The Influence of Knowledge, Attitudes, and Skills of Malaria Microscopists on the Accuracy of Laboratory Diagnosis Results

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Abstract: Malaria remains a significant public health issue in Indonesia, characterized by high rates of illness and death. Proper laboratory diagnosis is one of the keys to malaria prevention efforts. Malaria microscopists' proficiency, knowledge, attitudes, and skills require regular assessment to maintain diagnostic quality. This study examines the correlation between malaria microscopists' knowledge, attitudes, and competencies and the accuracy of laboratory diagnostic outcomes at the Jayapura City Health Center. This study used quantitative methods with descriptive and verification approaches. Data were collected through questionnaires and laboratory diagnosis results. The study sample was 13 malaria microscopists at the Jayapura City Health Center. The data were analyzed with SPSS software. The results showed that most respondents had a good level of knowledge (76.9%). Almost half of the respondents had a good attitude (46.2%). Most respondents had a sufficient level of skill (61.5%). Interestingly, although most respondents (76.9%) could diagnose malaria very accurately, this study did not find an effect of malaria microscopists' knowledge, attitude, and skills on the accuracy of diagnosis. The knowledge level of malaria microscopists at the Jayapura City Health Center is good, but their attitudes and skills still need to be improved. It is recommended that microscope Officers routinely attend training to improve their knowledge, attitudes and skills.
Keywords: Accuracy of diagnosis; attitude; malaria microscopists; skill.

INTRODUCTION

Malaria is a contagious disease triggered by parasites from the Plasmodium genus. These parasites are passed to humans through the bite of female Anopheles mosquitoes[1]. Based on the 2022 WHO malaria report, there were 247 million malaria cases in 2021, up from 245 million in 2020. The estimated malaria-related deaths were 619,000 in 2021, slightly down from 625,000 in 2020. During the peak of the COVID-19 pandemic (2020-2021), disruptions caused by the pandemic resulted in approximately 13 million additional malaria cases and 63,000 more deaths[2].

Data on malaria cases in Indonesia show that in 2019, there were 250,628 malaria cases; in 2020, there were 226,334 cases; and in 2021, there were 94,610 cases. Papua is still a malaria-endemic area. Based on data from the Papua Province Health Profile in 2019, the Annual Parasite Incidence (API) rate in Papua Province is 64 per 1000

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population, meaning that in 1000 population, there are 64 cases of malaria. Meanwhile, Jayapura City has an API of 95 and a Case Fatality Rate (CFR) of 0.01. This API rate is much higher than the 2019 national rate of 0.93 per 1000 population[3].

The World Health Organization (WHO) advises that all suspected malaria cases should be confirmed through malaria microscopy or a Rapid Diagnostic Test (RDT) before starting treatment[4]. One of the efforts to reduce the mortality and morbidity rate of malaria is with proper laboratory diagnosis. The results of research on the reliability of microscopic diagnosis of malaria in Sawahlunto City, West Sumatra, from the 3 Puskesmas studied, found that Sei Durian, Silungkang, and Talawi were poor, poor, and moderate with Kappanya values of 0.024; 0.008 and 0.442[5]. Therefore, the proficiency of malaria microscopy laboratory personnel, including knowledge, attitudes, and skills, needs to be evaluated to maintain the quality of malaria microscopy laboratory personnel.

The gold standard for confirming a malaria diagnosis is the microscopic examination of thick and thin blood smears. This method is highly accurate, particularly when conducted by skilled and experienced laboratory technicians. Therefore, the reliability of microscopic results heavily depends on the technician's expertise and experience[6].

Competence is a combination of intelligent and responsible actions that qualify an individual to be recognized by society as capable of performing tasks in specific work areas. It encompasses a foundation of personality, mastery of knowledge and skills, workability, and appropriate attitudes and behaviours. These elements align with the individual's level of expertise and understanding of social norms within their chosen field [7].

A person's knowledge about a disease encompasses their comprehension of its causes, signs, symptoms, and methods of prevention or treatment. Their attitude reflects their feelings and beliefs regarding the disease. Lastly, skills are demonstrated through the individual's actions, which are influenced by their understanding and attitude towards the disease[8].

Research conducted by Kotepui et al., 2019 shows that most health workers have good knowledge, attitudes, and practices related to malaria detection[9]. Among various health worker positions, medical technologists have more excellent knowledge of malaria detection than assistant medical technicians or laboratory assistants. Meanwhile, another study by Ismail NE et al. 2019 showed that most respondents (50.5%) had a moderate level of knowledge about malaria and its management[8].

The results of the cross-examination report conducted by the Jayapura city crosschecker in January 2023 at one of the Jayapura city health centres obtained a sensitivity value of 100%, 94% specificity, and 75% species accuracy. In another clinical laboratory in June 2023, the sensitivity value was 50%, specificity 94%, and species accuracy value 0%. The lack of knowledge and skills of malaria microscopy laboratory personnel can cause a lack of sensitivity, specificity, and species accuracy values.

There has been research on the knowledge, attitudes, and good practices of health workers related to malaria detection[9]. However, there are still limited findings on the relationship between knowledge, attitudes, and skills of malaria microscopy officers with diagnostic accuracy. So, this study aims to analyze the relationship between the knowledge, attitudes, and skills of malaria microscopy officers with the accuracy of laboratory diagnosis results at the Jayapura City Health Center.

MATERIALS AND METHODS

A quantitative research approach that utilizes descriptive and verification methods. Descriptive and verification methods are used to determine the accuracy of facts and to explain the relationships between studied variables by collecting, processing, analyzing, and interpreting data through statistical hypothesis testing.This study's data collection technique was to measure the knowledge, attitudes and skills of microscope officers using a Linkert scale questionnaire[8,9].

Knowledge levels are assessed using a Likert scale, which includes both positive questions to gauge positive responses and negative questions to gauge negative responses. Positive questions are scored 5, 4, 3, 2, and 1, while negative questions are scored 1, 2, 3, 4, and 5. The total score in measuring knowledge is 45 points. Respondents with a score of 35-45 are considered to have good knowledge, respondents with a score of 25-.35 are considered to have fair knowledge, and respondents with a score of <25 are deemed to have poor knowledge.

Indicators to measure the attitude of laboratory personnel included time, expertise, cost, and the ability of the blood smear technique to detect malaria. Questions were also asked about detection techniques using other methods, such as rapid diagnosis tests (RDTs) and their comparison with the blood smear technique regarding sensitivity and specificity. The scoring items for the above six questions related to attitude were assessed using a Likert scale. Respondents' agreement levels with statements were scored as follows: strongly agree = 5 points, agree = 4 points, undecided = 3 points, disagree = 2 points, and strongly disagree = 1 point. The maximum possible score was 30. Scores were categorized as poor (< 15), moderate (15 - < 25), and reasonable (25 - 30).

Respondents were evaluated on their malaria detection skills by answering questions or statements regarding Giemsa staining techniques, the quantity of blood used, fixation, staining of white blood cells, the preparation and storage of Giemsa dye, and the process of identifying parasites under a microscope. Each question or statement is given a score for each respondent's answer on a Likert scale. The answer strongly agree is given 5 points, agree 4 points, undecided 3 points, disagree 2 points, and strongly disagree is given 1 point. The maximum total score is 45 points. The assessment of each respondent is based on the number of scores, namely having poor skills if they get a score < 25, moderate skills if they get a score of 25 - < 35, and sound level skills if they get a score of 35 - 45.

To measure the accuracy of laboratory diagnosis results using the results of malaria diagnosis performed by malaria microscopists in the Jayapura City area, ten slides per person were then validated by crosschecker microscopists in Jayapura City. The examination method was randomly selected, with as many as ten slides (representing negative and positive slides) for Health Center, examined by malaria microscopists in the Puskesmas laboratory and re-checked by malaria crosscheckers. This study was conducted at Health Center laboratories in Jayapura City from January to April 2024.

Table 1. Kappa Value Calculation Formula

		Examination II		Total
Examination I	Negative result	A	b	N1
	Positive result	C	d	N2
	Total	N3	N4	N

Description:

Observation score=[(a+b/N] x 100%=x %

Expected value based on needs=[(N3 x N1)/[(N4 x N2)]/Nx100%=y %

Actual value out of necessity= (x-y)%=z %

Potential value beyond basic needs=(100-y) %

Kappa value=(Actual value out of necessity)/(Potential value beyond basic needs) =z/(100-y)

The reliability of the microscopic diagnosis was assessed by calculating the kappa value between the results of two examiners: the malaria microscopy laboratory staff at the health center and the malaria microscopists at the Jayapura city level.

Table 2. Kappa Value

Kappa value	Reability rating
< 0	very bad
0 – 0,20	bad
0,21 – 0,40	less
0,41-0,60	medium
0,61 – 0,80	good
0,81 - 1	Very good

A Kappa value between 0.61 to 1 is considered reliable. The research data were analyzed using SPSS software, which involved statistical tests and hypothesis testing (t-test and F test), as well as multiple linear regression analysis, correlation coefficient, and determination coefficient.

The Jayapura Ministry of Health Polytechnic Health Research Ethics Committee No.205/KEPK/-J/VIII/2023 approved this research.

RESULTS AND DISCUSSION

Data collection through questionnaires obtained the results of characteristics based on age, gender, and Education.

The study's results in Table 3 show that the characteristics of respondents based on age were mainly at the age of 41-50, amounting to 7 people (53.8%); based on gender, most women were nine people (69.2%), and men were four people (30.8%); based on the level of education, the most D3 education was ten people (76.9%). Characteristics of Respondents' Answers to Knowledge (X1), Attitude (X2) and Skills (X3) variables and Accuracy of Results (Y).

The study results in Table 4 obtained the level of knowledge of malaria microscopic laboratory personnel as good as 10 (76.9%), and the level of expertise was sufficient at 3 (23.1%). This study aligns with the research of Addis D et al. (2023), which found that 64.2% of research respondents had good knowledge about malaria[10]. Even research by

Mahmudah NA et al. (2020) shows the results of respondents' responses to knowledge about malaria prevention and control; of the eight respondents, all (100%) had high knowledge[11]. Different research results were conducted by Kotepui et al. (2019) only 27 respondents (22.9%) demonstrated good knowledge, while 88 (74.6%) had adequate knowledge, and 3 (2.5%) had limited knowledge about malaria detection[9]

Table 3. Characteristics by Age, Gender, Education

Variable	frequency	Percentage
Age		
21 - 30	1	7,7
31 - 40	4	30,8
41 - 50	7	53,8
51 - 60	1	7,7
gender		
male	4	30,8
female	9	69,2
Education		
High School	2	15,4
Diploma	10	76,9
Bachelor	1	7,7
Total	13	100

Table 4. Description of Knowledge Variables (X1)

Knowledge Variable (X1)	Frequency	Percentage
Simply	3	23,1
Good	10	76,9
Total	13	100

Table 5. Description of the Attitude Variable (X2)

Attitude Variable (X1)	Frequency	Percentage
Simply	7	53,8
Good	6	46,2
Total	13	100

The study results in Table 5 show that of the 13 respondents with a good attitude, as many as six people (46.2%), while those with a moderate attitude were seven (53.8%). This study aligns with research conducted by Addis et al. (2023). In the overall attitude score, 46.9% of respondents showed a positive attitude, and 53.1% showed a negative attitude[10]. The findings suggest a disparity between the knowledge and attitudes of malaria microscopy laboratory personnel. This gap is believed to stem from various factors, including a cultural environment that is not supportive of malaria control, which means that despite having good knowledge, it does not influence the attitudes of the laboratory staff.

Table 6. Description of Skill Variable (X3)

Skill Variable (X3)	Frequency	Percentage
Simply	8	61,5
Good	5	38,5
Total	13	100

The study's findings are presented in Table 6. show that of the 13 respondents who had good skills, five people (38.5%), while those who had sufficient knowledge were eight people (61.5%). This distribution shows various skills among the respondents, with most showing adequate knowledge and a small proportion showing good skills. This study is consistent with the findings of Addis et al. (2023), which revealed that only 17.3% of participants demonstrated good malaria prevention practices, while 42.7% exhibited poor practice skills[10].

Table 7. Variable Description of Result Accuracy (Y)

Variable Result Accuracy (Y)	Frequency	Percentage
Less	1	7,7
Good	2	15,4
Very good	10	76,9
Total	13	100

The results showed that most respondents, as many as 13 people, had perfect Accuracy of malaria diagnosis results of 10 people (76.9%), good as many as two people (15.4%), while less as many as one person (7.7%), these results indicate that most respondents were able to diagnose malaria very accurately. Several factors, such as the availability of appropriate equipment, reagents, trained personnel, and conducive working conditions, influence the quality of malaria diagnosis. Establishing a dependable laboratory network and implementing a quality management system are crucial for accurate case verification and source tracing in malaria diagnosis[12,14].

The table below shows the partial t-test results for the impact of Knowledge (X1) on the Accuracy of results (Y).

Table 8. T-test of Influence (X1), Attitude (X2), Skills (X3) on Y

	Model	Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	Constant	4.360	1.641		2.657	.026
	Knowledge	.427	.652	.215	.654	.530
	Attitude	-.900	.589	-.537	-1.528	.161
	Skill	.960	.577	.559	1.663	.131

a. Dependent Variable: Accuracy of results

The results of the partial analysis research between the knowledge variable (X1) and the accuracy of malaria diagnosis results using the partial t-test. The results of the t-test statistical test obtained a significance value (sig.) of 0.530> 0.05; it can be concluded that H0 is accepted and H1 is rejected, which means that knowledge (x1) does not affect

the accuracy of the results (y). Although descriptively, the average knowledge level of respondents is good at 76.9%, while the accuracy of laboratory diagnosis results is perfect on average at 76.9%. This study is in line with the research of Zhang X et al. (2023) that the level of knowledge of laboratory technicians in malaria microscopic examination may not directly impact the accuracy of diagnosis[15]. However, research by Kotepui et al., 2019 states that laboratory personnel's knowledge, attitudes, and practices related to malaria detection are essential for accurate diagnosis[9]. The quality of microscopic diagnosis is also influenced by various factors such as slide preparation, staining methodology, microscopist skills, and the quality of the microscope used[16].

According to the t-test results in Table 8, the t value for the attitude variable (X2) is -1.528, while the critical t value is 2.20. This indicates that the calculated t value of -1.787 is less than the critical t value of 2.201. Therefore, the null hypothesis (H0) is accepted, and the alternative hypothesis (H1) is rejected, meaning that attitude (X2) does not affect the accuracy of the results (Y). With the significance value (sig.) of 0.161> 0.05, it can be concluded that H0 is accepted and H1 is rejected, which means that attitude (x2) does not affect the accuracy of the results (Y). The results of the partial analysis research between the attitude variable (X2) and the accuracy of the results of malaria diagnosis found no influence between attitude (X2) and the accuracy of the results (Y). This study differs from that conducted by Omondi CJ et al. 2023 in which accurate diagnosis and timely treatment are fundamental to effectively managing this disease[17]. Positive behavioural changes related to good laboratory practices, quality management systems, and attitudes towards laboratory practices, in general, have been associated with increased accuracy and reliability of diagnosis[18].

According to the t-test results in Table 8, the calculated t-value is 1.663, less than the critical t-value of 2.201. This indicates that the null hypothesis (H0) is accepted and the alternative hypothesis (H1) is rejected, suggesting no significant effect of Skills (X3) on the accuracy of the results (Y). Additionally, with a significance value (sig.) of 0.131, which is greater than 0.05, it further confirms that Skills (X3) do not influence the accuracy of the results (Y). The results of the partial analysis research between the skill variable (X3) and the accuracy of the results of malaria diagnosis found no influence between Skills (X3) on the accuracy of the results (Y). Certification and competency assessment are essential to ensure microscopists have the necessary skills for accurate malaria diagnosis[19]. Skills training of Plasmodium microscopists has been shown to significantly improve species identification accuracy in malaria diagnosis[20].

The simultaneous test (F test) determines whether the independent variables (knowledge, attitudes, and skills) simultaneously affect the dependent variable (accuracy of results).

Table 9. Results of the Coefficient of Determination Test

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.558[a]	.312	.082	.833
a. Predictors: (Constant), Skills, Knowledge, Attitude				

In the summary model, the Adjusted R square value is 8.2%, meaning that the equation obtained can explain that the knowledge, attitude, and skills variables only affect 8.2%. In comparison, the remaining 92.8% is explained by other variables not examined.

Table 10. F Test Results

Model	Sum of Squares	df	Mean Square	f	Sig.
			ANOVA[a]		
Regression	2.830	3	.943	1.359	.316[b]
Residual	6.247	9	.694		
Total	9.077	12			
a. Dependent Variable: Result Accuracy					
b. Predictors: (Constant), Skills, Knowledge, Attitude					

An equation is suitable for use if the p-value in the F test is <0.05. In this F test, the p-value is 0.316> 0.05, meaning knowledge, attitudes, and skills do not affect the accuracy of malaria diagnosis results. The results of the simultaneous F-test study found no effect of knowledge, attitudes, and skills on the accuracy of malaria diagnosis. Factors such as microscopist refresher training, work experience, and participation in quality assurance programs are significantly associated with accurate malaria diagnosis[21]. To improve the accuracy of malaria diagnosis, it is recommended that microscopist refresher training be conducted more frequently and routinely, given its significant effect on diagnosis results.

One of the main drawbacks is the need for more generalizability of the results. Microscopic samples are often very limited in their representation of the wider population, so the results obtained may not apply to other conditions or situations outside the context of the study. This may reduce the external validity of the research findings.

CONCLUSION

The knowledge, attitude, and skills of malaria microscopists do not affect the accuracy of laboratory diagnosis results at Health Center in the Jayapura City area. Therefore, it is recommended that microscope officers routinely attend training to improve their knowledge, attitudes and skills.

ACKNOWLEDGEMENT

CONFLICT OF INTEREST

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