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FIELD EVALUATION OF THE MEADE READIVIEW HANDHELD MICROSCOPE FOR DIAGNOSIS OF INTESTINAL SCHISTOSOMIASIS IN UGANDAN SCHOOL CHILDREN

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Abstract. A novel, inexpensive handheld microscope, the Meade Readiview, was evaluated for field diagnosis of intestinal schistosomiasis by comparison of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) against conventional compound microscopy as part of a parasitologic survey in nine sentinel schools and a rapid mapping survey across 22 schools in Uganda. Fecal smears from 685 primary school children were examined and the overall prevalence of *Schistosoma mansoni* was 45%. However, prevalence by school ranged widely from 0% to 100%. For individual diagnosis the Readiview had a sensitivity of 85%, a specificity of 96%, a PPV of 95%, and an NPV of 88%. Due to the poorer movement control of the glass slide on the Readiview stage, fecal smears with less than four eggs could be overlooked. At the highest magnification (160×), egg-like objects could be confounding. Estimating prevalence by school was usually within ± 7% of that of conventional microscopy. Since the Readiview is more robust and portable, both in size and weight, and one-tenth as expensive as the traditional compound microscope, a change in the logistics and costs associated with field infection surveillance is possible. This inexpensive microscope is a pragmatic alternative to the compound microscope. It could play an important role in the collection of prevalence data to better guide anthelmintic drug delivery and also empower the diagnostic capacity of peripheral health centers where compound microscopes are few or absent.

INTRODUCTION

Intestinal schistosomiasis has been present in Uganda for a long time and continues to pose a considerable public health burden in 38 of 56 districts.[1,2] In March 2003, a National Control Program (NCP) was launched against bilharzia (schistosomiasis) and intestinal worms in 18 districts. Its aim was to provide regular anthelmintic treatments to children and adults within communities known or suspected to be at high risk of infection.[3] *Schistosoma mansoni* can be hyperendemic along much of the shorelines of Lakes Albert and Victoria and in certain places, infections in school age children can be almost universal.[2,4] Outside these areas there can be substantive heterogeneity of infection prevalence by school; over a local landscape prevalence may range from high (> 50%) to low (< 10%). This is attributable to the complex focality of transmission that has so far proven difficult to encapsulate and predict.[5] As a consequence, in areas where the transmission landscape is particularly heterogeneous, collection of additional prevalence data by school is necessary to better guide the anthelmintic drug delivery regimens recommended by the World Health Organization (WHO).[6,7]

Microscopic examination of fecal smears for parasite eggs from a single stool sample by the standardized thick smear (41.7 mg) Kato-Katz method remains the preferred option for diagnosis of *S. mansoni* in the field; it remains the pragmatic and accepted gold standard for routine epidemiologic surveillance recommended by WHO.[8] One major logistical constraint, however, is the availability of compound microscopes because these are relatively expensive and frequently not available within local, or first-point-of-call, health centers. Similarly, field-based roving teams are often constrained by the number of available, fully functioning microscopes that are both heavy and bulky and the optics of which can be easily damaged during transportation. Since primary schools in Uganda with on-site electricity are the exception, a field team may be forced to carry a power supply unless the microscope can use natural light.

The Readiview handheld microscope, manufactured by Meade Instruments Corporation (Irvine, CA), is an inexpensive (approximately US$70) monocular microscope of innovative design. With a weight less than 0.25 kg and just over 10 cm in diameter, the microscope is very portable and has few moving parts and a light-emitting diode (LED) light source. During an initial pretest, we judged the optical quality of the Readiview to be sufficient for inspection of Kato-Katz fecal smears and to be a convenient platform for photomicrography (Figure 1A). For the trained eye, *S. mansoni* eggs can be identified at either 80× or 160× magnification (Figure 1B and C). However, since the Readiview does not have a mechanical stage, movement control of the glass slide is poor; thus, the resultant egg count may not always be reliable because it is easy to duplicate or miss zones of inspection. Nevertheless, if only the detection of a schistosome egg and confirmation of infection is required, this is a suitable microscope.

In contrast with *S. haematobium* infections,[9,10] reliable questionnaire methods for estimating the prevalence of *S. mansoni* remain elusive.[11,12] Since appropriate anthelmintic drug delivery regimens are determined by infection prevalence thresholds and not infection intensity,[6] the search continues for less expensive, more widely implementable, parasitologic prevalence surveillance methods. The Readi-

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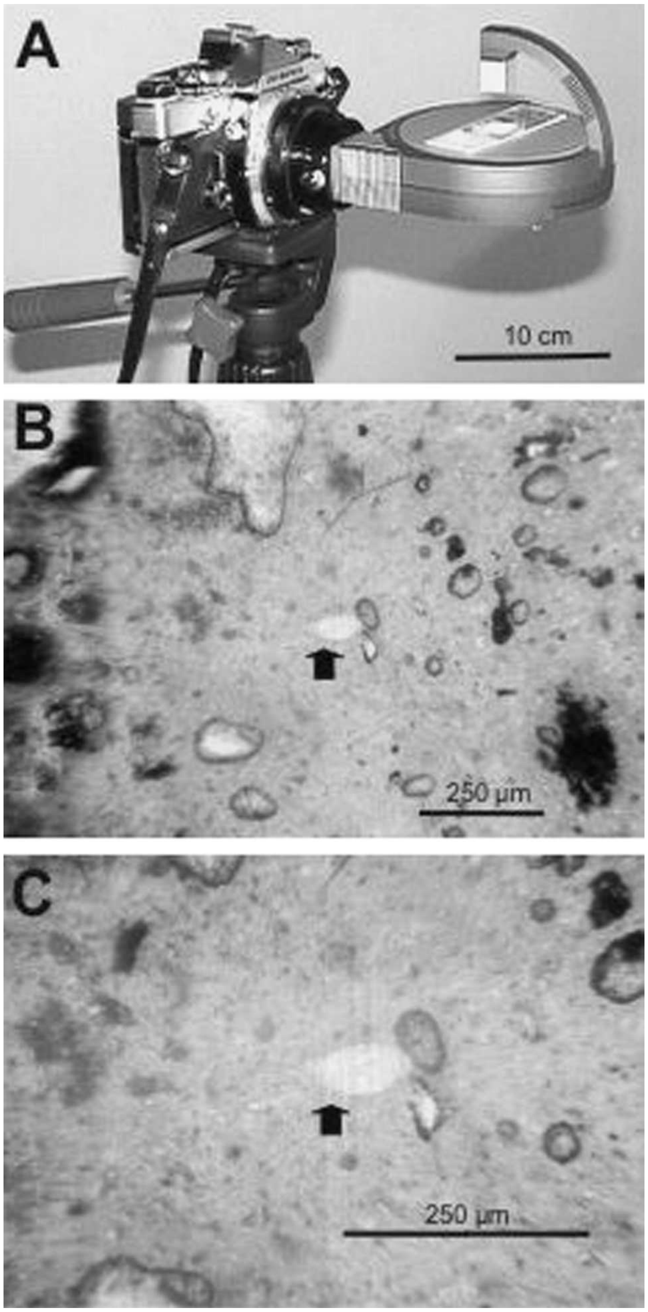

FIGURE 1. Traditional 35-mm single-lens reflex camera attached to the Readiview microscope showing the compact design of this portable microscope and quality of photomicrographs taken with this apparatus. **A**, Olympus (Tokyo, Japan) OM1 camera with ring mount attached to the Readiview using a T-mount adaptor. **B**, *Schistosoma mansoni* egg within a Kato-Katz fecal smear taken at 80× magnification (ASA 400 film, exposure = 2 seconds, camera mounted on tripod). **C**, *S. mansoni* egg at 160× magnification (ASA 400 film, exposure of 2.5 seconds, camera mounted on tripod).

view could therefore be an inexpensive alternative to the traditional compound microscope. We evaluated its performance under field-based conditions in two discrete transmission landscapes, Lake Albert and Lake Victoria. Specifically, we evaluated the diagnostic potential of this microscope in selected sentinel schools and in a rapid mapping exercise.

MATERIALS AND METHODS

Study area. Two transmission areas were chosen to be reflective of the major ecologic zones and epidemiologic landscapes[2,11,12] within Uganda. These were Hoima district near Lake Albert and Mayuge district near Lake Victoria, as shown in Figure 2. Differences in transmission included the species of intermediate snail hosts.[13] In the Lake Victoria region, but not the Lake Albert region, an inverse relationship between the prevalence of *S. mansoni* in schools with increasing distance from the lakeshore has been observed.[2,11] Five sentinel schools within each district were visited during the intervention baseline data collection periods during April (in Hoima) and July (Mayuge), thereby providing suitable access opportunities and logistic support for this microscope evaluation.

Diagnostic evaluation within sentinel schools. Table 1 shows details of 9 of the 10 schools within Hoima and Mayuge that were chosen. The first school visited acted as an in-school training day, the results of which were not included in this study. Within each school, the geographic location was recorded using a handheld global positioning system (GPS) (GPS etrex; Garmin, Olathe, KS), and a minimum of 30 children of matched sexes and approximately 11 years of age was selected to provide stool and urine samples for examination. Stool samples were individually screened through a 212-µm metal sieve and two (2 × 41.7 mg) separate Kato-Katz fecal smears were prepared for each child. Smears were read at the school site using a compound microscope with a natural light source and all other helminth eggs observed were recorded. These data were designated to be the gold standard data set for comparisons between subsequent methods of diagnosis.

Diagnostic evaluation. Four Vector Control Division technicians were trained during a single-day workshop in Kampala (an in-school training day) in the use of the Readiview microscope according to the manufacturer's instructions. Each technician was assessed by the investigators to ensure that a satisfactory level of competence with this microscope had been attained. Due to the difficulties in obtaining a precise egg count because of fingertip movement control, visual inspection of the fecal smear was conducted to determine the presence or absence of an *S. mansoni* egg. To decrease time spent during viewing, a fecal smear was considered positive as soon as the first distinctive egg could be observed and confidently identified. This could often be within the first 15 seconds of searching. In schools with high-intensity infections, the total time spent viewing fecal smears was often less than 30 minutes. In contrast, a fecal smear was considered negative if the microscopist failed to see an egg after repeatedly scanning the smear (taking more than three minutes to do so).

All tests were carried out in the field under the supervision of the imvestigators. For evaluation of the Readiview, the fecal smears were blinded for their egg counts so that the reader did not know if the smear was positive or negative for the presence of schistosome eggs. This was performed in a room separate from where conventional microscope reads were made. After initial analysis, if there was incongruence between the Readiview and compound microscope results (i.e., an egg was seen using the Readiview but not with the compound microscope) the fecal smear was re-examined using a compound microscope (at 400× magnification) by the investigators and a final result was determined. As an addi-

Table 1

Identity and geographic location of schools in the study with associated prevalences and intensities of *Schistosoma mansoni* and hookworm infections*

District number	Name, GPS coordinates	Intestinal schistosomiasis		Hookworm	
		Prevalence (%)	Geometric mean (e.p.g.)	Prevalence (%)	Geometric mean (e.p.g.)
Hoima					
1†	Runga PS N 01° 43′.989, E 31° 18′.450	90	330	30	187
2†	Kibiiro PS N 01° 40′.305, E 31° 15′.076	94	647	10	188
3†	Kibanjwa PS N 01° 29′.633, E 31° 17′.049	3	0	42	107
4†	Kasyeni PS N 01° 34′.860, E 31° 11′.187	62	210	50	120
Mayuge					
5†	Ikulwe PS N 00° 26′.617, E 33° 28′.939	10	1	55	195
6†	Lwanika PS N 00° 21′.363, E 33° 26′.597	73	21	76	270
7†	Bukizibu PS N 00° 15′.698, E 33° 30′.913	14	1	77	195
8†	Bwondha PS N 00° 10′.658, E 33° 31′.300	86	155	57	221
9†	Bugoto Lake View PS N 00° 19′.419, E 33° 37′.697	90	162	70	296
10‡	Maleka Parents PS N 00° 25′.271, E 33° 33′.351	0	0	75	57
11‡	Bweza PS N 00° 25′.317, E 33° 34′.326	0	0	85	87
12‡	Lukunu Muslim PS N 00° 24′.617, E 33° 35′.561	0	0	80	75
13‡	Peterson Memorial PS N 00° 24′.373, E 33° 35′.720	5	0.5	50	13
14‡	Nakazigo PS N 00° 25′.210, E 33° 36′.158	0	0	95	250
15‡	Nachidubuli PS N 00° 24′.193, E 33° 37′.170	10	0.5	85	222
16‡	Kigandalo PS N 00° 23′.288, E 33° 37′.338	15	1	85	137
17‡	Bugulu PS N 00° 24′.097, E 33° 38′.446	15	1	100	284
18‡	Nakitwalo PS N 00° 23′.989, E 33° 33′.922	10	1	95	870
19‡	Matovu Parent's PS N 00° 21′.633, E 33° 37′.224	10	0.5	80	124
20‡	Buyugu PS N 00° 21′.240, E 33° 41′.793	45	9	90	308
21‡	Butumbula PS N 00° 20′.757, E 33° 37′.799	55	10	90	300
22‡	St Andrews Bugoto PS N 00° 20′.522, E 33° 36′.551	45	7	90	275
23‡	Musubi Islamic PS N 00° 20′.042, E 33° 40′.240	50	7	85	154
24‡	Musubi Church of God PS N 00° 18′.665, E 33° 39′.925	75	48	80	97
25‡	Gori PS N 00° 08′.240, E 33° 33′.029	100	147	90	110
26‡	Jagusi Island PS N 00° 07′.418, E 33° 34′.487	60	20	65	40
27‡	Kaaza Island PS N 00° 06′.675, E 33° 35′.996	75	51	70	65
28‡	Serinyabi Island PS N 00° 03′.141, E 33° 36′.358	80	70	95	285
29‡	Bumba Island PS N 00° 01′.321, E 33° 38′.193	65	41	0	0
30‡	Sagitu Island PS S 00° 00′.633, E 33° 39′.244	100	722	75	83
31‡	Masulya Island Junior PS S 00° 02′.733, E 33° 37′.102	40	3	80	67

* GPS = global positioning system; e.p.g. = per gram (of feces); PS = primary school.
† Sentinel survey school.
‡ Mapping survey school.

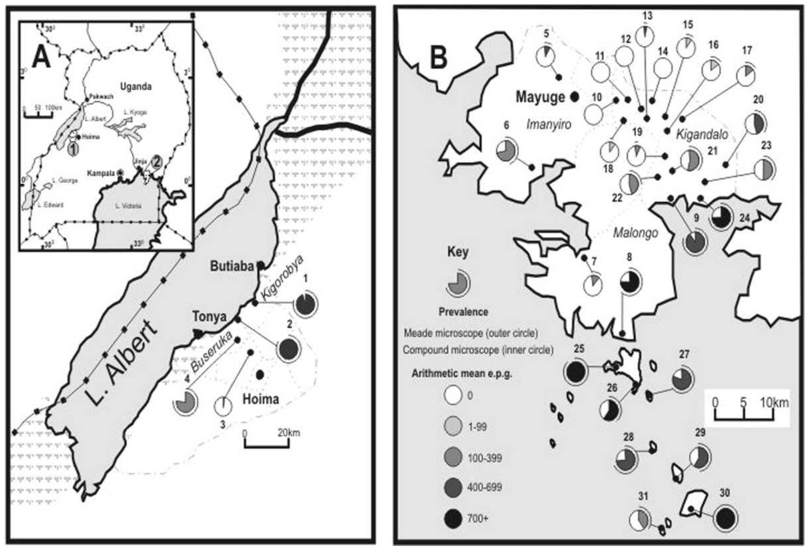

FIGURE 2. Map of Uganda showing the location of 31 schools in the Hoima and Mayuge districts. Thirty children in each school were examined in schools of Hoima and Mayuge, respectively. 1–9 and 20 children in each school were examined in schools 10–31. **A**, **Inset**, map of Uganda with shaded areas 1 and 2 showing the study areas. Map of the four chosen schools in the Hoima district annotated by the detected prevalence of *Schistosoma mansoni* infections using a compound microscope and the Readiview microscope. **B**, Map of the 27 chosen schools in the Mayuge district annotated by the detected prevalence of *S. mansoni* infections using a compound microscopy and the Readiview microscope. e.p.g. = eggs per gram (of feces).

tional compound microscopy quality control, 50 slides were independently viewed at the Diagnostic Parasitology Laboratory of the London School of Hygiene and Tropical Medicine. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated[14] for the performance of each test within each transmission area. The data were then pooled to form a total evidence matrix.

Prevalence survey. The Ugandan NCP was implementing an *en masse* treatment program to all primary schools in Malongo sub-county in Mayuge district.[3] Within Malongo, there are 27 schools with a total enrollment of some 15,000 children. The program set to expand drug distribution into the adjacent sub-county of Kigandalo. The aim of this prevalence survey was to examine the practicalities and performance of the Readiview under field conditions by determining the prevalence of *S. mansoni* within selected Kigandalo primary schools. In addition, we hoped to further validate, on a finer geographic scale, the general inverse relationship of prevalence of intestinal schistosomiasis and distance to lakeshore.[11]

During the initial evaluation in sentinel schools, it was difficult for two technicians to process and examine 30 stool and urine specimens for the 2 microscope reads on the same day. Since the prevalence evaluation exercise across the 22 schools in Kigandalo would be conducted by teams of technician-pairs, we improved the workload to an acceptable daily level by reducing the total number of children examined at each school to 20. Also, only single, not double, Kato-Katz smears were prepared for each child. Moreover, it was believed that such a sample size would be well within the capacity of a single technician of moderate experience working alone, visiting 2–3 schools per day using the Readiview microscope.

The details of the schools visited are shown in Table 1. The geographic location of each school was recorded using a handheld GPS (etrex; Garmin) and shortest distance to lakeshore (where it was assumed infection would take place) was calculated with ArcMap 8.3 software (Environmental Systems Research Institute, Redlands, CA). The sensitivity, specificity, PPV, and NPV were calculated[14] for each school and data were pooled to form a total matrix.

Anthelmintic treatment and ethical approval. Regardless of their infection status, all children examined in the surveys were treated in conjunction with a food item and soft drink with praziquantel (40 mg/kg) as calculated by child's height according to the amended WHO height pole and also with a single 400-mg albendazole tablet. Ethical approval for this study (application 03.36) was granted by National Health System Local Research Ethics Committee at St. Mary's Hospital in London and the Uganda Ministry of Health in Kampala. Written informed consent was obtained from the head teachers of each school and oral informed consent was obtained from each child before stool and urine samples were collected and anthelmintic treatments were administered.

RESULTS

Diagnostic evaluation. Nine schools were visited, four in Hoima and five in Mayuge. One hundred twenty-six children from Hoima and 150 from Mayuge participated in the study, and double Kato-Katz smears were obtained from them. An additional 22 schools were visited and 409 children were examined by a single Kato-Katz smear. In contrast to the schools on the mainland, the seven schools on the islands of Lake Victoria were often impoverished and it sometimes proved difficult to recruit 20 children approximately 11 years of age. For example, in Bumba Primary School (School 29), at the time of survey there was no more than 80 children present at the school site and most were 5–9 years of age.

The prevalence and geometric mean eggs per gram (of feces) (e.p.g.) determined by compound microscopy for all examined children at each school are shown in Table 1. The prevalence of infection with *S. mansoni* was approximately 45%. The total geometric mean (for all examined children) was 11 e.p.g. and the arithmetic mean (for infected cases only) was 268 e.p.g. Figure 2 shows the geographic distribution of prevalence and arithmetic mean (infected children only) by school showing the range of prevalence and intensity encountered. Infections were universal in two schools and the prevalence was greater than 85% in three other schools. In contrast, there were no infections in four schools and the prevalence was less than 20% in nine other schools. The maximum observed e.p.g. was 8,832 at Kibiiro (School 2) in Lake Albert region. An e.p.g. of 6,432 was observed at Musubi Church of God (School 24) on the mainland near Lake Victoria, and an e.p.g. of 6,864 was observed on Jagusi Island (School 26). Other intestinal helminths were detected, the most common of which was hookworm, with a total prevalence slightly in excess of 70% and generally more widely dispersed throughout the schools, with the exception of one school (Table 1). Other helminth infections had a combined total prevalence of less then 5% and in descending order included *Trichuris*, *Ascaris*, and *Hymenolepis*. No infections with *S. haematobium* were detected.

Sensitivity and specificity of Readiview. Using the Readiview microscope at 80× magnification, we could determine whether a schistosome egg was present in a fecal smear, in addition to the presence of hookworm eggs. The latter were easier to see at 160× magnification, but in this instance data on the hookworm status as determined by the Readiview were not collected. Only the presence or absence of *S. mansoni* eggs was recorded. For the four schools in Hoima, the sensitivity and specificity of correctly identifying an egg in a fecal smear were 85% and 100%, respectively. The sensitivity and specificity at five sentinel schools in Mayuge were 85% and 94%, respectively. For the prevalence evaluation within the remaining Mayuge schools, sensitivity and specificity were 89% and 96%, respectively. The sensitivity and specificity across all school data were 85% and 96%, respectively. The PPV and NPV across all data were 95% and 88%, respectively. Figure 3 shows a clear relationship between smear e.p.g. and proportion of smears correctly identified by the Readiview user (the congruent category) and smears where the user failed to identify a schistosome egg (the overlooked category). All fecal smears containing greater than 288 e.p.g. (greater than 12 eggs in the smear) were correctly identified without exception by the Readiview user and the lighter the infection (e.g., < 120 e.p.g.), the greater the proportional error of the Readiview user in overlooking the presence of a schistosome egg.

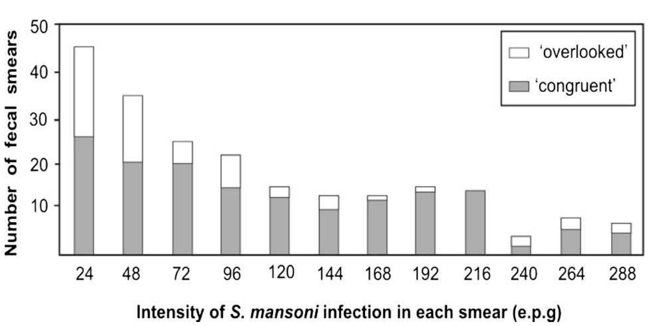

FIGURE 3. Congruence between a compound microscope and the Readiview microscope showing that fecal smears with less than four eggs are more frequently overlooked by the reader than those with greater than four eggs. All fecal smears with 12 eggs, which corresponds to an associated eggs per gram (of feces) (e.p.g.) ≥ 288, were correctly identified with the Readiview.

Estimating prevalence with the Readiview. The corresponding prevalences of intestinal schistosomiasis as determined by the compound microscope and the Readiview are shown in Figure 2. For the 27 schools in Mayuge, the prevalence by school as determined by the two microscopes was plotted against shortest distance to the lakeshore and is shown in Figure 4. A clear inverse relationship between prevalence and distance to lakeshore is observed. Across these data, the mean percentage errors for prevalence as determined by the Readiview compared with the compound microscope were ± 7%. If a cut-off criterion of 50% prevalence is used when annual chemotherapy should be given to all children, the sensitivity and specificity for the Readiview compared with that of the compound microscope were 64% and 100%, respectively, with a PPV of 100% and a NPV of 80%. Conversely, if a proxy of a prevalence ≥ 50%, such as the distance from the lake (all schools greater 5 km from the lakeshore have a prevalence less than 50%) was used, then the sensitivity and specificity of this decision would be 100% and 67%, respectively, with a PPV of 70% and an NPV of 100%.

DISCUSSION

This evaluation took place within a representative epidemiologic landscape in Uganda[2,12] with typical surveillance resources across schools with high, medium, and low prevalences (Table 1 and Figure 2). Although the general prevalence was 45%, infections were aggregated to schools such that 15 schools (48%) had a high prevalence (>50%), 6 schools (20%) had a moderate prevalence (>10%), and 10 schools (32%) had a low prevalence (≤10%). In Mayuge, all schools with high prevalences were located within a 5-km zone near the lake shore,[11] although this zone also had one school with a low prevalence and four schools with moderate

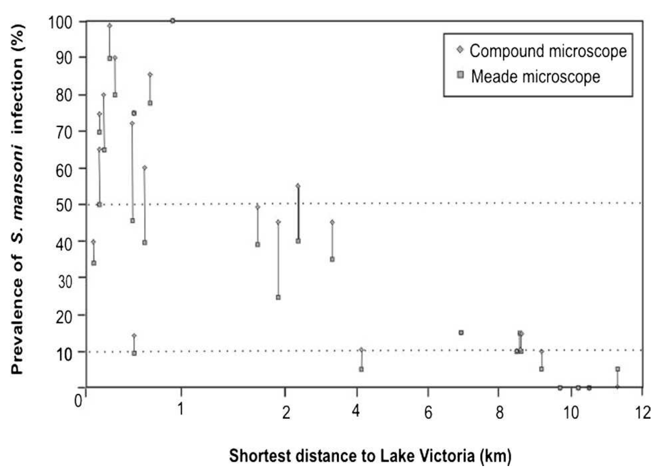

FIGURE 4. Bivariate plot of the prevalence of intestinal schistosomiasis within each school in Uganda as detemined by a compound microscope and the Readiview microscope against shortest distance of the school to the lakeshore. A clear negative association is apparent with both methods. Each data point is linked by a vertical line to illustrate prevalence by school for compound and Readiview microscopes, respectively.

prevalences. This is characteristic of the well-known geographic heterogeneity of *S. mansoni* infections.

There were no noteworthy changes in sensitivity and specificity of the methods between transmission areas (85% and 96% across these data). Contrary to our expectations was the slightly lower specificity of the Readiview, which indicated that false-positive results occurred. When the results obtained by the compound microscope and Readiview disagreed (i.e., an egg originally missed by the compound microscope was subsequently observed with the Readiview) further arbitration resolved most cases. However, this was not possible in some cases where glass slides were re-used and therefore not archived. When the Readiview was used, schistosome egg-like objects were occasionally observed and these could not be confidently rejected at a magnification of 160×. In contrast, they could be rejected with the compound microscope at a magnification of 400×. Empty and partially decomposed *S. mansoni* egg shells and egg-like objects are difficult to identify and in such instances the graticule of the compound microscope, which is absent from the Readiview, assists in identification. Accurate identification was also dependent on the experience of the microscopist concerned. Quality control identification of archived fecal smears at the London School of Hygiene and Tropical Medicine showed that the original compound microscopy assessment was no greater than ± 4 eggs per smear.

In contrast, the sensitivity of the Readiview was due to a concentration effect in that the greater the number of eggs present in the fecal smear, the greater the chance of observing at least one of them. An obvious relationship is clearly shown in Figure 3. In smears containing more than 12 eggs per smear, there was no discordance between microscopic results. In light of the sampled transmission areas, the PPV and NPV values of 95% and 88% should be typical of the diagnostic performance of the Readiview across such a heterogeneous disease area. However, in areas with the disease where light infections predominate, the PPV and NPV will probably be of slightly lower values than those reported here. Conversely, in areas where high intensity infections dominate, the PPV and NPV will likely increase.

In terms of a more systematic bias, prevalence data by school obtained using the Readiview was generally lower than that calculated by the compound microscopy. Since the percentage estimates were usually within ± 7% of each other, application of a correction factor to compensate for this discrepancy could be appropriate. Moreover, this lower estimate of prevalence is significant only for prevalences by school that fall within boundaries slightly less than 10% and 50%, which are the predetermined thresholds that would result in different drug delivery regimens.[6,8] For example, when we used the Readiview result to initiate treatment *en masse* when the 50% threshold was exceeded, a sensitivity of 64% and a specificity of 100% were observed. The Readiview may therefore allow confident exclusion of those schools where annual treatment *en masse* is not appropriate. However, it cannot detect all schools that should have been allocated mass treatment. Nevertheless, it may be possible in a simple manner to adjust these estimates of prevalence to better synchronize the treatment decision based upon Readiview and compound microscope data. For example, if one were to apply a prevalence increase of 7% to the Readiview data and assume that the newly adjusted prevalence exceeds a 45% threshold, the decision to allocate treatment *en masse* from Readiview data would have a sensitivity of 100% and a specificity of 100%.

Field diagnosis of *S. mansoni* infection is always a working compromise between the sensitivity and specificity of the diagnostic method,[15] the associated financial costs of whatever scale of implementation within the NCP the diagnostic method is required (in terms of capital equipment, consumable items, and associated staffing costs),[8] and the present and future logistic constraints at the time of adoption of the technique. These include staff training, transportation, equipment failure, and repair overheads. In this example, the capital costs of purchasing a compound microscope are at least a 10-fold higher than that of purchasing the Readiview. In addition, the likely functioning life span and adaptability of the compound microscope used by a field-based roving team would be much shorter than that of the more easily portable and robust Readiview. For example, it is unlikely that the LED of the Readiview will fail, and given the sturdy transportation box that accompanies this microscope and its few moving parts, the risk of damage during transit is low. If the AA batteries used by the Readiview are rechargeable, the daily replenishment costs of consumables used for both the compound microscope and Readiview would essentially be the same. However, the inevitable tradeoff of using this handheld microscope is the slightly lower accuracy of the prevalence estimate and absence of an associated fecal e.p.g.

In terms of surveillance finances, the main difference between adopting either the Readiview or the compound microscope would be the significant staffing and transportation cost reductions. With the Readiview it is feasible for a single technician working alone and using transport such as a bicycle or motorbike to carry all the associated surveillance equipment in a small bag and who could realistically visit 2–3 schools each day sampling 20 children at each school. Within a week, this single technician could determine the prevalence of intestinal schistosomiasis to a reasonable level of precision in 10–15 schools in a typical Ugandan district sub-county. In an alternative setting where a compound microscope is used, motorbike transport would pose too greater threat of damage to the microscope and transportation of the microscope and technician would therefore require a car with a driver. Clearly, the fuel budget of this technician and associated staff costs would be at least two-fold higher for each day of operation in the field. If the Readiview was used, this simple model of logistics could enable a team of five technicians working in parallel to collect prevalence data in the each of the 111 primary schools in Mayuge within 12 working days. If similar resources and funds were available to coordinate equivalent teams in other districts also working in parallel, a truly comprehensive prevalence map of the distribution of intestinal schistosomiais could be obtained in a relatively very short period to a level never previously realized. This would better estimate the total anthelmintic drug requirements for each district within the NCP and result in the most appropriate drug delivery regimens to each school. In so doing, better documentation of the geographic distribution of *S. mansoni* infections would show the true extent of the burden of this disease.[16,17]

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