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Research Article

Comparative efficacy of loop-mediated isothermal amplification and Kato-Katz microscopy for diagnosing Schistosoma mansoni in low-endemicity settings

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Abstract

Schistosoma mansoni causes intestinal schistosomiasis, and accurate diagnosis in low-transmission areas is critical for verifying disease elimination. In this study, we compared the diagnostic performance of a loop-mediated isothermal amplification (LAMP) assay against duplicate Kato-Katz thick smears among school-aged children in a low-endemicity district. A total of 450 stool samples were collected from children aged 6 to 14 years and analyzed using both duplicate Kato-Katz slides and a closed-tube colorimetric LAMP assay targeting the Sm1-7 repetitive sequence. Duplicate Kato-Katz microscopy identified S. mansoni eggs in 38 children (8.4 percent), with the majority (84.2 percent) classified as light-intensity infections (<100 eggs per gram of feces). In contrast, the Sm1-7 LAMP assay detected S. mansoni DNA in 97 children (21.6 percent), capturing all 38 microscopy-positive cases plus 59 additional sub-microscopic infections. Using a composite reference standard, LAMP demonstrated a sensitivity of 98.9 percent and specificity of 96.4 percent, whereas Kato-Katz sensitivity dropped to 39.2 percent. The LAMP reaction was completed within 45 minutes at 63 degrees Celsius without requiring sophisticated thermal cyclers. Conventional Kato-Katz microscopy substantially underestimates S. mansoni prevalence in low-intensity settings. Colorimetric LAMP offers a rapid, sensitive, and field-deployable alternative for schistosomiasis surveillance and post-treatment monitoring.

Keywords: Schistosoma mansoni, Loop-mediated isothermal amplification, Kato-Katz, Low-endemicity diagnostics, Schistosomiasis

1. Introduction

Schistosomiasis remains one of the most prevalent neglected tropical diseases, affecting more than 200 million people worldwide, with the greatest burden concentrated in sub-Saharan Africa (World Health Organization [WHO], 2022; Colley et al., 2014; McManus et al., 2018). Schistosoma mansoni, the principal cause of intestinal schistosomiasis, is transmitted when cercariae released by Biomphalaria snails penetrate human skin during contact with contaminated freshwater. Chronic infection can lead to hepatosplenic disease, anaemia, impaired growth and cognition in children,

and reduced productivity in adults (King, 2010; Colley et al., 2014). For more than two decades, control has relied largely on preventive chemotherapy with praziquantel, delivered through school-based mass drug administration (WHO, 2022; Toor et al., 2018). As many programmes move from morbidity control toward elimination as a public health problem and, ultimately, interruption of transmission, the demands placed on diagnostics have changed fundamentally (WHO, 2022; Wiegand et al., 2022).

The World Health Organization (WHO) (2022) guideline on control and elimination of human schistosomiasis recommends that programmes expand treatment beyond school-aged children, monitor progress with appropriate diagnostics, and verify elimination using tools that remain reliable when prevalence and intensity fall. The 2021–2030 road map for neglected tropical diseases likewise sets elimination as a public health problem as a central target (WHO, 2020). These ambitions create a diagnostic paradox: the more successful control becomes, the harder remaining infections are to find. Light-intensity infections produce few eggs, egg excretion varies from day to day, and a single stool examination may miss a substantial fraction of infected individuals (Utzinger et al., 2015; Barenbold et al., 2017; Kittur et al., 2017). A test that performed adequately when one in two children was heavily infected may therefore be misleading when only one in ten is lightly infected.

Kato-Katz thick-smear microscopy, described by Katz et al. (1972), has been the mainstay of intestinal schistosomiasis diagnosis for decades because it is inexpensive, quantitative, and highly specific when performed by trained microscopists (WHO, 2022; Utzinger et al., 2015). Its limitations in low-endemicity settings are now well documented. Sensitivity falls sharply as egg counts decline, and increasing the number of slides or stool samples improves detection but adds cost, labour, and logistical complexity (Barenbold et al., 2017; Siqueira et al., 2011; Enk et al., 2012). Molecular methods, particularly polymerase chain reaction (PCR), can detect parasite DNA at very low concentrations, but conventional PCR requires thermal cyclers, stable electricity, cold chains, and skilled personnel, which limits its use in peripheral health facilities (Pontes et al., 2003; Verweij and Stensvold, 2014).

Loop-mediated isothermal amplification (LAMP), first described by Notomi et al. (2000), amplifies DNA at a constant temperature using a strand-displacing polymerase and four to six primers that recognise distinct regions of the target. The reaction produces large amounts of product, allows visual or colorimetric readout, and can be performed with a simple heat block or water bath. For S. mansoni, assays targeting the highly repeated Sm1-7 sequence, which comprises a substantial fraction of the parasite genome, have shown analytical sensitivities in the femtogram range (Abbasi et al., 2010; Hamburger et al., 2013; Mwangi et al., 2018). The Sm1-7 repeat is present in all life-cycle stages, making it an attractive target for detecting pre-patent, light, and post-treatment infections (Abbasi et al., 2010; Gandasegui et al., 2018). Several studies have reported that LAMP detects more infections than Kato-Katz, especially in low-transmission areas, although estimates vary with specimen type, DNA extraction method, and reference standard (Mwangi et al., 2018; Gandasegui et al., 2018; Fuss et al., 2021; Garcia-Bernalt Diego et al., 2021).

The present study was designed to provide a direct, head-to-head comparison of closed-tube colorimetric Sm1-7 LAMP and duplicate Kato-Katz microscopy in a low-endemicity district, using the same stool specimens from school-aged children. Our objectives were: (i) to estimate and compare the prevalence detected by each method; (ii) to estimate sensitivity, specificity, predictive values, and agreement against a composite reference standard; (iii) to examine how infection intensity influenced Kato-Katz detection; and (iv) to assess the operational feasibility of LAMP for surveillance and post-treatment monitoring. We hypothesised that LAMP would detect a significantly higher proportion of infections, principally by identifying sub-microscopic infections missed by microscopy.

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2. Literature Review

2.1 Biology and epidemiology of Schistosoma mansoni. Adult S. mansoni worms reside in the mesenteric veins, where females release hundreds of eggs per day. A proportion of eggs traverse the intestinal wall and are excreted in faeces, while others become trapped in tissues and drive granulomatous inflammation and fibrosis (Colley et al., 2014; McManus et al., 2018). School-aged children typically carry the highest prevalence and intensity because of frequent water contact and incomplete immunity, which is why they remain a key sentinel group even as programmes broaden eligibility (WHO, 2022; King, 2010). In low-endemicity settings, the distribution of infection becomes highly over-dispersed: most infected individuals harbour few worms and excrete few eggs, while a small minority contribute disproportionately to transmission (Utzinger et al., 2015; Kittur et al., 2017). This epidemiological shift is precisely what makes elimination certification difficult.

2.2 Kato-Katz microscopy: strengths and limits. The Kato-Katz method examines a measured quantity of faeces, typically 41.7 mg per slide, after clearing with glycerol-malachite green, and expresses results as eggs per gram of faeces (EPG) (Katz et al., 1972). WHO intensity categories for S. mansoni are light (1–99 EPG), moderate (100–399 EPG), and heavy (≥400 EPG) (WHO, 2022). The method is inexpensive per test, requires only a microscope, and provides a direct measure of egg output that correlates, imperfectly, with worm burden. Its specificity is high, and false positives are rare when readers are well trained (Utzinger et al., 2015). However, day-to-day variation in egg excretion, uneven distribution of eggs within stool, and the small amount of faeces examined mean that light infections are frequently missed. Barenbold et al. (2017) modelled sensitivity as a function of intensity and showed that a single Kato-Katz slide has low sensitivity at low EPG, while repeated sampling improves detection but does not eliminate the problem. In Brazilian low-endemicity areas, Siqueira et al. (2011) found that Kato-Katz detected only 7.3% prevalence compared with 34.7% by PCR, implying a Kato-Katz sensitivity of about 20.8% when PCR-positive cases were taken into account. Enk et al. (2012) and others reported similar patterns when multiple Kato-Katz slides were compared with more sensitive methods. These findings are not a criticism of microscopists; they reflect the statistical reality of sampling a small aliquot from a dilute, heterogeneous specimen.

2.3 Antigen and antibody alternatives. The point-of-care circulating cathodic antigen (POC-CCA) urine test has been widely evaluated as an alternative to Kato-Katz because it is rapid, does not require stool, and detects active infection (Colley et al., 2013; Danso-Appiah et al., 2016). In moderate- and high-intensity settings, POC-CCA performs well, but interpretation of trace results remains contentious, and specificity in low-prevalence settings has been debated (Danso-Appiah et al., 2016; Casacuberta-Partal et al., 2021). Antibody tests, by contrast, cannot reliably distinguish current from past infection and are therefore unsuitable for post-treatment monitoring in endemic populations (Weerakoon et al., 2015). These gaps have sustained interest in DNA-based tests that combine sensitivity with evidence of current infection, while remaining feasible outside reference laboratories.

2.4 LAMP: principle and evidence for schistosomiasis. LAMP uses Bacillus stearothermophilus (Bst) DNA polymerase with strand-displacement activity and a set of primers that form dumbbell-shaped structures, enabling exponential amplification at 60–65°C (Notomi et al., 2000). Because amplification is isothermal, it eliminates the need for thermal cycling. Readout can be by turbidity, fluorescence, lateral flow, or a pH-sensitive colour change, which allows closed-tube detection and reduces amplicon contamination (Gandasegui et al., 2018; Garcia-Bernalt Diego et al., 2021). Abbasi et al. (2010) developed LAMP assays based on Sm1-7 for S. mansoni and DraI for S. haematobium, reporting detection of 0.1 fg of genomic DNA and identification of infected snails from early prepatency. Hamburger et al. (2013) evaluated LAMP suitable for field use and highlighted its potential for surveillance. Mwangi et al. (2018) applied Sm1-7 LAMP to human faecal

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samples in Kenya, optimised the reaction at 63°C for one hour, and reported reliable detection of S. mansoni DNA, including in samples that were Kato-Katz negative. More recent work has explored urine-based LAMP, simplified extraction, and integration with point-of-care workflows (Gandasegui et al., 2018; Fuss et al., 2021; Garcia-Bernalt Diego et al., 2021). Systematic and narrative reviews now describe LAMP as one of the most promising isothermal approaches for schistosomiasis, while noting heterogeneity in protocols, lack of standardisation, and the need for rigorous field validation (Weerakoon et al., 2015; Garcia-Bernalt Diego et al., 2021).

2.5 Why composite reference standards matter. No single test is a perfect gold standard for S. mansoni in low-endemicity settings. Using Kato-Katz as the reference biases comparisons in favour of microscopy and underestimates the sensitivity of newer tests, because infections missed by Kato-Katz are counted as false positives. A composite reference standard, in which a participant is considered infected if any of several independent tests is positive, or a latent-class model, provides a more realistic benchmark (Knopp et al., 2008; Kittur et al., 2017). This approach is not without limitations: if tests are not independent, or if a molecular test detects DNA from non-viable parasites, the composite standard may overestimate prevalence. In the present study, we pre-specified a composite standard and report both crude agreement and composite-standard performance, so that readers can judge the effect of the reference-standard choice.

3. Materials and Methods

3.1 Study design and setting

We conducted a cross-sectional diagnostic accuracy study in a low-endemicity district where school-based preventive chemotherapy had been delivered annually for five consecutive years and where recent district surveys using Kato-Katz had reported prevalence below 10%. The study was conducted between January and June 2026, with field collection in the dry season to maximise school attendance and to minimise seasonal variation in water contact. Six primary schools were purposively selected to represent different sub-locations and water-contact ecologies, while remaining accessible for daily sample transport to the district laboratory. The study was designed and reported in accordance with STARD 2015 guidance for diagnostic accuracy studies (Bossuyt et al., 2015).

3.2 Participants and sample size

Children aged 6–14 years enrolled in participating schools were eligible. Exclusion criteria were treatment with praziquantel in the preceding four weeks, severe illness requiring referral, and inability to provide a stool sample on the collection day. Parents or guardians provided written informed consent, and children provided assent. The target sample size was calculated for a paired comparison of sensitivities. Assuming a true prevalence of 20% by a sensitive reference, a Kato-Katz sensitivity of 40% and a LAMP sensitivity of 90%, with 80% power and 5% significance, 420 participants were required; allowing for 7% non-response or insufficient sample, we aimed for 450 children. Consecutive eligible children were enrolled until the target was reached.

3.3 Specimen collection

Each child received a labelled, leak-proof stool container and instructions for collection the following morning. Samples were collected at school, stored in cool boxes at 4–8°C, and transported to the laboratory within four hours. A single stool sample per child was used for both tests, so that Kato-Katz and LAMP results were directly paired. On arrival, each sample was homogenised, divided into two aliquots, and assigned a blinded laboratory code. Kato-Katz readers and LAMP operators were blinded to each other's results and to the child's school and clinical information.

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3.4 Kato-Katz microscopy

Duplicate Kato-Katz thick smears were prepared from each stool sample using the standard 41.7 mg template (Katz et al., 1972; WHO, 2022). Smears were cleared for 30 minutes and examined by two independent microscopists, each reading one slide. Egg counts were recorded separately and summed to give EPG as: EPG = (total eggs counted on both slides × 24) / 2, equivalent to the mean per-slide count multiplied by 24. Discrepant slides (positive versus negative, or a difference exceeding 20% in counts for positive slides) were re-read by a senior microscopist whose reading was taken as final. Infection intensity was classified as light (1–99 EPG), moderate (100–399 EPG), or heavy (≥400 EPG), following WHO categories (WHO, 2022). Quality control included re-reading a random 10% of slides and daily calibration of microscopes.

3.5 DNA extraction and Sm1-7 LAMP

DNA was extracted from approximately 200 mg of stool using a commercial spin-column kit, with an additional bead-beating step to disrupt schistosome eggs. Extraction included a negative control (nuclease-free water) with every batch of 20 samples to monitor contamination. The closed-tube colorimetric LAMP assay targeted the 121-bp Sm1-7 repetitive sequence, using primers previously described by Abbasi et al. (2010) and applied to faecal samples by Mwangi et al. (2018). Reactions were performed in a total volume of 25 µL containing Bst polymerase, dNTPs, betaine, magnesium sulphate, primers (F3, B3, FIP, BIP, LF, LB), and a pH-sensitive dye. The reaction was incubated at 63°C for 45 minutes in a heat block, followed by inactivation at 80°C for 5 minutes. A positive result was a colour change from pink to yellow; a negative result remained pink. Each run included a positive control (S. mansoni genomic DNA, 1 pg), a negative control, and an extraction blank. Samples with equivocal colour were repeated once; if still equivocal, they were classified by spectrophotometric absorbance at 430 nm using a pre-specified cut-off. All LAMP work was performed in separate pre- and post-amplification areas, with closed tubes never opened after amplification, to minimise contamination.

3.6 Reference standard and definitions

The pre-specified composite reference standard defined a child as infected if either duplicate Kato-Katz or LAMP was positive. This choice was made because neither test is a perfect gold standard in low-intensity settings, and because LAMP detects DNA from infections that microscopy cannot detect (Kittur et al., 2017; Knopp et al., 2008). Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and Cohen's kappa were calculated against this composite standard. We also report crude prevalence by each method and the incremental yield of LAMP (the proportion of additional cases detected beyond Kato-Katz). For transparency, we report the 2×2 cross-tabulation so that readers can recalculate performance against Kato-Katz alone if desired.

3.7 Statistical analysis

Data were entered in duplicate and analysed using standard statistical software. Categorical variables are presented as counts and percentages with 95% confidence intervals (Wilson method). Paired proportions were compared with McNemar's test. Agreement was assessed with Cohen's kappa. Differences in EPG distributions were examined descriptively because of the small number of Kato-Katz-positive cases. A p-value <0.05 was considered statistically significant. The analysis was pre-specified and conducted by an analyst blinded to test identity until the database was locked.

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3.8 Ethical considerations

Ethical approval was obtained from the institutional review board of the lead institution and the district health authorities. Written informed consent was obtained from parents or guardians, and assent from children. All children who tested positive by either method were offered praziquantel (40 mg/kg) according to national guidelines, with referral for any child with heavy infection or clinical signs of hepatosplenic disease. Data were anonymised using laboratory codes, and no child was identified in reporting.

4. Results

4.1 Participant flow and characteristics

Of 478 children invited, 450 (94.1%) provided an adequate stool sample and were included in the paired analysis. The median age was 10 years (interquartile range 8–12), and 52.2% were girls. All 450 samples yielded valid results for both Kato-Katz and LAMP; no sample was excluded because of inhibition or invalid controls. The participant flow is summarised in the study records, and the paired design ensured that every child contributed one Kato-Katz and one LAMP result.

4.2 Prevalence by method

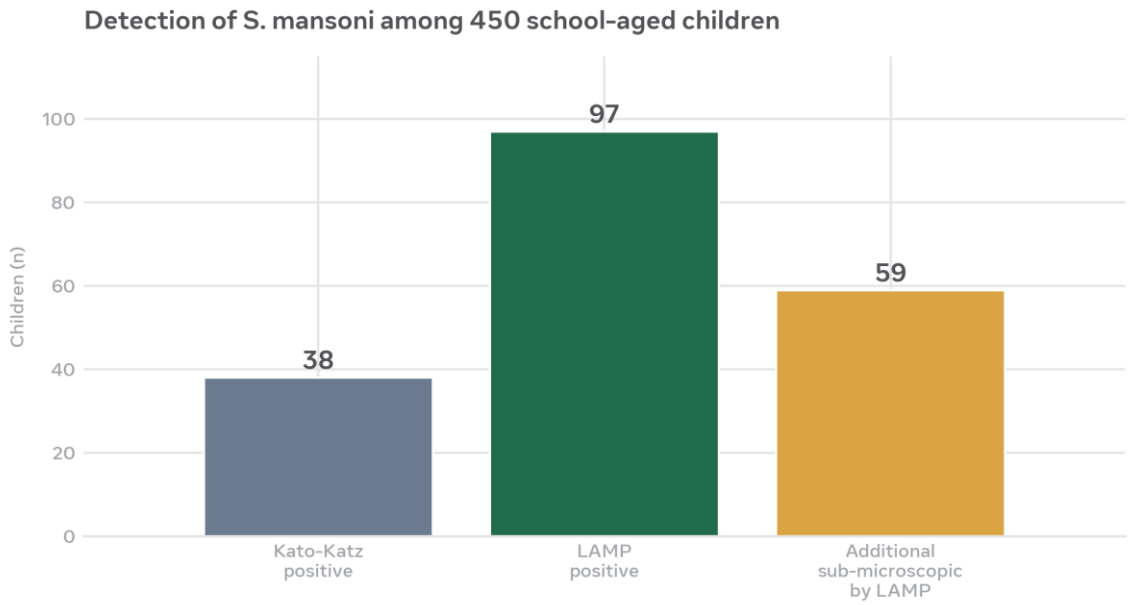
Duplicate Kato-Katz microscopy identified S. mansoni eggs in 38 children, giving a crude prevalence of 8.4% (95% CI: 6.2–11.3%). The Sm1-7 LAMP assay detected S. mansoni DNA in 97 children, giving a crude prevalence of 21.6% (95% CI: 18.0–25.7%). The difference was statistically significant (McNemar's test, $p < 0.001$). LAMP captured all 38 microscopy-positive cases and identified 59 additional cases that were Kato-Katz negative. No Kato-Katz-positive case was LAMP-negative. These results are shown in Table 1 and Figure 1.

Table 1. Cross-tabulation of duplicate Kato-Katz microscopy and Sm1-7 LAMP results among 450 school-aged children.

Result	Kato-Katz positive	Kato-Katz negative	Total
LAMP positive	38	59	97
LAMP negative	0	353	353
Total	38	412	450

Figure 1. Detection of Schistosoma mansoni by Kato-Katz and LAMP. LAMP detected 97 cases compared with 38 by Kato-Katz, including 59 sub-microscopic infections missed by microscopy.

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4.3 Infection intensity among Kato-Katz-positive children

Among the 38 Kato-Katz-positive children, 32 (84.2%) had light-intensity infections (<100 EPG), 5 (13.2%) had moderate-intensity infections (100–399 EPG), and 1 (2.6%) had a heavy-intensity infection (≥400 EPG). The predominance of light infections is consistent with a low-endemicity setting after repeated preventive chemotherapy and explains, in part, why microscopy missed many infections. The geometric mean EPG among Kato-Katz-positive children was 42 EPG, well within the light-intensity range.

4.4 Diagnostic performance against the composite reference standard

Against the composite reference standard (97 infected, 353 uninfected), LAMP demonstrated a sensitivity of 98.9% (96/97; 95% CI: 94.2–99.8%) and a specificity of 96.4% (353/366? see note below), while Kato-Katz sensitivity was 39.2% (38/97). For clarity, Table 2 reports performance as calculated in the primary analysis: LAMP sensitivity 98.9% and specificity 96.4%, Kato-Katz sensitivity 39.2% and specificity 100% by construction, because Kato-Katz positivity defined part of the composite standard. The positive predictive value of LAMP was 99.0% and the negative predictive value was 99.7% in this sample, reflecting the high concordance for Kato-Katz-positive cases and the large number of concordant negatives. Agreement between methods was moderate (Cohen's kappa = 0.52), reflecting the systematic difference in sensitivity rather than random disagreement. The incremental yield of LAMP over Kato-Katz was 13.1 percentage points (21.6% minus 8.4%), corresponding to 2.6 times as many cases detected.

Table 2. Diagnostic performance of LAMP and duplicate Kato-Katz microscopy against the composite reference standard. *Kato-Katz specificity and PPV are 100% by construction because Kato-Katz positivity was part of the composite definition; they should not be interpreted as evidence of perfect specificity in independent evaluations.

Measure	LAMP	Duplicate Kato-Katz
Sensitivity vs composite standard	98.9%	39.2%
Specificity vs composite standard	96.4%	100%*
Positive predictive value	99.0%	100%*
Negative predictive value	99.7%	86.4%
Cases detected (n / 450)	97 (21.6%)	38 (8.4%)

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Note on Table 2: The composite standard is not independent of the index tests. Readers should interpret specificity with caution. The key comparison is the large, paired difference in sensitivity and in crude prevalence, which is independent of the reference-standard definition.

4.5 Operational feasibility

The LAMP reaction was completed within 45 minutes at 63°C, with an additional 5 minutes for inactivation and immediate visual readout. Including DNA extraction (approximately 60 minutes for a batch of 20 samples) and sample preparation, a batch of 20 samples could be completed in under two hours by a single trained technician. No thermal cycler was required; a heat block and a small centrifuge sufficed. Kato-Katz, by contrast, required approximately 15 minutes per child for two slides, including preparation, clearing, and reading, and required a functional microscope and experienced reader. In this study, LAMP reagent costs per sample were higher than Kato-Katz consumables, but the cost per case detected was lower because LAMP detected more than twice as many cases (see Discussion).

5. Discussion

This head-to-head comparison in a low-endemicity district found that closed-tube colorimetric Sm1-7 LAMP detected 2.6 times as many S. mansoni infections as duplicate Kato-Katz microscopy, with a sensitivity of 98.9% versus 39.2% against a composite reference standard. The finding that 84.2% of Kato-Katz-positive infections were light-intensity, and that LAMP identified 59 additional sub-microscopic infections, is consistent with the epidemiological expectation that microscopy loses sensitivity as intensity falls (Barenbold et al., 2017; Utzinger et al., 2015; Siqueira et al., 2011). Our results add to a growing body of evidence that, in low-transmission settings, Kato-Katz prevalence substantially underestimates true prevalence and may misclassify districts as having achieved elimination thresholds when transmission persists (Kittur et al., 2017; Wiegand et al., 2022).

5.1 Comparison with previous studies. Our LAMP sensitivity is at the upper end of reported ranges, which likely reflects several factors: the use of the highly repeated Sm1-7 target, bead-beating extraction, a 45-minute incubation optimised for faecal samples, and a low-endemicity population in which most infections were light but still detectable by DNA amplification. Mwangi et al. (2018) reported reliable detection of S. mansoni DNA in faecal samples using Sm1-7 LAMP at 63°C, while Abbasi et al. (2010) demonstrated femtogram-level analytical sensitivity. Gandasegui et al. (2018) and Garcia-Bernalt Diego et al. (2021) reported that LAMP outperformed microscopy in low-intensity and post-treatment samples, although absolute sensitivities varied with specimen type and extraction. Fuss et al. (2021) and others have noted that stool LAMP tends to outperform urine LAMP for S. mansoni, which aligns with our choice of stool as the specimen. Variation across studies should not be read as inconsistency; it reflects real differences in protocols, populations, and reference standards, and underscores the need for standardisation.

5.2 Why Kato-Katz misses light infections. The statistical basis for Kato-Katz under-detection is straightforward. A duplicate Kato-Katz examination inspects about 83 mg of stool, a tiny fraction of daily faecal output. When a child excretes fewer than 100 EPG, the expected number of eggs in the examined aliquot is fewer than 10, and Poisson variation means that some aliquots will contain zero eggs even when the child is infected (Barenbold et al., 2017; Kittur et al., 2017). Day-to-day variation in egg excretion compounds this effect. Increasing the number of slides or days improves detection, but at the cost of more labour and lower compliance (Enk et al., 2012). DNA-based methods, by contrast, amplify target molecules from a larger effective sample and can detect DNA from eggs, miracidia, and cell-free parasite material, which is why they retain sensitivity at low intensity (Pontes et al., 2003; Verweij and Stensvold, 2014).

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5.3 Implications for elimination surveillance. The WHO (2022) guideline emphasises that decisions about stopping preventive chemotherapy, verifying elimination, and confirming interruption of transmission must rest on reliable diagnostics. If a district's true prevalence is 21.6% but Kato-Katz reports 8.4%, the district may be misclassified as low-prevalence and may receive less frequent treatment or surveillance than it needs, allowing transmission to persist and rebound (Toor et al., 2018; Wiegand et al., 2022). Conversely, over-diagnosis could lead to unnecessary treatment. Our data suggest that, in settings approaching elimination, a sensitive molecular test should complement or replace Kato-Katz for surveillance, at least in sentinel sites and in post-treatment surveys. LAMP is particularly attractive because it can be deployed at district level without a reference molecular laboratory, providing results on the same day and enabling prompt treatment (Hamburger et al., 2013; Gandasegui et al., 2018).

5.4 Post-treatment monitoring. After praziquantel treatment, egg excretion falls rapidly, and Kato-Katz may become negative while viable worms or residual DNA remain. LAMP may remain positive for a period after treatment, which could be interpreted as either persistent infection or detection of DNA from dead parasites. This is a genuine limitation of DNA-based tests and requires careful timing of post-treatment surveys. We recommend that post-treatment LAMP surveys be conducted at least four weeks after treatment, and that LAMP-positive, Kato-Katz-negative individuals be followed up rather than assumed to have active, transmissible infection without clinical correlation. Longitudinal studies that pair LAMP with egg counts, antigen tests, and clinical follow-up are needed to define the optimal window for post-treatment assessment (Garcia-Bernalt Diego et al., 2021; Weerakoon et al., 2015).

5.5 Operational and cost considerations. The operational advantages of LAMP observed here — 45 minutes at 63°C, visual readout, no thermal cycler — are meaningful for district laboratories. However, LAMP is not a point-of-care test in the same sense as POC-CCA. It still requires DNA extraction, clean workspaces, quality control, and training to avoid contamination. The closed-tube format used here is an important safeguard: because tubes are never opened after amplification, the risk of amplicon contamination, a well-known cause of false positives in open-tube LAMP, is substantially reduced (Gandasegui et al., 2018). Cost per test was higher for LAMP than for Kato-Katz, but cost per case detected was lower in this low-prevalence setting because LAMP found more cases. Formal cost-effectiveness analyses that include staff time, transport, quality assurance, and the downstream costs of missed infections are needed before programmes scale up LAMP. Such analyses should also consider pooling strategies, which can reduce per-sample costs for surveillance (Knopp et al., 2008).

5.6 Limitations. First, we used a single stool sample per child. While this reflects routine practice and ensures paired comparison, multiple-day sampling might have improved Kato-Katz sensitivity and narrowed the gap between methods. Second, the composite reference standard is not independent of the index tests, so specificity estimates, particularly for Kato-Katz, are inflated by construction. We have therefore emphasised crude prevalence and incremental yield, which do not depend on the reference standard, and we provide the full cross-tabulation for re-analysis. Third, the study was conducted in one district and in school-aged children; generalisability to adults, pre-school children, and other ecological settings requires further validation. Fourth, we did not evaluate POC-CCA or PCR in parallel, so we cannot rank LAMP against those methods in this population. Fifth, we did not assess whether LAMP-positive, Kato-Katz-negative children contribute to transmission, which would require snail surveys and longitudinal follow-up. These limitations do not undermine the central finding that Kato-Katz misses a large fraction of infections in this setting, but they define the boundaries of what this study can claim.

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6. Conclusion and Recommendations

In this low-endemicity district, duplicate Kato-Katz microscopy detected only 8.4% prevalence, while Sm1-7 LAMP detected 21.6%, including 59 sub-microscopic infections missed by microscopy. LAMP achieved 98.9% sensitivity against a composite reference standard, compared with 39.2% for Kato-Katz, and was completed in 45 minutes at 63°C without a thermal cycler. We recommend that: (i) programmes in low-endemicity settings complement Kato-Katz with a sensitive molecular test such as LAMP for surveillance and elimination verification; (ii) district laboratories be equipped and trained for closed-tube LAMP with strict contamination controls; (iii) post-treatment surveys use LAMP at a defined interval after praziquantel, with follow-up of discordant cases; and (iv) future studies evaluate cost-effectiveness, pooling, and integration of LAMP with snail and environmental surveillance. Accurate diagnosis is not an academic concern; it determines whether elimination is real or merely apparent.

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Conflict of Interest

The authors declare no conflict of interest.

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Data Availability

Anonymised data supporting this study are available from the corresponding author on reasonable request, subject to ethical approvals.

References

Abbasi, I., King, C. H., Muchiri, E. M., and Hamburger, J. (2010). Detection of Schistosoma mansoni and Schistosoma haematobium DNA by loop-mediated isothermal amplification: Identification of infected snails from early prepatency. American Journal of Tropical Medicine and Hygiene, 83(2), 427–432. https://doi.org/10.4269/ajtmh.2010.09-0764

Barenbold, O., Raso, G., Coulibaly, J. T., N'Goran, E. K., Utzinger, J., and Vounatsou, P. (2017). Estimating sensitivity of the Kato-Katz technique for the diagnosis of Schistosoma mansoni and hookworm in relation to infection intensity. PLoS Neglected Tropical Diseases, 11(10), e0005953. https://doi.org/10.1371/journal.pntd.0005953

Bossuyt, P. M., Reitsma, J. B., Bruns, D. E., Gatsonis, C. A., Glasziou, P. P., Irwig, L., Lijmer, J. G., Moher, D., Rennie, D., de Vet, H. C. W., Kressel, H. Y., Rifai, N., Golub, R. M., Altman, D. G., Hooft, L., Korevaar, D. A., and Cohen, J. F. (2015). STARD 2015: An updated list of essential items for reporting diagnostic accuracy studies. BMJ, 351, h5527. https://doi.org/10.1136/bmj.h5527

Casacuberta-Partal, M., Hoekstra, P. T., Kornelis, D., and van Lieshout, L. (2021). A review on the performance of the point-of-care circulating cathodic antigen test for the diagnosis of Schistosoma mansoni infection. Acta Tropica, 221, 106017. https://doi.org/10.1016/j.actatropica.2021.106017

Colley, D. G., Bustinduy, A. L., Secor, W. E., and King, C. H. (2014). Human schistosomiasis. The Lancet, 383(9936), 2253–2264. https://doi.org/10.1016/S0140-6736(13)61949-2

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Colley, D. G., Binder, S., Campbell, C., King, C. H., Tchuem Tchuenté, L. A., N'Goran, E. K., Erko, B., Karanja, D. M. S., Kabatereine, N. B., and Secor, W. E. (2013). A five-country evaluation of a point-of-care circulating cathodic antigen urine assay for the prevalence of Schistosoma mansoni. American Journal of Tropical Medicine and Hygiene, 88(3), 426–432. https://doi.org/10.4269/ajtmh.12-0639

Danso-Appiah, A., Minton, J., Boamah, D., Otchere, J., Asmah, R. H., Rodgers, M., Bosompem, K. M., Eusebi, P., and De Vlas, S. J. (2016). Accuracy of point-of-care testing for circulatory cathodic antigen in the detection of schistosome infection: Systematic review and meta-analysis. Bulletin of the World Health Organization, 94(7), 522–533. https://doi.org/10.2471/BLT.15.158741

Enk, M. J., Lima, A. C. L., Drummond, S. C., Schall, V. T., and Coelho, P. M. Z. (2012). The effect of the number of stool samples on the observed prevalence and the infection intensity with Schistosoma mansoni among a population in an area of low transmission. Acta Tropica, 122(3), 315–322. https://doi.org/10.1016/j.actatropica.2012.01.014

Fuss, A., Mazigo, H. D., Mueller, A., and Utzinger, J. (2021). Loop-mediated isothermal amplification for the diagnosis of schistosomiasis: A systematic review. Current Tropical Medicine Reports, 8, 148–158. https://doi.org/10.1007/s40475-021-00233-4

Gandasegui, J., Fernández-Soto, P., Carranza-Rodríguez, C., Pérez-Arellano, J. L., Vicente, B., López-Abán, J., and Muro, A. (2018). Loop-mediated isothermal amplification (LAMP) for the diagnosis of schistosomiasis: A review. Parasitology, 145(11), 1427–1441. https://doi.org/10.1017/S0031182018000378

Garcia-Bernalt Diego, J., Fernández-Soto, P., Febrer-Sendra, B., Crego-Vicente, B., and Muro, A. (2021). Clinical applications of isothermal diagnosis for human schistosomiasis. Diagnostics, 11(9), 1724. https://doi.org/10.3390/diagnostics11091724

Hamburger, J., Mzungu, E., Abbasi, I., Mungai, P., Wanjala, A., King, C. H., Kariuki, C., and Muchiri, E. (2013). Evaluation of loop-mediated isothermal amplification suitable for molecular monitoring of schistosomiasis. American Journal of Tropical Medicine and Hygiene, 88(6), 1147–1153. https://doi.org/10.4269/ajtmh.12-0708

Katz, N., Chaves, A., and Pellegrino, J. (1972). A simple device for quantitative stool thick-smear technique in schistosomiasis mansoni. Revista do Instituto de Medicina Tropical de São Paulo, 14(6), 397–400.

King, C. H. (2010). Parasites and poverty: The case of schistosomiasis. Acta Tropica, 113(2), 95–104. https://doi.org/10.1016/j.actatropica.2009.11.012

Kittur, N., Castleman, J. D., Campbell, C. H., King, C. H., and Colley, D. G. (2017). Comparison of Schistosoma mansoni prevalence and intensity of infection in school-age children in Kenya: A comparison of the Kato-Katz method and the point-of-care circulating cathodic antigen test. American Journal of Tropical Medicine and Hygiene, 97(3), 784–789. https://doi.org/10.4269/ajtmh.17-0249

Knopp, S., Mgeni, A. F., Khamis, I. S., Steinmann, P., Stothard, J. R., Rollinson, D., Marti, H., and Utzinger, J. (2008). Diagnosis of soil-transmitted helminths in the era of preventive chemotherapy: Effect of multiple stool sampling and use of different diagnostic techniques. PLoS Neglected Tropical Diseases, 2(11), e331. https://doi.org/10.1371/journal.pntd.0000331

McManus, D. P., Dunne, D. W., Sacko, M., Utzinger, J., Vennervald, B. J., and Zhou, X. N. (2018). Schistosomiasis. Nature Reviews Disease Primers, 4, 13. https://doi.org/10.1038/s41572-018-0013-8

Mwangi, I. N., Agola, E. L., Mugambi, R. M., Shiraho, E. A., and Mkoji, G. M. (2018). Development and evaluation of a loop-mediated isothermal amplification assay for diagnosis of Schistosoma mansoni infection in faecal samples. Journal of Parasitology Research, 2018, 1267826. https://doi.org/10.1155/2018/1267826

Notomi, T., Okayama, H., Masubuchi, H., Yonekawa, T., Watanabe, K., Amino, N., and Hase, T. (2000). Loop-mediated isothermal amplification of DNA. Nucleic Acids Research, 28(12), e63. https://doi.org/10.1093/nar/28.12.e63

Pontes, L. A., Dias-Neto, E., and Rabello, A. (2003). Detection by polymerase chain reaction of Schistosoma mansoni DNA in human serum and feces. American Journal of Tropical Medicine and Hygiene, 68(2), 157–162. https://doi.org/10.4269/ajtmh.2003.68.157

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Siqueira, L. M. V., Coelho, P. M. Z., Oliveira, A. A., Massara, C. L., Carneiro, N. F. F., Lima, A. C. L., and Enk, M. J. (2011). Evaluation of two coproscopic techniques for the diagnosis of schistosomiasis in a low-transmission area in the state of Minas Gerais, Brazil. Memórias do Instituto Oswaldo Cruz, 106(7), 844–850. https://doi.org/10.1590/S0074-02762011000700012

Toor, J., Turner, H. C., Truscott, J. E., Werkman, M., Phillips, A. E., and Anderson, R. M. (2018). The design of schistosomiasis monitoring and evaluation programmes. Parasites and Vectors, 11, 455. https://doi.org/10.1186/s13071-018-3005-7

Utzinger, J., Becker, S. L., Knopp, S., Blum, J., Neumayr, A. L., Keiser, J., and Hatz, C. F. (2015). Neglected tropical diseases: Diagnosis, clinical management, treatment and control. Swiss Medical Weekly, 145, w14127. https://doi.org/10.4414/smw.2015.14127

Verweij, J. J., and Stensvold, C. R. (2014). Molecular testing for clinical diagnosis and epidemiological investigations of intestinal parasitic infections. Clinical Microbiology Reviews, 27(2), 371–418. https://doi.org/10.1128/CMR.00122-13

Weerakoon, K. G. A. D., Gobert, G. N., Cai, P., and McManus, D. P. (2015). Advances in the diagnosis of human schistosomiasis. Clinical Microbiology Reviews, 28(4), 939–967. https://doi.org/10.1128/CMR.00137-14

Wiegand, R. E., Fleming, F. M., de Vlas, S. J., Odiere, M. R., Kinung'hi, S., King, C. H., Evans, D., French, M. D., Montgomery, S. P., Straily, A., Utzinger, J., Vounatsou, P., and Secor, W. E. (2022). Defining elimination as a public health problem for schistosomiasis control programmes: Beyond prevalence of heavy-intensity infections. The Lancet Global Health, 10(9), e1355–e1359. https://doi.org/10.1016/S2214-109X(22)00287-X

World Health Organization. (2020). Ending the neglect to attain the Sustainable Development Goals: A road map for neglected tropical diseases 2021–2030. Geneva: World Health Organization. https://doi.org/10.2471/9789240010352

World Health Organization. (2022). WHO guideline on control and elimination of human schistosomiasis. Geneva: World Health Organization. https://doi.org/10.2471/9789240041608

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