Cost Analysis of Tests for the Detection of *Schistosoma mansoni* Infection in Children in Western Kenya

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Abstract. Financial resources tend to be limited in schistosomiasis endemic areas, forcing program managers to balance financial and scientific considerations when selecting detection assays. Therefore, we compared the costs of using single stool Kato-Katz, triplicate stool Kato-Katz, and point-of-contact circulating cathodic antigen (POC-CCA) assays for the detection of *Schistosoma mansoni* infection. Economic and financial costs were estimated from the viewpoint of a schistosomiasis control program using the ingredients approach. Costs related to specimen collection, sample processing and analysis, and treatment delivery were considered. Analysis inputs and assumptions were tested using one-way and two-way sensitivity analysis. The total per-person cost of performing the single Kato-Katz, triplicate Kato-Katz, and POC-CCA was US$6.89, US$17.54, and US$7.26, respectively. Major cost drivers included labor, transportation, and supplies. In addition, we provide a costing tool to guide program managers in evaluating detection costs in specific settings, as costs may vary temporally and spatially.

INTRODUCTION

Comprehensive disease mapping using accurate detection assays is vital to the effective control and eventual elimination of neglected tropical diseases such as intestinal schistosomiasis.[1] In settings where *Schistosoma mansoni* is endemic, financial resources tend to be limited for health programs. Therefore, program managers and policy makers must balance scientific and economic considerations when determining allocation of scarce health resources and use those approaches that are most cost-effective.[2]

For disease mapping, the detection of *S. mansoni* infection is commonly performed by the detection and quantification of eggs in stool using the Kato-Katz method.[3,4] The Kato-Katz method offers numerous advantages including high specificity and simultaneous detection of infections with intestinal worms, while at the same time providing a straightforward technique that requires minimal supplies and equipment.[5] However, this assay offers poor sensitivity, especially in low-intensity infections, is laborious, and may expose workers to infectious stool.[5–11]

To address some of the concerns with the Kato-Katz technique, considerable research has been devoted to alternative tests for *S. mansoni* infections. This research has led to the development of a urine-based point-of-contact test for schistosome circulating cathodic antigen (POC-CCA) as a method for detecting infection with *S. mansoni*.[12,13] The POC-CCA assay is commercially available through Rapid Medical Diagnostics (Pretoria, South Africa), and has been evaluated for sensitivity, specificity, and ease of use in a number of settings.[14–19] However, there has been concern that the cost of the POC-CCA assay may be a barrier to widespread adoption of this technique for schistosomiasis control programs[14,16,17,20]; therefore, there is a need for a comprehensive evaluation of the cost-effectiveness of the POC-CCA technique in relation to other available tests.[13] Although the cost of the materials and equipment are commonly cited as expenses, other cost contributions such as labor and transportation are rarely discussed.[17,20] Thus, we have pursued a comprehensive assessment of cost-effectiveness to determine all of the expenses associated with each assay relative to their effectiveness.

We present a cost evaluation of the Kato-Katz and POC-CCA techniques for the detection of *S. mansoni* within the context of a mapping survey. Particularly, the costs associated with collection, processing, and analysis of samples, as well as the costs related with the treatment of individuals determined to be infected during mapping were evaluated. Extensive evaluation of the costs associated with the respective assays serves as the first step in determining the cost-effectiveness of tests relative to each other.

MATERIALS AND METHODS

Objectives. The aim of this analysis was to assess, from the viewpoint of the national schistosomiasis control program, the total cost of using POC-CCA, single Kato-Katz, and triplicate Kato-Katz for the field-based detection of *S. mansoni* during school-based mapping exercises. We did this by valuing the costs of two alternative models against the base case of a single Kato-Katz assay using the ingredients approach.[21,22] The primary outcome measure was the total cost of each diagnosis per person, calculated by dividing the total cost by number of children tested. This outcome included the costs of treating individuals who were found to be *S. mansoni* positive. The overall objective is to generate cost estimates that can be used for future cost-effectiveness analyses.

Study background and population. From October 2010 through April 2011, a research study was undertaken to evaluate the performance of the POC-CCA assay in comparison to laboratory-based Kato-Katz stool examinations to detect *S. mansoni* infections in children across a schistosomiasis prevalence gradient in western Kenya (Foo and others[23]). Randomly selected children, 8–12 years of age, from primary schools in the Asembo region, located along the northern shore of the Winam Gulf of Lake Victoria in western Kenya, were evaluated by collecting urine samples for POC-CCA analysis and stool samples for Kato-Katz analysis. Samples

were collected on 3 consecutive days and processed as described elsewhere (Foo and others[23]). Sensitivity and specificity of the various tests were evaluated using Bayesian latent class analysis (LCA).

The resource consumption and cost data from this study were used to evaluate expenses under three testing scenarios (described below). Within the study context, various samples were collected concurrently; however, to evaluate the costs of each assay as if they were adopted for programmatic use, we modeled costs according to the World Health Organization (WHO) mapping guidelines, and the costs and resource use relevant to each assay were identified and evaluated separately.[24]

Description of base case and alternative models. Three models were evaluated and compared. All models followed the WHO recommended mapping guidelines for the selection of individuals[24]; however, the screening tool used to evaluate *S. mansoni* infection was varied. According to our model, 50 children were randomly selected from a single school in 5 villages per district and screened by an experienced research team using the chosen screening tool; the total cohort model includes 250 children.

The base case model is defined as the WHO-recommended mapping guidelines using a single Kato-Katz as the screening tool. Selected individuals were evaluated for *S. mansoni* infection using a single stool sample collected at the school by a field assistant; stool samples were subsequently transported and evaluated at a reference laboratory. Two slides were prepared for the sample by a laboratory assistant; both slides were evaluated by Kato-Katz thick-smear examination, read and reported by a trained microscopist. This model assumes that stools could be collected from two schools per day, the laboratory assistant could prepare 250 slides per day, and microscopists could read 50 slides per person per day. Individuals were considered infected if either of the two slides was positive for *S. mansoni* eggs. In this model, treatment is carried out on a return visit to the school.

The first alternative model conducts the WHO-recommended mapping guidelines using three stool samples, each with duplicate Kato-Katz slides as the screening tool. Selected individuals were evaluated for *S. mansoni* infection using three stool samples collected at the school on consecutive days, which were subsequently transported and evaluated at a reference laboratory. Two slides were prepared for each of the stool samples by a laboratory assistant, totaling six slides for each study participant. All of the slides were evaluated by Kato-Katz thick-smear examination, read and results reported by a trained microscopist. This model used the same assumptions as the single Kato-Katz described above. Individuals were considered to be infected if any single slide was positive for *S. mansoni* eggs. As with the single Kato-Katz approach, a return visit to the school is required to deliver treatment.

The second alternative model conducts the WHO-recommended mapping guidelines using a single POC-CCA test as the screening tool. Selected individuals were evaluated for *S. mansoni* infection using a single urine sample collected at the school by a field assistant and tested by a field technologist. The POC-CCA testing was performed at the school according to the manufacturer's instructions (Rapid Medical Diagnostics). The test was read and results recorded by the laboratory technologist after a 20-minute development time. This model assumes that two schools can be evaluated and

subsequently treated per day. Individuals were considered infected if the urine test was positive according to manufacturer's instructions.

All models include labor contribution of a field coordinator and a data entry specialist who is considered able to enter 500 records per day. All individuals who were identified as *S. mansoni* positive were treated with weight-dependent dosing of praziquantel (40 mg/kg) by a study nurse, either at the time of the field test (POC-CCA) or during a subsequent visit to the school (Kato-Katz). For treatment on subsequent field visits, it was assumed that treatment could be delivered to three schools per day.

Cost data and resource use. A cost inventory and appraisal of resource requirements was conducted retrospectively at the study site in Kisumu, Kenya. Inputs were calculated using the ingredients approach that requires identifying all inputs to perform the respective test, as well as their estimated quantities and value.[21] Estimates of financial and economic costs were evaluated from the health service perspective, in this case Kenya Medical Research Institute (KEMRI). Resource use was determined by direct observation, as well as key-informant interviews with individuals involved in the implementation of the POC-CCA evaluation study described above. Key model input categories included labor, transport, supplies, capital expenses, and overhead costs (Table 1). The cost included all expenses related to specimen collection, sample processing and analysis, data management, and treatment delivery. All costs were reported in 2010 United States dollar (USD) unless otherwise stated, using the exchange rate of 90 Kenyan shillings (KSh) to 1 USD that was current at the time of the study.

Labor costs included salary and benefits based on the salary scales for civil servants set by the Ministry of State for Public Service, according to the salary grade commensurate to the various personnel.[25] The total annual salary, including all supplemental pay and benefits, was calculated and converted

TABLE 1
Cost categories and ingredients included

Cost category	Ingredients included
Labor	Salary based on Ministry of Health pay scale for civil servants, including salary supplements (housing, risk, and supervision supplements)
	Benefits (medical insurance, workers compensation insurance, group personal accident insurance, group life insurance, and annual gratuity)
Supplies	Laboratory consumables (including test kits)
	Field supplies (including sample collection materials)
	Treatment supplies
	Stationary and other support supplies
Capital	Laboratory equipment (e.g., microscopes)
	Laboratory durable goods (e.g., glassware and storage containers)
	Field-based durable goods (e.g., cool boxes)
Transportation	Driver
	Vehicle repairs
	Transport supplies
	Tires and lube
	Vehicle replacement
Overhead	Buildings and facilities
	Administrative support
	Motor pool access
	Other

into a daily wage. The number of person-days required to perform the respective test was modeled and multiplied by the daily wage for each personnel category.

Transportation costs were calculated as a fixed cost-per-kilometer as set by KEMRI/CDC administration; the fixed cost included the driver, vehicle repairs, transportation supplies, tires and lube, vehicle replacement, as well as other associated transportation costs. Transport resource use was estimated based on KEMRI's project vehicle logs from the study period, and assumed an average 45 km distance between KEMRI's Kisian laboratory and target school, as well as a 20 km distance between schools visited on the same day.

Supply costs took into account the costs of all field, laboratory, and treatment consumable supplies required to conduct the respective tests. Costs for consumable materials were extracted from KEMRI/CDC's stock price list where available, from the supplier, or otherwise from expert consultation when the price was not available. For the purposes of calculating the cost of treatment, 20% prevalence was assumed for all models. The cost for treatment of infected individuals was calculated using an average of 2.5 tablets per child.[26]

Capital costs, including equipment and durable goods, were calculated using straight-line depreciation. The useful life of equipment and durable goods was estimated though consultation with laboratory staff and experts. The useful life of capital items included 5 years for microscopes, 3 years for computers, and 2 years for all other items. Daily economic costs for capital items and durable goods were calculated and multiplied by the estimated number of days of use for the survey.

To account for the indirect costs involved in administration and management of the survey, such as buildings and facilities, administrative support, and motor pool access, we applied a fixed overhead percentage (20%) of the sum of direct costs, as is common practice in other cost assessments.[27,28] This amount represented KEMRI's indirect cost applied to the study costs for 2010.

One-way sensitivity analysis. A series of one-way sensitivity analyses were performed to test the robustness of the cost calculation, to determine how changes in certain cost categories affected the total cost, as well as to test underlying assumptions in the model. Influential components were identified and evaluated by a series of one-way and two-way sensitivity models using Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA). The impact of reduced POC-CCA cassette price on the total cost was evaluated by varying the price from $1.98 to $1.83 and $1.68. These values were derived from the company-advertised base price ($1.98 per test) and bulk pricing ($1.83 per test for purchasing between 10,000 and 50,000 tests and $1.68 per test for order-

ing more than 50,000 tests). The bulk price points were considered to be plausible future base price points. In addition, we had initially assumed that it was only possible to collect stool for Kato-Katz examination from children at two schools per day; this assumption was tested by increasing the number of schools to three per day. We considered POC-CCA evaluation in three schools per day to be unattainable and therefore did not test this assumption. In addition, to account for varying costs across settings, we evaluated labor costs, supply costs, and transport costs at a 50% increase and decrease from the baseline.

Two-way sensitivity analysis. A series of two-way sensitivity analyses were performed over the possible ranges defined above. This was done by varying two cost variables simultaneously while holding the other variables constant. Of note, in two-way sensitivity analyses, the overhead also varied as a fixed percentage of all direct costs. Three principal cost drivers identified for the three assays were varied in combination: supply, labor, and transport costs. The impacts of the component cost changes on the total cost were evaluated.

RESULTS

Costs. The total cost per person by test, costs stratified by cost category, as well as the percent contribution of each cost category to the total cost are presented in Table 2 in 2010 USD.

Supply costs. The costs of supplies including materials required to collect, process, and analyze biologic samples as well as the costs for providing treatment of individuals found to be infected were considered. The costs associated with supplies were $1.09 and $2.79 for single stool Kato-Katz and triplicate stool Kato-Katz, respectively. For the POC-CCA, recurrent supply costs were $3.15 including the price of the test cassettes ($1.98 per test).

Capital costs. The costs of capital assets were annualized across the useful life of the items; therefore only the cost of their use during the survey was considered in the analysis. The costs associated with these items included equipment and durable goods and were $0.16 for both single and triplicate stool Kato-Katz. Capital items for Kato-Katz testing, in order of decreasing economic contribution, included microscopes, a computer, slide folders, cool boxes, and tally counters. For the urine CCA, recurrent costs were $0.02. For the POC-CCA test, capital contributions were minimal and included a computer and timers.

Labor costs. The composition of the survey team varied depending on the test being used; however, all models included labor contributions of a field coordinator, study nurse, and data entry specialist. The Kato-Katz testing models included a field assistant to collect samples, a laboratory assistant to prepare Kato-Katz slides, and microscopists to read slides. The

TABLE 2
Cost per test stratified by input type by diagnostic

Test	Costs (% total)					
	Supplies	Capital	Labor	Transport	Overhead	Total
Single Kato-Katz	$1.09 (15.8)	$0.16 (2.3)	$2.90 (42.1)	$1.59 (23.1)	$1.15 (16.7)	$ 6.89
Triplicate Kato-Katz	$2.79 (15.9)	$0.16 (0.9)	$8.49 (48.4)	$3.18 (18.1)	$2.92 (16.6)	$17.54
POC-CCA	$3.15 (43.4)	$0.02 (0.3)	$1.98 (27.3)	$0.90 (12.4)	$1.21 (16.7)	$ 7.26

POC-CCA = point-of-contact circulating cathodic antigen.

Parameter tested	Cost in US $					
	Single Kato-Katz	% Deviation	Triplicate Kato-Katz	% Deviation	Urine-CCA	% Deviation
Baseline	$6.89	–	$17.54	–	$7.26	–
Costs due to labor						
50% increase	$8.62	25.1%	$22.63	29.0%	$8.45	16.4%
50% decrease	$5.15	−25.3%	$12.44	−29.1%	$6.05	−16.7%
Costs due to supplies						
CCA sold at $1.83	–	–	–	–	$7.07	−2.6%
CCA sold at $1.68	–	–	–	–	$6.89	−5.1%
50% increase	$7.54	9.4%	$19.21	9.5%	$9.15	26.0%
50% decrease	$6.23	−9.6%	$15.86	−9.6%	$5.37	−26.0%
Costs due to transport						
50% increase	$7.84	13.8%	$19.45	10.9%	$7.79	7.3%
50% decrease	$5.93	−13.9%	$15.63	−10.9%	$6.72	−7.4%
Costs due to overhead						
10%	$6.31	−8.4%	$16.08	−8.3%	$6.65	−8.4%
30%	$7.46	8.3%	$19.00	8.3%	$7.85	8.1%
Other changes						
Visit three schools per day (Kato-Katz)	$5.13	−25.5%	$11.85	−32.4%	–	–

SOP = standard operating procedure.

POC-CCA required a field assistant to collect samples and a laboratory technologist to perform and interpret POC-CCA tests. The costs of per person tested associated with labor were $2.90 and $8.49 for single and triplicate stool Kato-Katz, respectively. For the POC-CCA, labor costs were $1.98 per person tested.

Transportation costs. The cost associated with transportation was set at $0.72 (65.02 KSh)/km. This price included the cost of the driver ($0.16), vehicle repairs ($0.18), transportation supplies ($0.16), tires and lubes ($0.04), vehicle replacement ($0.14), and other transport costs ($0.04). Total transportation costs for each test were calculated by the cost-per-kilometer rate by the average number of round trips from KEMRI's Kisian laboratory to the target schools. The single and triplicate stool Kato-Katz required two and four round trips, respectively—one for each sample collected, plus an additional trip for treatment. The POC-CCA required one round-trip per school where both testing and treatment was conducted. Total cost associated with transportation was $1.59 and $3.18 for single and triplicate stool Kato-Katz, respectively. For the POC-CCA testing, transportation costs were $0.90.

Overhead costs. A fixed percentage (20%) of the sum of direct costs was calculated to account for the indirect costs involved in administration and management of the survey, such as buildings and facilities, administrative support, and motor pool access. Therefore, the percent contribution of overhead expenses to each test remained constant. The indirect costs were $1.15 and $2.92 for single and triplicate stool Kato-Katz, respectively, while the overhead costs for the POC-CCA were $1.21.

Total costs. The total costs of performing the tests were $6.89 per person for the single Kato-Katz, $17.54 per person for triplicate Kato-Katz, and $7.26 per person for POC-CCA. The principal cost drivers were labor (42.1%) and transport (23.1%) for the single stool Kato-Katz, labor (48.4%) and transport (18.1%) for the triplicate stool Kato-Katz, and supplies (43.4%) and labor (27.3%) for the POC-CCA.

One-way sensitivity analysis. One-way sensitivity analysis was used by varying cost calculations and standard operating procedures (SOPs) across a plausible range and investigating the resulting changes to total testing cost. Summary results of one-way sensitivity analyses are presented in Table 3. With all other variables held constant, the reduction of the POC-CCA test from $1.98 per test to $1.83 per test resulted in a total cost of $7.07 per person (−2.6%). When the price was further reduced to $1.68, the total POC-CCA cost per person was $6.89 (−5.1%). We evaluated our assumption that stools for Kato-Katz examination could be collected from two schools per day by increasing the number of schools to three per day. This change resulted in a decrease in the survey duration, consequently reducing labor and transport costs. Under this scenario, the cost of single stool Kato-Katz testing was reduced to $5.13 per person (−25.5%) and the cost of diagnosis by triplicate stool Kato-Katz was reduced to $11.85 per person (−32.4%).

To account for the fact that costs could be more or less expensive in other settings where schistosomiasis mapping could be performed, influential costs were varied as a percentage (±50%) around the baseline. The ranges used for the single stool Kato-Katz were $0.80–$2.39 for transport, $1.45–$4.35 for labor, and $0.55–$1.64 for supplies. The ranges used for triplicate stool Kato-Katz were $1.59–$4.77 for transport, $4.25–$12.74 for labor, and $1.40–$4.19 for supplies. Finally, the ranges used for the POC-CCA were $0.45–$1.35 for transport, $0.99–$2.97 for labor, and $1.58–$4.73 for supplies. Changes in transportation costs (±50%) were influential on the total cost of all tests: single stool Kato-Katz (±13.8%), triplicate stool Kato-Katz (±10.9%), and the POC-CCA (±7.3%). Changes in labor costs (±50%) were more influential in single stool Kato-Katz (±25.1%) and triplicate stool Kato-Katz (±29.0%) than for the POC-CCA (±16.4%). In contrast, changes of supply costs were more influential on POC-CCA (±26.0%) than on single (±9.4%) or triplicate (±9.5%) stool Kato-Katz. Increases and decreases in overhead affected the total testing costs at an equal percentage.

Two-way sensitivity analysis. Two-way sensitivity analysis was performed by varying two cost variables across plausible ranges simultaneously while holding the other variables constant. Three principal cost drivers were varied in combination: supply costs, labor costs, and transport costs. These were

varied across the plausible ranges used in one-way sensitivity analysis (±50% baseline). Varying supply and labor costs simultaneously resulted in a total cost range of $4.49–$9.28, $10.78–$24.31, and $4.18–$10.34 for single stool Kato-Katz, triplicate stool Kato-Katz, and POC-CCA, respectively. Varying supply and transport costs simultaneously resulted in a total cost range of $5.28–$8.50, $13.96–$21.13, and $4.83–$9.69 for single stool Kato-Katz, triplicate stool Kato-Katz, and POC-CCA, respectively. Finally, varying labor and transport costs simultaneously resulted in a total cost range of $4.19–$9.58, $10.54–$24.55, and $5.53–$8.99 for single stool Kato-Katz, triplicate stool Kato-Katz, and POC-CCA, respectively. For each analysis, the overhead for each test was adjusted dynamically as 20% of the sum of the other cost categories.

DISCUSSION

This analysis constitutes the first step in a larger process of assessing the cost-effectiveness of tests to detect *S. mansoni* during mapping surveys. The purpose of this first component is to generate a better understanding of the costs associated with POC-CCA and to compare these costs to the costs associated with Kato-Katz diagnostics. We hope these data will provide improved guidance for program managers and policy makers to examine the appropriate testing options in their setting(s). To further assist program managers and decision makers, we provide costing worksheets for POC-CCA and Kato-Katz assays as supplemental materials to this manuscript (Supplemental Worksheets 1 and 2, respectively). We hope that these materials will allow analyses and decisions to be tailored to specific settings where SOPs and costs may be different than our setting.

We performed a cost assessment of three testing models to perform field-based detection of *S. mansoni* from the perspective of the provider, in this case the national schistosomiasis program. Mass treatment programs in most known settings are designed to encourage involvement by having minimal cost to participants. School-based testing exploits existing infrastructure to provide a platform for easy testing and treatment. Based on this, we anticipate that participants will incur no direct cost. We also assume minimal indirect costs to participants, as no additional transportation is needed for testing or treatment. An opportunity cost is incurred by children who are asked to participate in this program during school hours and children experiencing treatment side effects may also experience indirect opportunity costs by loss of school time. However, these costs are considered minimal and greatly outweighed by the benefits of treatment, and therefore we evaluated the costs from the provider perspective rather than the societal perspective.

In the baseline scenarios, the least costly testing approach was the single stool Kato-Katz ($6.89), followed by the POC-CCA ($7.26) and the triplicate stool Kato-Katz ($17.54). The contribution of each cost category to the total cost varied by test. When calculating these costs, we attempted to be as inclusive and realistic as possible when capturing inputs for the assays.

The cost of the single stool Kato-Katz is strongly influenced by labor costs (42.1%) owing to the fact that Kato-Katz testing is a multistep process requiring numerous staff to collect and process fresh stool samples, as well as personnel required to analyze resulting slides. Transportation is another impor-

tant component (23.1%) as treatment requires a subsequent visit, and in this setting the cost associated with transportation is sizeable. Similarly, the cost of the triplicate stool Kato-Katz is strongly influenced by labor costs (48.4%) and transportation (18.1%).

In contrast, the main cost driver of the POC-CCA is supplies, which accounted for 43.4% of the total cost. More than 60% of the supply cost results from purchasing the POC-CCA test kits. By reducing the cost of the POC-CCA cassette from $1.98 to $1.68 each, it is possible to reduce the total cost of the POC-CCA to the level of the single stool Kato-Katz ($6.89). It is worth noting that the price of the POC-CCA has reduced substantially since its introduction to the commercial market. Since the time of this analysis, the cost of the POC-CCA has been reduced, and current pricing ranged from $1.46 to $1.76 depending on quantity requested. Using these prices and assuming all other costs remained constant, the total POC-CCA testing cost would be between $6.62 and $6.98. It is conceivable that the POC-CCA may be priced at a level that is competitive to the single Kato-Katz, as the current manufacturer advertised bulk pricing rates encompass the target POC-CCA cost from the 2010 analysis.

The next most important cost drivers of the POC-CCA were labor (27.3%) and transportation (12.4%), while capital costs were negligible. Although this assay requires fewer personnel and less time to perform, the testing is performed by a laboratory technologist who receives higher pay than the microscopist who performs Kato-Katz in this setting. Further cost reductions could result from training lower pay-grade personnel to perform this testing.

Discussions concerning the cost of various tests often centered around the costs of supplies; however, results shown here and elsewhere[28,29] suggest that in addition to supplies, personnel and transportation need to be recognized and accounted for in the budgeting process, as they are important cost drivers. Although supply costs may be more or less stable across African settings,[28] costs associated with personnel may vary considerably. Transportation costs, particularly fuel costs, are also expected to vary considerably, both geographically and temporally.

This costing study was performed in one setting, which limits the ability to generalize these findings to other settings, where each costing input may be higher or lower. The authors acknowledge that these costs could vary considerably by site with innumerable combinations of input costs. However, a less extensive costing study performed as part of a POC-CCA evaluation in Uganda found that using the POC-CCA at a village level was actually less expensive than using the Kato-Katz.[30] To account for variation in SOPs and costs in other settings, we performed extensive one-way and two-way sensitivity analyses. We believe that while the absolute costs may vary, this comparison of the costs of POC-CCA and the Kato-Katz tests will likely remain useful.

Although the cost analysis of urine-CCA is novel, cost-analysis has been previously undertaken for Kato-Katz for the diagnosis of soil-transmitted helminths.[29] This study calculated a cost of only $2.06 (2009 USD) per person tested for the evaluation equivalent to the single stool Kato-Katz presented here (2010 US$6.89). The differences noted between the previous cost estimation and the findings presented here were due to varying materials and other cost inputs considered,

SOPs, and cost of transportation. In addition, our analyses consider costs associated with returning to perform treatment, while the other analysis considered diagnosis alone.

There are several limitations associated with this analysis. The cost assessment was undertaken retrospectively by creating models based on expert opinion using the ingredients approach rather than actual survey costs. In addition, our analyses assumed the use of experienced personnel, and therefore we did not consider the costs of training that may be required in other settings where experienced personnel are not readily available. Finally, because this evaluation was undertaken from the perspective of the schistosomiasis program, the opportunity cost associated with losing the capability to simultaneously detect soil-transmitted helminths, which occurs when shifting from the use of Kato-Katz to POC-CCA, was not considered.[14] This loss is a vitally important consideration and must be taken into account, especially for integrated neglected tropical disease (NTD) programs.

In conclusion, in this setting the single-Kato Katz is currently the least expensive method evaluated to test for *S. mansoni* in a field setting. However, the slightly higher cost of POC-CCA may be justified if it provides a more sensitive method to detect schistosomiasis or if this assay is more acceptable to participants and practitioners than stool collection that is needed to perform Kato-Katz. Furthermore, given the reduction in the POC-CCA kits in recent years, it is plausible that the POC-CCA could match the cost of the single stool Kato-Katz (i.e., reduction of the POC-CCA cassette cost). By contrast, it should be acknowledged that while the POC-CCA is only useful for detecting schistosome infections, the Kato-Katz method can also be used to detect soil-transmitted helminth infections, which could affect method selection and costs in integrated control programs. Thus, in addition to cost, program managers should take into consideration other factors including the purpose of the survey, accuracy of each test, the organisms being surveyed, and other influences such as adaptation of new technology.

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