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ORIGINAL

Evaluation of Environmental Health Literacy in High School Students Regarding Environmental Management Aspects for Malaria Vector Control Instrument Development and Validation

Evaluación de la Alfabetización en Salud Ambiental en Estudiantes de Secundaria sobre Aspectos de Gestión Ambiental para el Desarrollo y Validación de un Instrumento de Control del Vector de la Malaria

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ABSTRACT

Introduction: this study aims to develop and validate an instrument to evaluate EHL related to environmental management practices for malaria vector control among high school students.
Method: this study used a cross-sectional design with samples of high school students selected through Multistage Random Sampling in five schools. The sample size was determined based on the ratio of ten respondents per item. A total of 387 questionnaires were returned with a response rate of 77,4 %. After eliminating 36 multivariate outliers, 351 questionnaires were further analyzed.
Results: the initial instrument consisted of 39 items evaluated by seven expert panelists (I-CVI: 0,86–1,00; S-CVI/AVE: 0,92). Five items with I-CVI < 0,78 were removed, and three items were revised based on face validity. EFA with varimax rotation identified five factors explaining 53,57 % of the total variance. The CFA results showed a good fit model (CMIN/df: 1,824; RMSEA: 0,049; RMR: 0,03; TLI: 0,931; CFI: 0,937). The final instrument included 28 items in four main domains: knowledge (factual and conceptual), information skills, attitudes, and environmental management practices.
Conclusions: the developed instrument showed good validity and reliability in evaluating EHL on the dimensions of knowledge, information skills, attitudes, and environmental management practices in high school students.

Keywords: Environmental Health Literacy; Disease Vectors; Malaria; High School Students; Instrument Development.

RESUMEN

Introducción: este estudio tiene como objetivo desarrollar y validar un instrumento para evaluar la alfabetización en salud ambiental (ASA) relacionada con las prácticas de gestión ambiental para el control del vector de la malaria en estudiantes de secundaria.
Método: se utilizó un diseño transversal con muestras de estudiantes de secundaria seleccionados mediante muestreo aleatorio por etapas múltiples en cinco escuelas. El tamaño de la muestra se determinó en base a

una proporción de diez encuestados por ítem. Se devolvieron 387 cuestionarios, con una tasa de respuesta del 77,4 %. Tras eliminar 36 valores atípicos multivariados, se analizaron 351 cuestionarios.
Resultados: el instrumento inicial constaba de 39 ítems, evaluados por siete panelistas expertos (I-CVI: 0,86–1,00; S-CVI/AVE: 0,92). Se eliminaron cinco ítems con I-CVI < 0,78 y se revisaron tres ítems según la validez aparente. El análisis factorial exploratorio (AFE) con rotación varimax identificó cinco factores que explicaban el 53,57 % de la varianza total. Los resultados del análisis factorial confirmatorio (AFC) mostraron un buen ajuste del modelo (CMIN/df: 1,824; RMSEA: 0,049; RMR: 0,03; TLI: 0,931; CFI: 0,937). El instrumento final incluyó 28 ítems en cuatro dominios principales: conocimiento (factual y conceptual), habilidades de información, actitudes y prácticas de gestión ambiental.
Conclusiones: el instrumento desarrollado mostró buena validez y confiabilidad para evaluar la ASA en las dimensiones de conocimiento, habilidades de información, actitudes y prácticas de gestión ambiental en estudiantes de secundaria.

Palabras clave: Alfabetización en Salud Ambiental; Vectores de Enfermedades; Malaria; Estudiantes de Secundaria; Desarrollo de Instrumentos.

INTRODUCTION

Malaria remains a global public health challenge that has a significant impact on morbidity, mortality, and economic productivity. In 2022, there are an estimated 249 million cases of malaria in 85 endemic countries, an increase of 5 million cases compared to 2021. Globally, malaria deaths have decreased from 864 000 cases in 2000 to 608 000 cases in 2022. Although progress has been made in malaria control efforts globally, challenges such as increasing cases in certain regions, as well as environmental changes are factors that affect the effectiveness of disease control strategies.[1]

Indonesia is one of the countries in Southeast Asia that still faces serious challenges in malaria control efforts.[2] Data from the Ministry of Health recorded an increase in cases from 304 607 cases in 2021 to 418 546 cases in 2023, with Papua Province contributing around 89 % of the total national cases. The student group is one of the most affected, accounting for 22,53 % of all malaria sufferers.[3]

Various strategies have been implemented to control malaria, including chemical, biological, and environmental methods.[4] The World Health Organization (WHO) recommends the use of long-lasting insecticide-treated bed nets (LLINs) and indoor residual spraying (IRS) as the main strategies in malaria control.[5] However, increasing mosquito resistance to insecticides and high rates of outdoor transmission have reduced the effectiveness of this method.[4]

In response to these challenges, environmental management approaches have gained attention as a companion to existing control methods.[4,6] This method aims to inhibit the development of mosquitoes by changing the ecosystem to be less supportive of the malaria vector life cycle.[6] Previous studies have shown that environmental management is effective in reducing malaria incidence sustainably, while minimizing the ecological impacts of chemical-based interventions.[7,8] In addition, environmental management can contribute to local self-reliance by utilizing local resources and knowledge in malaria control efforts.[9]

Environmental factors play an important role in the spread of malaria, with approximately 42 % of the global burden of the disease being caused by modifiable environmental factors.[9] In this context, Environmental Health Literacy (EHL) is a very relevant concept in supporting malaria control efforts. EHL is a concept that developed from an understanding of the relationship between environmental exposure and its impact on human health.[10] This lack of understanding results in an inability to prevent or address health risks due to environmental factors.[11]

Health Literacy (HL) is often associated with low awareness and adherence to disease prevention measures, including malaria.[12] Increasing HL can contribute to behavioral change and elimination of environmental health disparities.[11,12] Studies show that in developed countries such as Europe, only about 67,2 % of students have moderate HL levels, despite relatively adequate access to health information.[13] In developing countries, the challenges are greater, with the majority of adolescents showing low HL levels.[13,14] In Indonesia, based on a survey conducted by Candrakusuma et al.[14], it was found that the functional literacy of Senior High School (SMA) students that was likely sufficient was only 24,57 %. This condition indicates the need for more systematic interventions to improve HL among school students.

Increasing EHL can be a key strategy in environment-based malaria control, especially for adolescents. The epidemiological transition of malaria shows that malaria cases in older children in several countries have increased significantly.[15,16,17] In addition, most school-age children who are infected with malaria are asymptomatic, thus acting as a persistent reservoir of infection. Therefore, malaria intervention and prevention in school-age children can reduce the burden of malaria in this age group and become a key intervention to reduce global malaria transmission.[15,17]

The development of valid and reliable measurement scales is a fundamental step in assessing and improving EHL, both at the individual and community levels.[10,12] In recent years, various EHL measurement instruments have been developed based on theories and models of behavior change.[18] For example, Lichtveld et al.[19] developed an EHL scale that covers aspects of knowledge, attitudes, and behaviors toward various environmental media such as air, food, and water in graduate and undergraduate students. Kwak et al.[20] then adapted the scale into a Korean version (K-EHL). Other studies have examined the relationship between EHL dimensions, such as perceptions and beliefs, and protective behaviors toward environmental health risks.[21] However, so far there has been no scale specifically designed to evaluate EHL in high school students in the context of environmental management for malaria control. Specific HL measurements would provide more specific knowledge and reasoning about the disease that would allow for the implementation of appropriate strategies to address the disease.[22]

Framework Knowledge, Attitude, and Practice (KAP) has been used in various studies to assess community understanding regarding malaria control, especially in Eastern Indonesia.[23,24] However, this model has not optimally integrated the EHL dimensions that include skills in accessing environmental information, understanding the relationship between environmental exposure and health, and the ability to make appropriate decisions to reduce environmental exposure.[25] In addition, existing studies only focus on the adult population, while attention to adolescent groups is still limited. In fact, adolescents are a high-risk group, but have not been a priority in malaria control efforts.[15,17]

Objectives

This study aims to develop and validate a survey instrument to evaluate EHL in high school students in the context of environmental management as a sustainable malaria vector control strategy. The evaluation includes aspects of knowledge, skills, attitudes, and practices in environmental management. This is useful for collecting important information in designing control interventions, so as to ensure participation, acceptance, and compliance and become the basis for developing environmental health education interventions in schools for sustainable malaria control .

METHOD

The development and validation of this instrument was carried out in March – July 2024 in two phases.

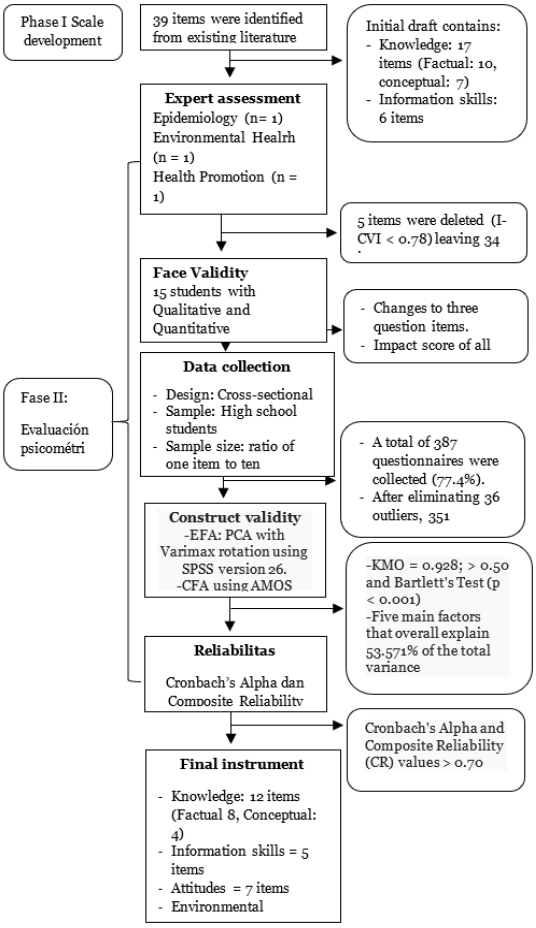

Figure 1. Instrument Development Flowchart

Conceptual framework

EHL is a key element in understanding the relationship between environmental exposures and public health.[10,26] As a multidimensional concept, EHL encompasses the understandings, attitudes, and actions that influence individuals and communities to use environmental information in making health-related decisions.[25] Adequate knowledge enables individuals to understand the various risks they face, thus having the capacity to make more appropriate decisions to minimize the health impacts of environmental factors.[10]

Environmental knowledge is one of the foundations of EHL, consisting of several dimensions including factual and conceptual dimensions.[27,28] Factual knowledge focuses on basic information about environmental factors that affect human health, while conceptual knowledge emphasizes the interconnectedness of ecosystems and their impacts on quality of life, including awareness of collective responsibility in reducing environmental risks.[11,27,29] Integration of different types of knowledge not only supports a deeper understanding of environmental impacts on health but also motivates more scientific behavior, including among students.[30]

In addition to knowledge, information skills play an important role in assessing and managing environmental health risks. The ability to find, understand, and evaluate relevant information enables individuals to sort valid data, support learning processes, and improve the effectiveness of decision-making.[10,31] In the context of education, mastery of these skills facilitates the dissemination of accurate information and evidence-based decision-making.[31]

In addition to knowledge and skills, individual attitudes also influence the effectiveness of EHL implementation. Positive attitudes encourage proactive responses to environmental health challenges, strengthen collective awareness, and motivate active participation in environmental risk management.[25] These attitudes are then reflected in real behavior, where individuals who understand EHL can promote environmental management practices and influence communities to adopt actions that support sustainable health.[10,25,32]

Thus, the combination of in-depth knowledge, adequate information skills, and positive attitudes can empower individuals, including students, as agents of change. They are not only able to manage environmental health risks independently, but also contribute to collective efforts in creating a healthier and more sustainable environment.[31]

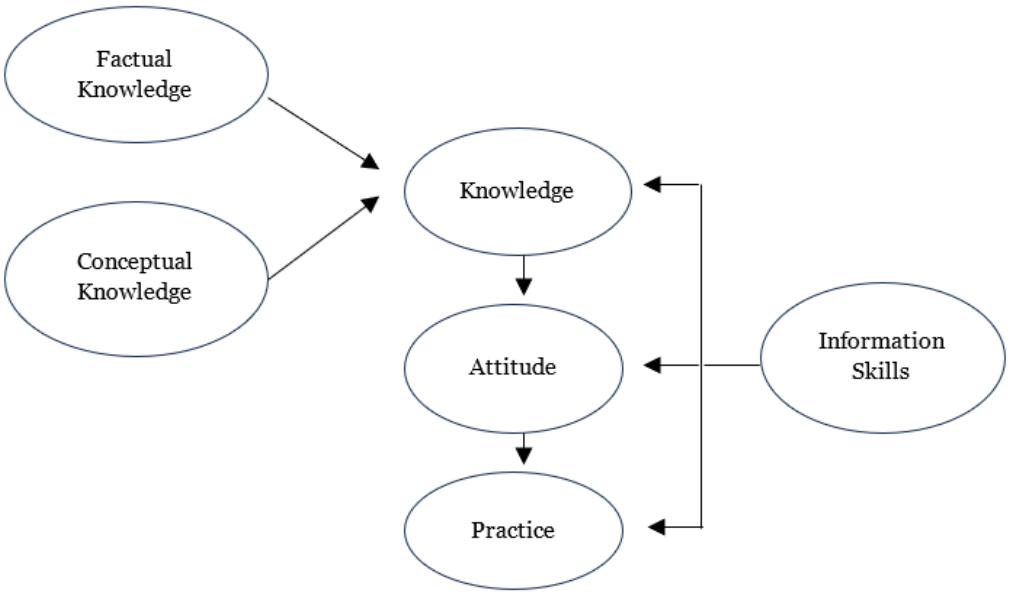

Figure 2. Conceptual framework for instrument development

First phase

Item creation

The instrument developed in this study is based on a deductive approach by referring to theoretical reviews and existing scales.[33] Items are created in four domains of knowledge, information skills, attitudes, and environmental management practices, with the knowledge variable containing two subsections, namely factual knowledge and conceptual knowledge.

Knowledge is defined as students' understanding of the causes and bionomics of malaria vectors, while conceptual knowledge refers to the understanding of the relationship between environmental exposure and health, including awareness of collective responsibility in mitigating malaria risk. Information skills are defined as students' ability to find, understand, and assess information on the influence of the environment on malaria incidence. Attitude is defined as students' assessments that include beliefs, feelings, and intentions to act to manage the environment to prevent malaria. Practice is defined as real actions taken by students, both

individually and collectively, in environmental management as an effort to prevent malaria.

Instrument uses a five-point Likert Scale to measure each construct. The scale varies according to the nature of the construct being measured, for example, the response scale for environmental management practice items ranges from "very often" to "very never", while for other constructs the scale ranges from "strongly agree" to "strongly disagree". The initial items were selected and adapted from several sources. The conceptual knowledge and information skills items underlying EHL were obtained from several sources, including.[11,34] Factual knowledge, attitudes and behavior of environmental management were obtained from [4,6,42,9,35,36,37,38,39,40,41] categorized based on the domains of factual knowledge, attitudes and practices. Several items that were repetitive and irrelevant to environmental management for malaria control were removed.

After the selection process and elimination of less relevant items, the initial instrument consisted of 39 items distributed in five latent constructs. This distribution includes 10 items for factual knowledge, seven items for conceptual knowledge, six items for information skills, nine items for attitudes, and seven items for practices. This instrument structure is expected to produce valid and reliable measurements in measuring factors that contribute to environmental management behavior for malaria control in students.

Second phase

To assess the psychometric properties of this instrument, a series of analyses were carried out, such as: content validity, face validity, construct validity and reliability.

Validity of content

Validity aims to evaluate the relevance of each item in the measurement instrument.[43,44] A total of seven experts were appointed based on expertise in Epidemiology, Environmental Health, Health Promotion, Entomology, Ecology, and two malaria program personnel.[44,45] The experts assessed the relevance of the items using a four-point Likert scale, which was then dichotomized into relevant and irrelevant categories.[44]

Evaluation was conducted using the Item-Content Validity Index (I-CVI) and Scale-Content Validity Index (S-CVI), where I-CVI above 0,78 is considered good, while S-CVI/Ave more than 0,90 is categorized as very good.[43] Inter-rater consistency was examined using a modified Kappa statistic to ensure agreement between raters. Kappa values of more than 0,74 are considered very good, while values between 0,60 and 0,74 are considered good.[43] This approach ensures that the instrument has high content validity, increasing resolution in the measurement of the concept being studied.[43]

Face validity

Validity ensures the clarity and relevance of items in a measurement instrument before being used in a survey.[44] This evaluation reduces the potential for misinterpretation and improves respondents' understanding of the instrument. The test was conducted qualitatively and quantitatively involving 15 high school students who had characteristics comparable to the target population.[33] The sample was selected using convenience sampling to identify potential ambiguities. Quantitative assessments used a 5-point Likert scale, where a score of 5 indicates the highest level of importance ("very important"), and a score of 1 indicates the lowest level of importance ("very unimportant"). Impact scores were calculated based on frequency and importance. An item was considered to have met face validity if its impact score exceeded 1,5.[44]

Construct validity and reliability

Design and data collection

Study used a cross-sectional design to assess the construct validity and reliability of the developed instrument. The sample consisted of high school students aged 15–18 years in Jayapura City, Papua Province, Indonesia. The determination of the sample size was based on the minimum ratio of the number of items to responses, which was one item to ten responses.[33] The number of items in this instrument after assessing content validity and face validity was 34 items so that a minimum of 340 respondents were needed. The sample selection used the Multistage Random Sampling method based on the administrative area of the sub-district. Of the five sub-districts, each was represented by one randomly selected school. The selection of respondents in each school was carried out using proportional random sampling.

Study did not involve 10th grade students because they had just transitioned from Junior High School (SMP) at the time of data collection. The inclusion criteria in this study included 11th and 12th grade students who were actively enrolled in the selected schools and were willing to be respondents. There were no specific exclusion criteria in the selection of this study sample.

Collection was conducted using instruments that had been tested for content validity and face validity, with questionnaire distribution facilitated by the principal and designated teachers. The study protocol was explained in detail to teachers to ensure compliance with the research design. Respondents were given clear instructions regarding completing the questionnaire and were asked to return it immediately upon completion.

Data processing and analysis

Pre-analysis

Each questionnaire that met the requirements through visual inspection was entered into Epi-data 4.6 and then exported to SPSS 26. Multivariate normality test was conducted through multivariate kurtosis value with a maximum Critical Ratio (CR) limit = 5.[46] If this assumption was not met, the data was transformed into normal score.[47] Multivariate outliers were tested using Mahalanobis Distance, where data were considered to be free of outliers if the Chi-square probability value was > 0,001.[48] Common Method Bias (CMB) was examined using Harman's Single Factor Test, with the criterion of total single factor variation < 50 %.[49]

Construct validity and instrument reliability

EFA was used to identify the initial factor structure based on the theoretical approach underlying the development of the instrument.[50] This analysis was conducted using Principal Component Analysis (PCA) with Varimax rotation using SPSS software version 26. Evaluation of sample adequacy was conducted through the Kaiser-Meyer-Olkin (KMO) index with a minimum limit of 0,50, as well as Bartlett's Test of Sphericity to assess the adequacy of correlations between indicators. Factor Loadings (FL) were used to measure the contribution of indicators to the latent construct, with a minimum value of 0,50 as the acceptance criterion.[50]

After the initial structure was obtained, CFA was conducted to confirm the suitability of the factor structure based on theory.[47] This analysis used AMOS software version 23,0 with main indicators such as FL and Variance Extracted (VE). A minimum FL value of 0,50 ensures the contribution of the indicator to the latent construct, while VE with a value above 0,50 indicates that the proportion of variance explained by the latent construct is sufficient.[50]

The fit of the model to the empirical data was evaluated using the Goodness of Fit (GOF) index, including Chi-Square (CMIN) with p-value > 0,05, the ratio of Chi-Square to degrees of freedom (CMIN/df) < 5, Root Mean Square Error of Approximation (RMSEA) < 0,08, Tucker Lewis Index (TLI) > 0,90, Comparative Fit Index (CFI) > 0,90, and Root Mean Square Residual (RMR) < 0,05.[51,52]

Discriminant validity

Discriminant validity testing was carried out using the Heterotrait-Monotrait Ratio (HTMT) to assess the extent to which the constructs in the model have clear differences from each other. If the HTMT value <0,90 indicates that the discriminant validity is accepted.[53]

Reliability

Instrument reliability is assessed based on internal consistency, which reflects the homogeneity of items in a scale.[54] Instrument reliability is measured by Composite Reliability (CR) or Cronbach's Alpha, with a value ≥ 0,70 as an indicator of good internal consistency.[53]

Ethics statement

Committee, Faculty of Public Health, Hasanuddin University approved this study through Ethics Approval Recommendation Number: 86/UN4.14.1/TP.01.02/2024.

RESULTS AND DISCUSSION

Results

The purpose of the study was explained to the participants, written consent was obtained from all participants through informed consent as evidenced by signature. The purpose of the study was explained on the questionnaire and there was no coercion for participants to be willing to participate in the study. Participants were also informed that they had the full right to refuse to participate or withdraw from the study at any time. Confidentiality was maintained by using codes instead of participant names.

The results of this study are presented in two parts, namely: 1) psychometric properties; and 2) participant demographics.

Validity of Content

Of the 39 initial items assessed, five items were removed because they had an I-CVI value of less than 0,78. After removing irrelevant items, 34 items remained. The I-CVI values of these items ranged from 0,86 to 1,00 with an S-CVI/AVE of 0,92. The modified Kappa statistical results showed a very good level of agreement (0,85 to 1,00).

Face Validity

The evaluation of face validity was conducted qualitatively and quantitatively. Qualitatively, three items needed revision because they were considered unfamiliar terms, too broad in scope and poorly understood. For example, the word "vector" was considered unfamiliar to students so it was changed to "insects or other animals that carry diseases". Quantitatively, all items obtained an impact score > 1,5 so no items were deleted.

Construct validity and reliability

Pre-analysis

A total of 387 questionnaires were returned by participants with a response rate of 77,4 %. After eliminating 36 outliers, 351 questionnaires were further analyzed. The normality test showed that the data were not normally distributed (kurtosis = 61,167, CR = 11,581 > 5), so the analysis used bootstrapping. The CMB test with Harman's Single Factor Test showed a single factor variance of 30,22 % (<50 %), indicating no common method bias.

Exploratory Factor Analysis (EFA)

Table 1. Factor loading matrix

Items	Component				
	FK	AT	EM	CK	IS
PD1	0,722				
PD2	0,722				
PD3	0,703				
PD4	0,698				
PD5	0,679				
PD6	0,661				
PD7	0,713				
PD8	0,699				
PD9	0,279			0,319	
PK1				0,679	
PK2				0,742	
PK3				0,717	
PK4				0,696	
KT1					0,621
KT2					0,637
KT3					0,675
KT4					0,747
KT5	0,57				0,255
SK1		0,738			
SK2		0,721			
SK3		0,76			
SK4		0,736			
SK5		0,729			
SK6		0,134			
SK7		0,549			
SK8		0,386			0,319
SK9		0,611			
TD1			0,726		
TD2			0,759		
TD3			0,414		
TD4			0,377		
TD5			0,295		
TD6			0,737		
TD7			0,596		

Note: FK: factual knowledge, AT: Attitude, EM: environmental management, CK: conceptual knowledge, IS: information skills.

The results of the Kaiser-Meyer-Olkin test (KMO = 0,928; > 0,50) indicate the adequacy of the sample size and Bartlett's Test of Sphericity (x^2 = 5168,21; df = 561; p < 0,001) indicate the adequacy of the correlation between indicators. EFA with varimax rotation identified five main factors explaining 53,571 % of the cumulative variance. Several indicators were found to have FL below 0,50, indicating a possible correlation with other variables. However, all items were retained for further analysis using CFA to obtain a more natural factor structure and ensure more precise and valid results.[55]

Factual knowledge includes nine items measured by questions such as "Malaria is caused by Plasmodium infection, which is transmitted through the bite of female Anopheles mosquitoes" and "Anopheles mosquitoes can bite both inside and outside the home". Conceptual knowledge includes four items measured by questions such as, "The environment is a medium for transmitting diseases through water, food, disease-carrying insects" and "Maintaining a healthy environment is the responsibility of individuals, communities, and the government together". Information skills include five items measured by questions such as "I am able to find information about the influence of the environment on malaria" and "I can discuss malaria control strategies with health workers and teachers to reduce the risk of malaria".

Attitudes include nine items measured by questions such as, "Malaria control will not be effective without environmental management efforts" and "Environmental management must be carried out continuously and consistently to prevent malaria". Environmental management practices include seven items measured by questions such as, "I routinely carry out environmental management that is appropriate to the conditions of my house and environment to prevent malaria" and "I routinely participate and invite others to work together to clean the environment to eliminate mosquito nests and breeding grounds".

Confirmatory Factor Analysis (CFA)

Initial CFA showed six invalid items (FL < 0,50) and were removed. The re-estimation results of the CFA model showed 28 valid items with FL > 0,50. Although KT5 in the EFA test appeared to correlate more strongly with the factual knowledge variable, however, when the CFA test was conducted, the KT5 indicator was able to correlate quite strongly with KT1-KT4 with LF: 0,548. These results confirm that the KT5 measurement theory can still be used as an instrument to measure information skills. Furthermore, the convergent validity indicated by the Variance Extracted (VE) was also accepted, indicating that there was a strong correlation between indicators in measuring the same variable. The resulting VE value was > 0,50.

Table 2. Summary of CFA Results

Dimensions	Number of Items	FL min	FL max	Cronbach's Alpha	Construct Reliability	Variance Extraction
KN						
FK	7	0,685	0,755	0,883	0,766	0,621
CK	4	0,703	0,746			
IS	5	0,548	0,771	0,835	0,840	0,515
AT	7	0,618	0,771	0,873	0,875	0,500
EM	4	0,717	0,790	0,831	0,833	0,555

Note: KN: Knowledge; FK: Factual knowledge; CK: Conceptual knowledge; IS: Information Skills; AT: Attitude; EM: Environmental management practices

This study confirmed the initial factor structure developed, where items can be grouped into four main domains: knowledge (factual and conceptual knowledge), information skills, attitudes, and environmental management practices. The developed measurement model showed good validity and reliability.

Goodness of Fit Model Evaluation

Evaluation shows that although the Chi-Square value (CMIN = 623,733; df = 342, p < 0,05) indicates a model that does not fit the empirical data. However, considering that the Chi-Square test is very sensitive to sample size and model complexity, an alternative evaluation is carried out using the ratio between Chi-Square and degrees of freedom (CMIN / df).[52] The alternative test using the ratio of Chi-Square to degrees of freedom (CMIN / df = 1,824) shows a good fit model.[51] Other indices are shown in table 3.

Table 3. Evaluation of Goodness of Fit Model

GOF Index	Mark	Fit Criteria
CMIN/df	1,824	< 5 (fit)
RMSEA	0,049	< 0,08 (fit)
RMR	0,03	< 0,05 (good)
TLI	0,931	> 0,90 (good)
CFI	0,937	> 0,90 (good)

Discriminant Validity

HTMT analysis shows the correlation value between variables is less than 0,90, indicating that the constructs have clear differences from each other (table 4).

Table 4. Discriminant validity of the instrument

	KN	IS	AT	EM
KN	0,788	0,625	0,608	0,469
IS	0,638	0,718	0,652	0,602
AT	0,675	0,630	0,707	0,500
EM	0,533	0,591	0,493	0,745

Note: KN: Knowledge; IS: Information Skills; AT: Attitude; EM: Environmental management practices

Reliability

Cronbach's Alpha and Composite Reliability (CR) values for all constructs exceeded 0,70, indicating good reliability (table 2).

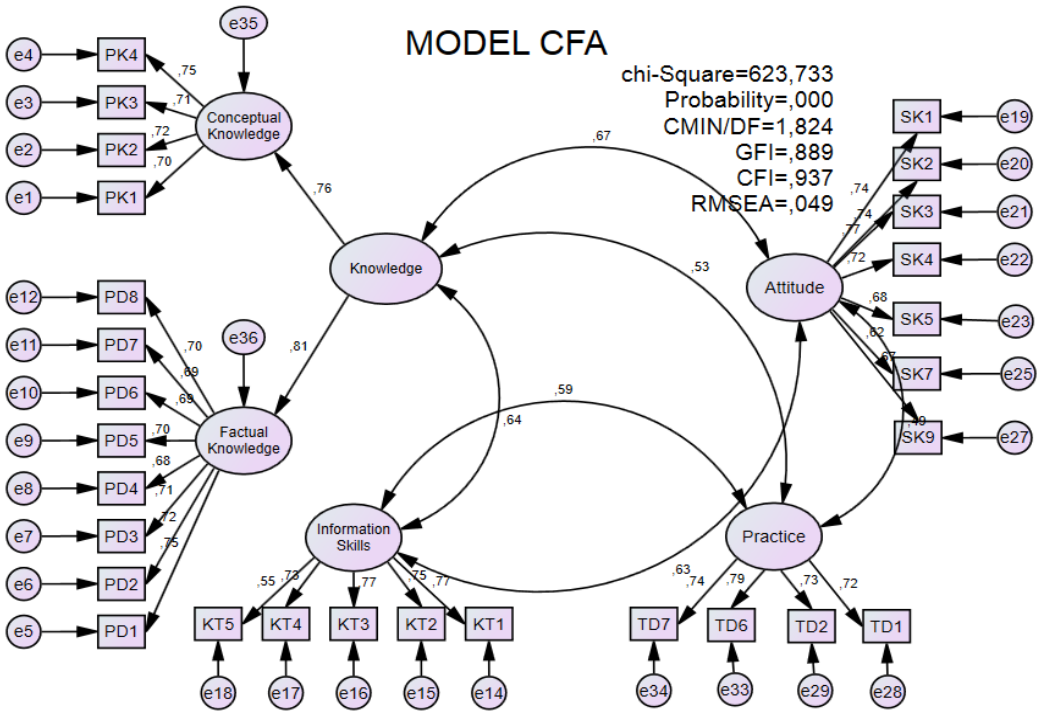

Figure 3. Confirmatory factor analysis model of instrument

Respondent demographics

Study involved 351 respondents with a mean age of 16,50 years (SD = 0,671). Respondents consisted of 147 males (41,9 %) and 204 females (58,1 %). A total of 51,3 % of respondents reported having suffered from malaria. Other demographic characteristics are summarized in table 5.

Table 5. Demographic characteristics of respondents

Demographic characteristics	n	%
Age (years)		
15	16	4,6
16	164	46,7
17	152	43,3
18	19	5,4
Class		
Grade 11	187	53,3
Grade 12	164	46,7
Gender		
Man	147	41,9
Woman	204	58,1
Parents' job		
ASN/TNI/Polri	123	35,0
Private employees	87	24,8
Self-employed	80	22,8
Farm/Gardening	19	5,4
Laborers and other daily jobs	42	12,0
History of suffering from malaria		
Once	180	51,3
Never	171	48,7

DISCUSSION

Study aims to develop and assess the validity of an instrument to evaluate EHL in high school students in the dimensions of knowledge, information skills, attitudes, and environmental management practices for malaria vector control. The development and assessment of the instrument were carried out in two stages, namely the development of a scale carried out using the deductive method[33] and psychometric evaluation to ensure its validity and reliability.

Based on the literature review, 39 items were obtained which were categorized into five main domains: factual knowledge, conceptual knowledge, information skills, attitudes, and environmental management practices. All items used a five-point Likert scale to measure respondents' responses.

Validity was assessed by seven expert panelists through I-CVI. Five items with I-CVI < 0,78 were eliminated, resulting in I-CVI values ranging from 0,86–1,00 and S-CVI/Ave of 0,92. The results of the Kappa analysis showed a very good level of agreement (0,85–1,00).[43] Face validity was tested qualitatively by involving 15 students who had similar demographic characteristics to the target population, resulting in three revised items. Quantitative evaluation showed that all items had an Impact Score above 1,5, making them suitable for use.[44]

Results identified five main factors explaining 53,57 % of the total variance. This finding is in line with the classification of Chinese Citizens' Health and Environmental Literacy.[34,56] And in line with the findings of Mahat[28] in the study of Development of Environmental Awareness Measurement Tools Through Sustainable Development Education, where knowledge can be divided into several subconstructs. In addition, it is also consistent with research by Lichtveld et al.[19] who have developed the General EHL Scale and specific knowledge, attitudes and behavior of environmental media, showing that the three factors (knowledge, attitudes and behavior) form different constructs.

Although face validity has been conducted, the results of the initial CFA analysis showed that six indicators had FL <0,50, namely PD9 (FL: 0,349), SK6 (FL: 0,274), SK8 (FL: 0,447), TD3 (FL: 0,167), TD4 (FL: 0,249), and TD5 (FL: 0,146). This low FL value may indicate ambiguity in understanding the item, limited relevance of the item to the construct being measured, or the possibility of the existence of multidimensional aspects in the item.[57] In addition, the level of experience and understanding of respondents regarding the measurement context can also affect the validity of the indicators.[58]

For example, item PD9, which focuses on the responsibility of environmental management in malaria prevention, requires active involvement from individuals, communities, and governments together. The analysis results showed that this item was correlated with other factors, such as conceptual knowledge, indicating

overlap between constructs. Similarly, items SK6 and SK8, which measure attitudes toward environmental management costs and the negative impacts of malaria control methods, showed low FL values, which is likely due to respondents' limited experience in making decisions related to financial aspects and understanding of the long-term effects of insecticide use in malaria vector control.[59,60]

In the domain of environmental management practices, three invalid items were also found. The three items theoretically measure behavioral modifications to prevent mosquito bites, namely the use of mosquito nets (TD3), wearing long-sleeved clothing (TD4), and limiting outdoor activities at night (TD5). The low FL on the three items was due to the minimal variation in responses, which was likely due to the low experience of these practices among the majority of students. These results are supported by previous studies showing that awareness and practices of individual protection against malaria in adolescents are relatively low.[61,62]

After the removal of six invalid indicators, re-CFA analysis showed that the remaining 28 items had good validity, with FL of all items above 0,50 and VE value more than 0,50. These results indicate a strong correlation between indicators in measuring the same variable. The confirmed factor structure consists of seven factual knowledge items, four conceptual knowledge items, five information skills items, seven attitude items, and four environmental management practice items.

The reliability of the instrument was tested using Cronbach's Alpha and CR, with a value of more than 0,70, indicating good internal consistency. Discriminant validity was tested using HTMT showing a value below 0,90 indicating that each construct has a clear difference from each other.

Evaluation Goodness of Fit (GOF) shows that although the Chi-Square (CMIN) value has a p-value < 0,05, which indicates a difference between the model and the data, the alternative test shows good results . The CMIN/df value of 1,824 < 5 indicates a fit model.[51] Other indicators also confirm the model's fit with empirical data, such as RMSEA = 0,049 (<0,08); RMR = 0,03 (<0,05); and TLI = 0,931 and CFI = 0,937 (both >0,90), indicating that the model has a very good fit.[47,51,52,53,54,55,56,57,58,59,60,61,62]

Given the increasing prevalence of malaria in school-age children, especially in older age groups, and their role as persistent reservoirs of infection, a more comprehensive approach to control efforts is needed.[15,16,17] Interventions targeting this age group have the potential not only to reduce the burden of malaria in school-age children but also to contribute to the control of malaria transmission globally.[15,17]

Increasing EHL can be a key strategy in environment-based malaria control, especially for adolescents. The epidemiological transition of malaria shows that malaria cases in older children in several countries have increased significantly.[15,16,17] In addition, most school-age children who are infected with malaria are asymptomatic, thus acting as a persistent reservoir of infection. Therefore, malaria intervention and prevention in school-age children can reduce the burden of malaria in this age group and become a key intervention to reduce global malaria transmission.[15,17]

Study has several limitations. First, the geographical coverage is limited to areas with high malaria endemicity, so generalization to areas with low endemicity levels needs to be done with caution. However, this coverage is also an advantage because it allows for a more contextual analysis. Second, the study sample consisted only of high school students, so it does not reflect EHL in other age groups. Third, the use of the same sample for EFA and CFA analyses may increase the risk of bias in the resulting factor structure, thereby reducing the generalizability of the model.[63]

Therefore, further research is recommended involving a wider population and diverse social, cultural and environmental characteristics including areas with lower malaria endemicity. In addition, the use of a larger sample size needs to be considered so that EFA and CFA analyses can be conducted independently and can accommodate more EHL dimensions. Thus, this instrument can continue to be developed to support sustainable malaria control efforts.

CONCLUSIONS

This study provides evidence of the validity of an instrument to evaluate EHL in high school students related to environmental management for malaria vector control. This instrument can be used to collect important information as a basis for developing environmental health education interventions in schools to support sustainable malaria control efforts.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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