XVII INTERNATIONAL SYMPOSIUM ON
SCHISTOSOMIASIS
PERSPECTIVES ON SCHISTOSOMIASIS ELIMINATION
NOVEMBER 10-13TH 2024 | SALVADOR - BAHIA

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TITLE

EVALUATION AND OPTIMIZATION OF POINT-OF-CARE IMMUNOCHROMATOGRAPHIC TEST (POC-CCA) READINGS PERFORMED IN AN AREA OF HIGH ENDEMICITY IN NORTHEASTERN BRAZIL FOR SCHISTOSOMIASIS, USING IMAGE ANALYSIS

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ABSTRACT

Schistosomiasis, caused by the Schistosoma mansoni parasite, is a Neglected Tropical Disease with a significant impact in underdeveloped countries. The Kato-Katz (KK) method, recommended by the World Health Organization, is widely used, but it has low sensitivity in regions with low endemicity. The POC-CCA, an immunochromatographic test that detects parasitic antigens in urine, has emerged as a sensitive and rapid alternative. However, this test is prone to variations in interpretation between readers, especially when the test response is weak (trace), which can affect the determination of prevalence. This study aimed to quantify the coloration of POC-CCA test results to reduce the subjectivity involved in visual interpretation. For this purpose, a dataset of 158 images from POC-CCA tests was used, collected from a highly endemic area for schistosomiasis. The ImageJ® software, a public Java-based image analysis tool, was employed to quantify the pixel intensity of the test results' color. This pixel quantification strategy demonstrated good accuracy, effectively distinguishing between positive and negative results, with an area under the ROC curve of 0.859. The optimal cutoff point was 0.042 pixels, corresponding to a Youden's J index maximum of 0.656. At this threshold, sensitivity reached 0.779, and specificity was 0.877. When compared to the Kato-Katz results and other POC-CCA reading strategies, pixel quantification showed similar prevalence rates of positives and negatives to the Kato-Katz method and qualitative visual reading. However, the prevalence of positive cases was lower than that observed with the G Score reading strategy (G1 to G10). A weak, yet statistically significant, positive correlation ($r^2 = 0.4812$, $p < 0.0001$) was identified between the OPG results of the Kato-Katz test and pixel quantification of the POC-CCA test. There was good agreement between the pixel quantification reading strategy and the Kato-Katz test (Kappa value = 0.6572, $p < 0.0001$), as well as with stratified G Score readings (Kappa value = 0.5498, $p < 0.0001$) and qualitative visual interpretation (Kappa value = 0.5383, $p < 0.0001$). Although the image processing technique performed satisfactorily, there is room for improvements in usability and efficiency, including parameter optimization and refining signal cutoff metrics. The study concludes that the visual interpretation of the POC-CCA test is inherently subjective; however, pixel quantification provides an objective analysis, eliminating subjectivity and enabling a more precise determination of test results.

KEYWORDS

Pixels; POC-CCA; Immunochromatographic; Schistosomiasis; Schistosoma mansoni

FINANCIAL SUPPORT