communities. They were taught in pairs: one performing the ultrasound examination and the other recording the results to fortify the importance of careful and complete recording of data. Reproducibility of the ultrasound examinations was tested by having the same ultrasonography examine the same patient on subsequent days (internal validity) and by having two ultrasonographers examine the same subject on the same day (external validity).

To learn how to perform ultrasound examinations in rural communities and to obtain sufficient subjects with normal or minimally abnormal ultrasound findings, the trainees joined teams working at rural sites. The final examination consisted of a written and practical ultrasound examination of 10 patients with recording of the results. If the student passed the examination, they received certification and were allowed to examine subjects in the Project. If they did not pass, they were given individual instruction on those aspects in which they showed weakness. Five training courses, each training 5–8 ultrasonographers, were given during the first 2 years of the project; a total of 28 physicians were certified as ultrasonographers by this course. The later courses were used to train additional ultrasonographers to replace those who dropped out of the Project and to retrain those who were not performing up to expectations.

Quality control. This was performed during actual examinations in communities. One of the authors (GTS), accompanied by an experienced ultrasonographer, joined teams while they examined subjects in the communities and observed the examination of 8–10 subjects by both the field team's ultrasonographer and the experienced examiner. Both physical and ultrasonographic examinations were performed and recorded by both examiners. An assumption was made that if there was a discrepancy between results, the experienced ultrasonographer's findings were correct, with a proviso that his (or her) results were not considered incorrect by the observer. This also provided continuing education since discussions of methods and results were held following the examination.

On comparing results from the 2 examiners, the following

general points were noted: 1) methods and results of the physical examination were highly variable, in particular measurements of liver span, and 2) there was considerable variability in some ultrasonographic findings. Continuous measurements were considered the same if they did not vary by more than 20%, e.g., liver spans in the MCL of 10 cm and 12 cm were not considered different. Results reported as dichotomous measurements required agreement to be considered the same.

Some difficulties occurred because the initial requirements were either too demanding or time-consuming, e.g., measurement of the diameter of normal sized splenic veins. Other problems were caused by variations in measurements by different ultrasonographers, e.g., portal tract thickening, liver span in the MCL and midsternal line, and posterior bladder wall thickness. Two major problems were discovered, but unfortunately, not corrected. Height, which was used to correct for body size in estimating liver size, was not recorded in a propotion of subjects and not all teams insisted that subjects being examined have full urinary bladders. Despite this technical variability and lack of prior ultrasound experience by some ultrasonographers, useful and reliable information was obtained because of the highly standardized examination and examiners were trained to measure and record very specific structures and not to concern themselves with diagnoses.

Our method of quality control, although being direct and practical, was very time-consuming and was only used 2 or 3 times for each EPI 1, 2, 3 team. No ultrasonographers were evaluated more than twice and some were not tested.

DISCUSSION

The most important objective of the EPI 1, 2, 3 Project probably was assessment of community morbidity due to schistosomiasis. Studies of community morbidity of schistosomiasis have been based upon the qualitative excretion of *Schistosoma* ova in the stool or urine and screening physical examinations.[4–7] Quantitative parasitology is only a surrogate for morbidity, in that it has some correlation with the subject's worm burden, which in turn correlates with the pathologic findings.[8,9] The physical examinations performed in communities by different examiners are notoriously unreliable, even when performed as part of research projects, e.g., the EPI 1, 2, 3 Project. Abdominal ultrasonography, which uses a pulse echo device to record reflected waves of a sound beam in 2 dimensions, is relatively inexpensive and portable, can produce images in real time in any plane without revision of format, and does not depend on ionizing radiation or cause biological hazards, is ideal for screening populations for schistosomal morbidity.[10,11] It can be used to screen subjects in communities,[10] as well as patients in the hospital.[11] There is sufficient guidelines to detect and grade the more severe lesions caused by schistosomiasis in hospital patients.[3,12–14] We have also published results of studies showing that abdominal ultrasonography can be used for assessing less severe lesions in subjects living in endemic communities,[15–17] although the specificity of grade I lesions for schistosomal periportal fibrosis is poor.[18]

Therefore, it was appropriate to include abdominal ultrasonographic assessment of morbidity as a component of the EPI 1, 2, 3 Project and we believe the 14,000 subjects in the subgroup having morbidity investigations is the largest population having community investigations of this kind. Because of the size of the project, problems in standardization and quality control occurred despite our efforts to address these issues. The following observations on reliability of the data were made: 1) almost all of the data we scrutinized are credible; 2) because of differences between the performance of physical examinations between groups, comparisons of results of these examinations should not be made between groups; 3) because not all subjects were examined with full urinary bladders, particularly by one group, the prevalence of urinary bladder wall lesions is lower than they actually were; and 4) because many ultrasonographers measured periportal tracts, even when they were not thickened, the prevalence of grade I PPF is falsely high, particularly in some EPI 1, 2, 3 groups. A deficiency caused by inexperience of some of the ultrasonographers and the standardized examination method they used, which had no impact directly upon schistosomal morbidity measurement, was the inability to detect nonschistosomal-caused abdominal lesions, e.g., gall stones.

Despite these limitations, we believe that the EPI 1, 2, 3 Project provides a very valuable estimate of morbidity due to schistosomiasis in Egypt, and its finding that morbidity is less than previously suspected and often cannot be directly associated with schistosomal infection is valid.[19]

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Authors' addresses: M. Farid Abdel-Wahab, Gamal Esmat, Yaser El-Boraey, Iman Ramzy, and Eman Medhat, Department of Tropical Medicine, Kasr El Aini Hospital, Faculty of Medicine, University of Cairo, Cairo, Egypt. G. Thomas Strickland, International Health Program, Department of Epidemiology and Preventive Medicine, School of Medicine, University of Maryland at Baltimore, Baltimore, MD 21201.

Reprint requests: Schistosomiasis Research Project, Medical Services Corporation International, 1716 Wilson Boulevard, Arlington, VA 22209.

REFERENCES

1. El-Khoby T, Hussein MH, Galal N, Miller FD, 2000. Epidemiology 1, 2, 3: origins, objectives, organization, and implementation. *Am J Trop Med Hyg 62 (suppl):* 2–7.
2. The Cairo Working Group, 1992. The use of diagnostic ultrasound in schistosomiasis—attempts at standardization of methodology. *Acta Trop 51:* 15–28.
3. Abdel-Wahab MF, Esmat G, Farrag A, El-Boraey YA, Strickland GT, 1992. Grading of hepatic schistosomiasis by the use of ultrasonography. *Am J Trop Med Hyg 46:* 403–408.
4. Cook JA, Baker ST, Warren KS, Jordan P, 1974. A controlled study of morbidity of schistosomiasis mansoni in St Lucian children, based on quantitative egg excretion. *Am J Trop Med Hyg 23:* 625–633.
5. Arap Siongok TK, Mahmoud AAF, Ouma JH, Warren KS, Muller AS, Handa AK, Houser HB, 1976. Morbidity in schistosomiasis mansoni in relation to intensity of infection: study of a community in Machakos, Kenya. *Am J Trop Med Hyg 25:* 273–284.
6. Cline BL, Rymzo WT, Hiatt RA, Knight WB, Berrios-Duran LA, 1977. Morbidity from *Schistosoma mansoni* in a Puerto Rican community: a population-based study. *Am J Trop Med Hyg 26:* 109–117.

7. Abdel-Wahab MF, Strickland GT, El-Sahly A, Ahmed L, Zakaria S, El Kady N, Mahmoud S, 1980. Schistosomiasis mansoni in an Egyptian village in the Nile delta. *Am J Trop Med Hyg 29:* 868–874.
8. Cheever AW, Andrade ZA, 1967. Pathological lesions associated with *Schistosoma mansoni* infections in man. *Trans R Soc Trop Med Hyg 61:* 626–639.
9. Smith JH, Elwi A, Kamel IA, von Lichtenberg F, 1975. A quantitative post mortem analysis of urinary schistosomiasis in Egypt. II. Evolution and epidemiology. *Am J Trop Med Hyg 24:* 806–822.
10. Strickland GT, Abdel-Wahab MF, 1993. Abdominal ultrasonography for assessing morbidity from schistosomiasis. 1. Community studies. *Trans R Soc Trop Med Hyg 87:* 132–134.
11. Abdel-Wahab MF, Strickland GT, 1993. Abdominal ultrasonography for assessing morbidity from schistosomiasis. 2. Hospital studies. *Trans R Soc Trop Med Hyg 87:* 135–137.
12. Abdel-Wahab MF, Esmat G, Milad M, Abdel-Razek S, Strickland GT, 1989. Characteristic sonographic pattern of schistosomal hepatic fibrosis. *Am J Trop Med Hyg 40:* 72–76.
13. Abdel-Wahab MF, Ramzy I, Esmat G, El-Keffos H, Strickland GT, 1993. Ultrasound for detecting schistosomiasis haematobia urinary tract complications: comparison with radiographic procedures. *J Urol 148:* 346–350.
14. Abdel-Wahab MF, Esmat G, Farrag A, El-Boraey Y, Strickland GT, 1993. Ultrasonographic prediction of esophageal varices in schistosomiasis mansoni. *Am J Gastroenterol 88:* 560–563.
15. Abdel-Wahab MF, Esmat G, Narooz SI, Yosery A, Struewing JP, Strickland GT, 1990. Sonographic studies on schoolchildren in a village endemic for *Schistosoma mansoni. Trans R Soc Trop Med Hyg 84:* 69–73.
16. Abdel-Wahab MF, Esmat G, Ramzy I, Fouad R, Abdel-Rahman M, Yosery A, Strickland GT, 1992. *Schistosoma haematobium* in Egyptian schoolchildren: demonstration of both hepatic and urinary tract morbidity by ultrasonography. *Trans R Soc Trop Med Hyg 86:* 406–409.
17. Nafeh MA, Medhat A, Swifee Y, Moftah FM, Mohamed A, Soliman A-GA, Strickland GT, 1992. Ultrasonographic changes of the liver in *Schistosoma haematobium* infection. *Am J Trop Med Hyg 47:* 225–230.
18. Medhat A, Nafeh M, Swifee Y, Helmy A, Zaki S, Shehata M, Ibrahim S, Abdel-Kader DA, Strickland GT, 1998. Ultrasound-detected hepatic periportal thickening in patients with prolonged pyrexia. *Am J Trop Med Hyg 59:* 45–48.
19. El-Khoby T, Galal N, Fenwick A, Barakat R, El-Hawy A, Nooman Z, Habib M, Abdel-Wahab F, Gabr NS, Hammam HM, Hussein MH, Mikhail NNH, Cline BL, Strickland GT, 2000. The epidemiology of schistosomiasis in Egypt: summary findings in nine governorates. *Am J Trop Med Hyg 62 (suppl):* 88–99.