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Factors influencing quality assurance of malaria microscopy at Kajaani health centre IV, Wakiso district. A cross-sectional study.

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Abstract

Background:

Malaria microscopy remains the gold standard for laboratory diagnosis of malaria; however, its accuracy depends on effective quality assurance practices across pre-analytical, analytical, and post-analytical phases. This study assessed the factors influencing quality assurance of malaria microscopy at Kajjansi Health Centre IV in Wakiso District, Uganda.

Methodology:

A descriptive cross-sectional study employing quantitative methods was conducted among 84 healthcare workers, including laboratory personnel, interns, and volunteers. Participants were selected using simple random sampling. Data were collected using semi-structured questionnaires and analyzed using SPSS version 17.0 and Microsoft Excel. Descriptive statistics such as frequencies and percentages were used to summarize findings.

Results:

The majority of respondents were male (64.3%) and below 25 years (47.6%). About 71.4% had heard about malaria microscopy quality assurance, while 65.5% had practiced it. Key quality assurance practices included slide labeling (100%), correct sample collection (98.8%), and proper completion of request forms (94%). However, 8.3% reported using expired reagents. In-service training (83.3%) and cross-checking of results (96.4%) were associated with improved diagnostic accuracy. Pre-analytical errors, such as poor labeling, contributed to mixing up patient results (56%), while analytical challenges included inaccurate parasite quantification (50%). Major constraints identified were a lack of adequate workspace (66.7%), limited resources (45.2%), and unreliable electricity supply (17.9%). Motivation factors included fair pay (41.7%) and career growth (26.2%).

Conclusion:

Quality assurance practices significantly improve the accuracy of malaria microscopy; however, gaps remain due to infrastructural limitations, inadequate resources, and inconsistent adherence to quality protocols.

Recommendations:

Health facilities should strengthen continuous professional training, ensure a consistent supply of laboratory resources, and improve infrastructure, such as workspace and electricity. Implementation of regular supervision and external quality assurance programs is essential to enhance diagnostic accuracy and patient outcomes.

Keywords: *Malaria microscopy, Quality assurance, Diagnostic accuracy, pre-analytical factors, Health laboratory services, Wakiso District.*
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Background.

According to the CDC (2023), microscopic examination is the gold standard method for laboratory confirmation of malaria. Before releasing malaria microscopy results, it follows a pre-analytical, analytical, and post-analytical process for good quality results. Quality of health service care is the degree to which health services for individuals and populations increase the likelihood of desired health outcome by WHO (2023). Pre-analytic factors include specimen collection, sample handling, slide preparation, and

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others.

The analytical process involves examination of the sample, accuracy and competence of the laboratory professionals, while in the post-analytical factors, this occurs after the test results are generated, which include results interpretation, economic factors, storage of stock solution, and many more. Globally, in the malaria quality assurance manual versions 2 by WHO (2016) shows the factors that limits the availability and quality of microscopy which include lack of resources to provide all laboratories with equipment, good quality reagents, absence of effectiveness per service training, lack of sops, it also indicated the competence and how the performance can be improved, structure and function of quality assurance system. Another study conducted in Asian countries to synthesis evidence of accuracy of rapid on-site diagnostic test and microscopy for detection of asymptomatic malaria as part of surveillance activities showed that detection of *P. falciparum* sensitivity by RDT was 59% while microscopy was 55%, for *P. vivax* RAT was 51% and microscopy was 54% they concluded in their study that there was inappropriate for the detection of plasmodium infection (Naing *et al.*,2022).

In Africa, mainly in Ethiopia, the quality of malaria microscopy diagnosis in the health facility Laboratories showed was poor of 62.3%, including smearing quality, staining quality, and there was a significant gap in the service that could impact diagnostic service. An ISO 15189 document required for quality and competence recommends above or equal to 80% Sori *et al.*, 2018). A study in Angola in the Bengo, Benguela and Luanda assessed the impact of a training course on the quality of malaria diagnosis by microscopy and it showed that there was a significant increase in quality of thick and thin blood smear and for microscopy Benguela had highest value of specificity 92.9% and 98.8%, they conclude their study saying there is a need of continuous refresher training for microscopists and other laboratory staff (Moura *et al.*,2014).

In East Africa, Kenya the study was done to assess the accuracy of malaria diagnosis in low malaria transmission and found out by 756 malaria slide collected (204 27%) were read as positive by health facility microscopist and 103 (14%) as positive by experts and in their research they concluded that microscopists who had completed recently their training and worked in quality assurance pilot facility performed the best overall compared to non QA pilot facility microscopists who did not have refresher training so there was need in refresh training of the staff. Odhiambo *et al.*, (2017), Ngasala and Bushukatale (2019) conducted the study in Tanzania to assess the quality of malaria microscopy in selected private facilities in Tanzania and found out a total of 31/40 (77.5 %) of surveyed private health facilities, they used 253 panel slides and measured accuracy was high, i.e. sensitivity and specificity of microscopy detection of malaria parasite in health facilities were 84.3%. In Uganda, studies carried out in Entebbe in Wakiso district, although microscopy remains the gold standard for malaria diagnosis, little is known about the accuracy in the private health facilities in Uganda. The accuracy of malaria microscopy in this setting was high, although one-third of the patients diagnosed with malaria did not have the disease. The majority of the errors in the smear readings were made by two laboratory personnel, with the main factors associated with inaccurate smear results in this setting, and these private facilities would be ideal model facilities to improve the quality of malaria microscopy in Uganda, especially in the public sector, where accuracy is still poor. (Mutabazi *et al.*, 2021). This study assessed the factors influencing quality assurance of malaria microscopy at Kajjansi Health Centre IV in Wakiso District, Uganda.

Methodology.

Study Design.

This was based on a descriptive cross-sectional study which employed both qualitative and quantitative methods. Data was collected at once, and it was very convenient to carry out research in a short period of time.

Study Area.

The study area was Kajjansi Health Center IV in Kajjansi Town Council, Wakiso District, central region of Uganda, approximately 29 kilometers south of Kampala City. The catchment area consists of 4 parishes: Bweya, Kitende, Nalanda, and Wamala. Coordinates are, latitude: 0.2150, longitude: 32.5500. The study was carried out at Kajjansi health center IV because it is a government facility with coverage of the 4 parishes stated above.

Study population.

The study population had a total of 84 participants, including medical laboratory technicians, volunteers, medical interns, and health workers providing services at Kajjansi Health Center IV. This is because they participate in the diagnosis of malaria.

Sample size determination

The sample size was determined using a statistical formula suggested by Kish and Leslie (1965), which states: $N = \frac{Z^2pq}{d^2}$

Where N= sample size required, Z= confidence interval, P=

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prevalence, q=1-P, d= sampling error
Therefore, N = $\frac{(1.96)^2 x 0.7 x (1-0.7)}{(0.098 x 0.098)}$
N = 84 respondents

Sampling technique
A simple random sampling technique was used. This is because it minimizes bias.

Sampling procedure.
used a simple random sampling method where 7 days of the month were selected. Each of the selected days had twelve papers coloured GREEN and the rest coloured RED. Each respondent who picked GREEN consented to the study and was interviewed. The same procedure was adopted for the 7 days until the end of the data collection. The procedure was time-saving; thus, data was collected in a short period of time.

Data collection methods
The study was a quantitative study. Data was collected using data collection methods like surveys, which involved collecting information from a group of people by asking them questions and analyzing the results.

Data collection tools.
Data was collected with the help of a questionnaire. This is because a questionnaire is easy to use, eliminates interview bias, provides quick data collection, and saves time when obtaining large amounts of information from a large sample of people.

Questionnaire.
A standard semi-structured questionnaire was used in data collection. It was designed based on the study objectives and available information on factors affecting malaria quality assurance.

Data collection procedure
Questionnaires were administered to respondents who were asked to fill in the gaps where necessary or by ticking in the appropriate answer. Those respondents who were having difficulty in question interpretation were helped to interpret questions and were guided when answering by the research assistants.

Study variables.
This study used both independent and dependent variables.

Independent variables
These included factors affecting malaria microscopy quality assurance, e.g., poor staining of blood smears, wrongly identifying plasmodium species, failure to supervise and recheck the malaria microscopy results plus blood films.

Dependent variables
This included malaria microscopy quality assurance, e.g., re-checking blood smears before submitting results, use of well-prepared reagents, and use of known abbreviations.

Quality control
This was enhanced through pretesting of the questionnaire, training of the research assistants, piloting of the study, having clear inclusion and exclusion criteria, and allowing ample time for data collection.

Inclusion criteria
The study involved all healthcare providers, medical volunteers, and medical interns providing services at Kajjansi Health Center IV, and those who consented to the study.

Exclusion criteria
The study excluded all support staff and non-medical staff at Kajjansi health center IV, and those who did not consent to the study.

Pretesting the questionnaire.
The questionnaire was pretested to ensure that the tool had the capacity to measure what was intended. The questionnaire was assessed, and vague terms were identified and modified to enhance respondents' understanding.

Training of research assistants
Individuals were selected and trained on how the research was conducted and how data were collected. The assistants were assessed to ensure that quality data is collected.

Data analysis and presentation
Data was processed and analyzed using Microsoft Excel and SPSS 17.0 software. Qualitative data were therefore presented in figures, tables, pie-charts, and bar graphs.

Ethical consideration.
An introductory letter was obtained from the Mildmay Institute of Health Sciences (MIHS) research and ethics

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committee to the Health Center Human Resource Manager, Kajjansi Health Center IV, to seek permission for conducting the study. The respondents were informed that no immediate or direct benefit was to be provided from the study and allowed to consent before participating in the study. The information from the respondents was obtained with the highest order of privacy and confidentiality. The respondents in the study had the right to either accept or refuse to be part of the study with no penalties. No one was forced to participate, and there was no discrimination in the study.

Results.

Demographic characteristics of respondents

Table 1: Respondents' Demographic characteristics (N=84)

Characteristics		Frequency	Percentage
Age	Below 25	40	47.6
	25-30	20	23.8
	30-35	15	17.9
	Above 35	09	10.7
Total		84	100
Gender	Female	30	35.7
	Male	54	64.3
Total		84	100
Education level	Certificate	30	35.7
	Diploma	25	29.8
	Bachelor's degree	10	11.9
	Master's degree	0	0
	Volunteer	10	11.9
	Medical intern	09	10.7
Total		84	100
Nationality	Ugandan	80	95.2
	Foreigner	04	4.8
Total		84	100

Source of data (primary data, 2025)

Table 1 shows that the majority of the respondents, 40(47.6%), were in the age range of below 25 years, 20 (23.8%) in the range of 25-30 years, 15 (17.9%) in the range of 30-35 years, and 9 (10.7%) in the range above 35 years. The majority of the participants, 54 (64.3%), were males, and the least were 30 (35.7%) females. The majority of the respondents, 30 (35.7%), had Certificate education level, 25 (29.8%) had Diploma education level, 10 (11.9%) had Bachelors' degree education level, none had a Master's degree, 10 (11.9%) were volunteers, and 9 (10.7%) were medical interns. Many of the respondents, 80 (95.2%), were Ugandans, and 4(4.8%) were Foreigners.

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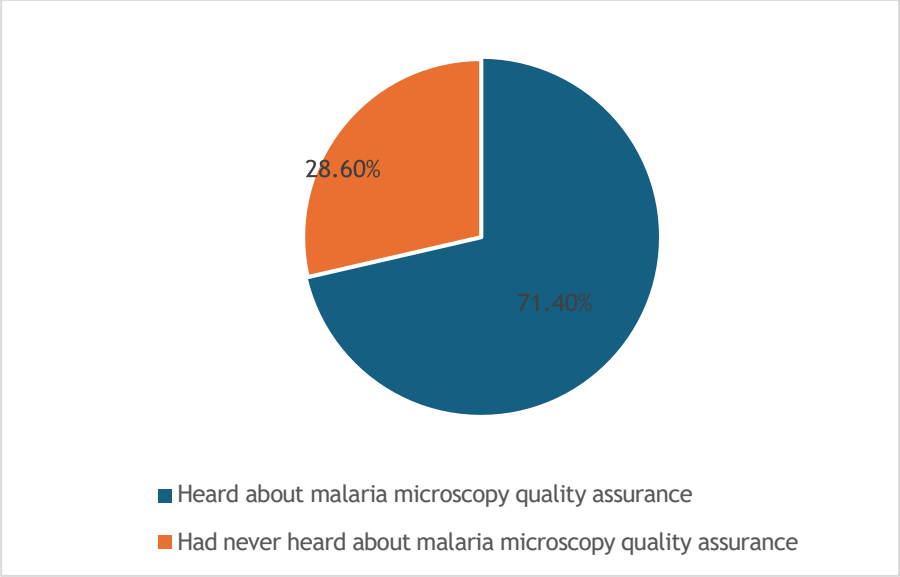
Figure 1: Shows the percentage of respondents who have ever heard about malaria microscopy quality assurance. (n=84)



Source of data (primary data, 2025)

Figure 1 shows that most respondents, 71.4% (60), had ever heard about malaria microscopy quality assurance, and 28.6% (24) had never heard about it.

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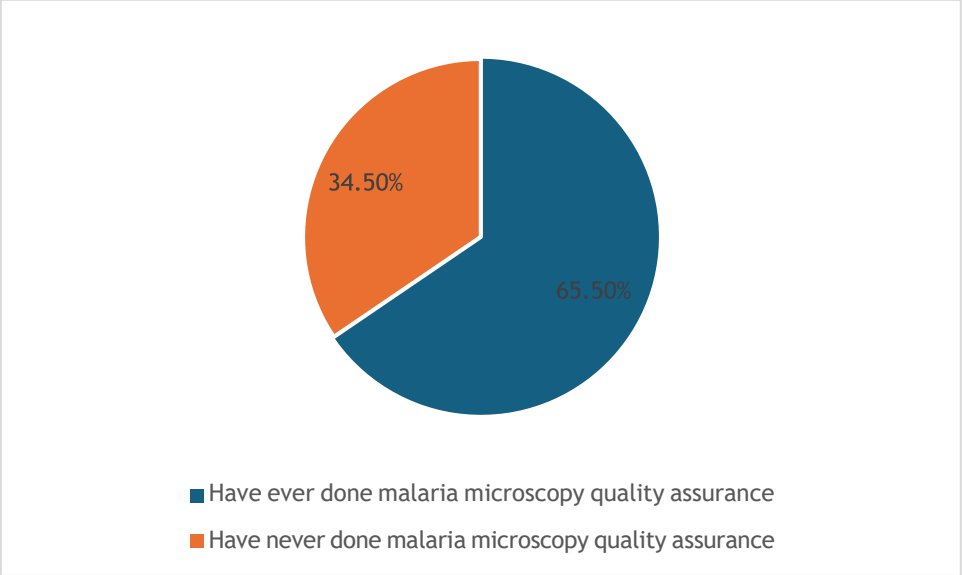
Figure 2: Shows respondents who have ever done quality assurance procedures during malaria microscopy diagnosis (n=84)



Source of data: (primary data, 2025)

Figure 2 shows that most of the respondents, 55(65.5%), had ever done malaria microscopy quality assurance, and 29 (34.5%) had never done malaria microscopy quality assurance.

Table 2: Quality assurance procedures during malaria microscopy done by respondents

Procedure done	Frequency	Percentage
Correct filling of the request forms	79	94
Collecting blood samples from the right patients	83	98.8
Labelling slides	84	100
Staining blood smears using expired reagents	7	8.3
All the above	7	8.3

Source of data: (primary data, 2025)

From the table 2, all the respondents 84 (100%) had done labelling of slides, 83 (98.8%) had practiced collection of samples from the right patients, 79 (94%) practiced correct filling of the request forms, 7 (8.3%) reported staining blood smears using expired reagents and 7 (8.3%) reported all the above procedures.

Table 3: Respondents' awareness about the outcomes due to poor quality assurance during malaria microscopy diagnosis.

Outcome due to poor quality assurance	Frequency	Percentage
Good quality smears	30	35.7
Inaccurate results due to many artifacts	40	47.6
Mixing up patients' results due to poor labelling	14	16.7

Source of data: (primary data, 2025)

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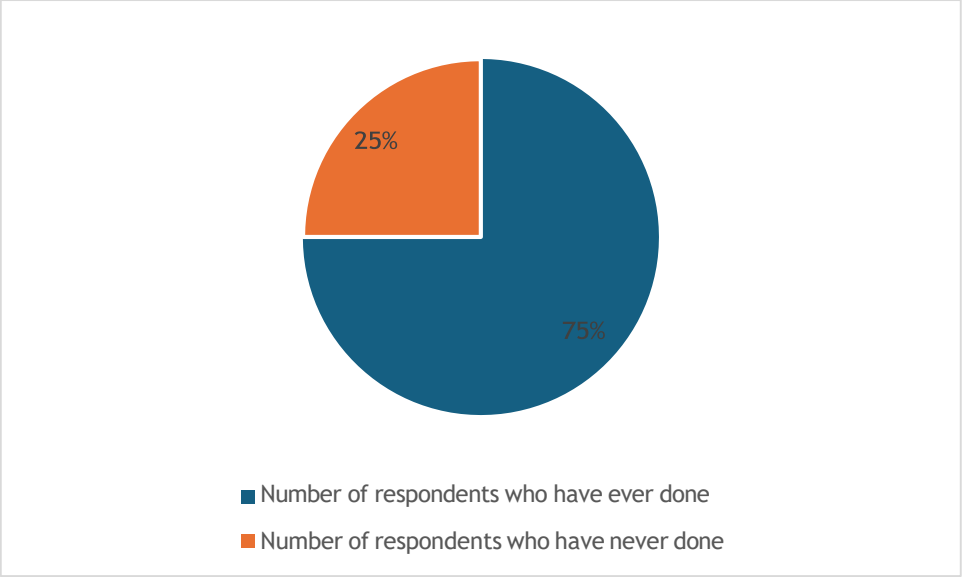
Table 3 shows that the highest number of participants, 40 (47.6%), reported inaccurate results due to many artifacts, 30 (35.7%) reported good quality smears, and 14 (16.7%) reported mixing up patients' results due to poor labelling as an outcome of poor quality assurance during malaria microscopy diagnosis.
Pre-analytical, analytical, and post-analytical factors affecting malaria microscopy quality assurance.

Figure 3: Shows the number of respondents who have ever done pre-analytical, analytical, and post-analytical steps in malaria microscopy quality assurance (n=84)



Source of data (primary data,2025)

Figure 3 shows majority of the respondents, 63 (75%), had done pre-analytical, analytical, and post-analytical steps in malaria quality assurance, while 21 (25%) had never done so.

Table 4: Shows assessments that have been practiced by a number of respondents

Assessment done	Frequency	Percentage
In-service training	70	83.3
Ensuring good optical conditions of microscopes	54	64.3
Incorrect species identification	2	2.4
Correct parasite quantification	42	50

Source of data (primary data, 2025)

Table 4 shows that most of the respondents 70, 83.3%) had reported in-service training, 54 (64.3%) reported ensuring good optical conditions of microscopes, 2 (2.4%) reported incorrect species identification, and 42 (50%) reported correct parasite quantification.

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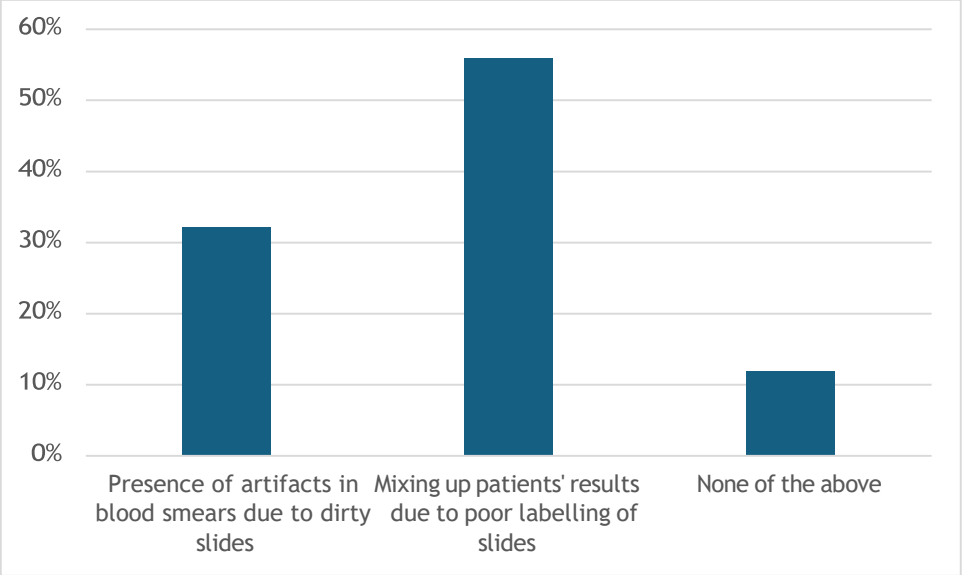
Figure 4: Shows the outcome of poor pre-analytical malaria microscopy quality assurance. (N=84)



Source of data (primary data, 2025)

Figure 4 shows that 27 (32.1%) of the respondents reported the presence of artifacts in blood smears due to dirty slides, 47 (56%) reported mixing up patients' results due to poor labelling of slides, and 10 (11.9%) reported none of the above outcomes of poor pre-analytical malaria microscopy quality assurance.

Table 5: Shows measures taken by respondents to perform post-analytical malaria microscopy quality assurance. (n=84)

Measure taken up by the respondent	Frequency	Percentage
Cross-checking results before submission to the physician	81	96.4
Mixing up patients' results	5	6
Correct interpretation of results	75	89.3
Record keeping of results	79	94

Source of data (primary data, 2025)

Table 5 shows that 81 (96.4%) of the respondents performed cross-checking results before submission to the physician,5 (6%) performed mixing up patients' results, 75 (89.3%) performed correct interpretation of results, and 79 (94%) performed record keeping of results as a post-analytical step to ensure quality results of malaria microscopy.

Social and economic factors affecting malaria microscopy quality assurance

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Table 6: Shows what motivates respondents more to perform malaria microscopy quality assurance. (N=84)

Motivation	Frequency	Percentage
Recognition	10	11.9
Fair pay	35	41.7
Carrier growth	22	26.2
Certificate awards	17	20.2

Source of data (primary data, 2025)

Table 6 shows that 10 (11.9%) of the respondents were motivated by recognition, 35 (41.7%) by fair pay, 22 (26.2%) by career growth, and 22 (20.2%) of the respondents were motivated by certificate awards.

Table 7: Shows infrastructure issues mostly affecting respondents' work

Infrastructure issue	Frequency	Percentage
Access to fewer microscopy resources, e.g., stain reagents	38	45.2
Lack of clean water	20	23.8
Lack of adequate workspace	56	66.7
Unreliable electricity supply	15	17.9

Source of data (primary data, 2025)

Table 7 shows that 38 (45.2%) of the respondents were affected by access to fewer microscopy resources, e.g., stain reagents, 20 (23.8%) were affected by lack of clean water, 56 (66.7%) were affected by lack of adequate workspace, and 15 (17.9%) were affected by unreliable electricity supply.

Discussion.

Most of the respondents had at least a certificate or diploma, with a few having a bachelor's degree; only 11.9% of the participants were volunteers. Although this demographic did not show any effect on malaria microscopy quality assurance.

The study findings are discussed in line with the three specific objectives of the study: to determine factors affecting malaria microscopy quality assurance, to determine pre-analytical, analytical, and post-analytical factors affecting malaria microscopy quality assurance, and social and economic factors affecting malaria microscopy quality assurance. The findings are discussed in comparison and contrast with findings from other earlier studies cited in the literature review section.

The first objective of the study was to determine factors affecting malaria microscopy quality assurance, data analysis and interpretation revealed that 71.4% of the respondents heard about malaria microscopy quality assurance however, only 65.5% of the respondents had ever practiced quality assurance procedures, it was noted that quality assurance programs encouraged and improved the respondents through different trainings e.g. how to label slides, this aligns with Alomba F, et al., 2019 whose study showed in Sub-Saharan Africa showed that supportive supervision improved the performance on preparation and staining of malaria parasites in several contexts. The 2nd objective of the study was to determine pre-analytical, analytical, and post-analytical factors affecting malaria microscopy quality assurance. Data analysis and interpretation revealed that 50% of the respondents were able to correctly quantify parasites,83.3% participated in in-service training, and 96.4% cross-checked results before submission to the physician. These results agree with Gidey, Bokretsion, et al. (2021, whose results showed that the sensitivity and specificity of routine slide reading and re-checking of results were 78.1% and 80.7%, respectively. The 3rd objective of the study was to determine the social and economic factors affecting malaria microscopy quality assurance. Data analysis and interpretation revealed that 66.7% of the respondents lacked adequate workspace, while 17.9% were greatly affected by unreliable electricity supply. These results agree with those of Kigozi R.N et al., 2021, who showed the significant factors associated with determinants of malaria testing at health facilities in Uganda included the availability of power supply.

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Conclusion.
Quality Assurance practices such as correct quantification of malaria parasites, in-service training, and cross checking of results of results before submission to the physician improved the accuracy of malaria microscopy diagnosis. However, a lack of adequate workspace and unreliable electricity supply hindered the accuracy and quality of malaria microscopy results.

Study limitations.
The study was too time-consuming and very expensive, but this was overcome by drawing a budget that was followed strictly.

Recommendation.
To improve malaria microscopy diagnosis and surveillance, I recommend that laboratories in different facilities encourage their laboratory staff to participate in external quality assurance and in-service training programs. Furthermore, research should be done by future researchers on External Quality Assurance practices, like cross-checking of results before submission to the physician, which should be highly maintained.

Acknowledgement.
I am thankful to the omnipotent Almighty God for his divine grace, mercy, wisdom, and knowledge that He bestows on me daily. He has enabled me to pursue and finally come to the end of this program.
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Finally, my special thanks to my colleagues and peers for their support, collaboration, and helpful discussions during this journey.

List of abbreviations.
ART – Antiretroviral Therapy
CDC – Centers for Disease Control and Prevention
EQA – External Quality Assurance
HC IV – Health Centre IV
ISO – International Organization for Standardization
MIHS – Mildmay Institute of Health Sciences
QA – Quality Assurance
RDT – Rapid Diagnostic Test
SOPs – Standard Operating Procedures
SPSS – Statistical Package for the Social Sciences
WHO – World Health Organization

Source of funding.
The study was not funded.

Conflict of interest.
There is no conflict of interest.

Availability of data
Data used in this study are available upon request from the corresponding author.

Authors contribution.
MS designed the study, conducted data collection, cleaned and analyzed data, and drafted the manuscript.
FS supervised all stages of the study from conceptualization of the topic to manuscript writing and submission.
AS supervised the entire research process
HN supervised the entire research process
FS supervised the entire research process.
JFN supervised the entire research process.

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