Predictive index for the success of school-based healthy lifestyle programs: a key role in primary prevention of cardiovascular risk factors in Kupang city

Índice predictivo del éxito de los programas escolares de estilos de vida saludables: Un papel clave en la prevención primaria de factores de riesgo cardiovascular en la ciudad de Kupang

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Received: 07/11/2025 Accepted: 09/01/2026 Published: 05/02/2026 DOI: http://doi.org/10.5281/zenodo.18626088

Abstract

This study aimed to develop a predictive index for assessing the success of the Clean and Healthy Living Behavior (PHBS) program in elementary schools within the working area of the Sikumana Health Center. Using a case-control design, 24 elementary schools (12 with unsuccessful implementation and 12 with successful implementation) were examined, involving 242 students and 24 teachers. Data were collected through questionnaires and observation sheets and analyzed using multiple logistic regression. The findings revealed that students' practical actions were the only significant predictor of program success (p=0.043; OR=19.362; 95% CI: 1.093-343.068). The predictive index was calculated using the formula: -10.301 + 2.963 × (Student Action Score), demonstrating overall accuracy of 79%, sensitivity of 66.7%, and specificity of 90.9% at the optimal cutoff point of 11.20. Although 52.5% of students had high knowledge levels and 66.7% of teachers showed positive attitudes, these factors did not significantly predict program success. This study emphasizes that focusing on the practical implementation of healthy behaviors by students, rather than just knowledge and attitudes, is crucial for the success of school health programs. The developed index can serve as a practical tool for identifying at-risk schools and allocating resources specifically for the primary prevention of cardiovascular risk factors.

Keywords: clean and healthy behavior, predictive index, school, primary prevention, cardiovascular risk factors

Resumen

Este estudio tuvo como objetivo desarrollar un índice predictivo para evaluar el éxito del programa de Comportamientos de Vida Limpios y Saludables (CVLS) en escuelas primarias del área de influencia del Centro de Salud de Sikumana. Mediante un diseño de casos y controles, se examinaron 24 escuelas primarias (12 con implementación fallida y 12 con implementación exitosa), con la participación de 242 estudiantes y 24 docentes. Los datos se recopilaron a través de cuestionarios y hojas de observación, y se analizaron mediante regresión logística múltiple. Los resultados revelaron que las acciones prácticas de los estudiantes fueron el único predictor significativo del éxito del programa (p=0,043; OR=19,362; IC del 95%: 1,093-343,068). El índice predictivo se calculó mediante la fórmula: -10,301 + 2,963 × (Puntuación de Acción del Estudiante), demostrando una precisión global del 79%, una sensibilidad del 66,7 % y una especificidad del 90,9 % en el punto de corte óptimo de 11,20. Si bien el 52,5 % de los estudiantes presentaba un alto nivel de conocimientos y el 66,7 % de los docentes mostraba actitudes positivas, estos factores no predijeron significativamente el éxito del programa. Este estudio subraya que centrarse en la implementación práctica de comportamientos saludables por parte de los estudiantes, en lugar de solo en el conocimiento y las actitudes, es fundamental para el éxito de los programas de salud escolar. El índice desarrollado puede servir como herramienta práctica para identificar escuelas en riesgo y asignar recursos específicamente para la prevención primaria de los factores de riesgo cardiovascular.

Palabras clave: comportamiento limpio y saludable, índice predictivo, escuela, prevención primaria, factores de riesgo cardiovascular.

Introduction

Clean and Healthy Living Behavior (PHBS) in schools refers to deliberate actions taken by all school members to prevent illness, maintain cleanliness, and promote overall well-being within the school environment[1]. Schools serve as strategic venues for instilling awareness about the importance of PHBS, where students are taught simple yet impactful practices, such as washing hands with soap and consuming healthy snacks, which contribute significantly to immediate health improvement and lay the foundation for long-term wellness. Moreover, elementary school-aged children (7–12 years) are in a crucial developmental stage for instilling PHBS values. At this age, they have strong potential to become agents of change by promoting healthy practices in their surroundings, helping to establish PHBS as a positive and lasting habit that can track into adulthood.

PHBS in schools involves the active participation of various stakeholders, including students, teachers, and parents. PHBS serves as a vital component of health education, which encompasses aspects of physical, mental, emotional, and social well-being, thereby fostering students' knowledge, skills, and positive attitudes toward health[2]. While health education traditionally serves as a preventive effort to combat infectious diseases, encourage immunization, and facilitate access to other health services, its role is increasingly recognized in the primary prevention of non-communicable diseases (NCDs). Schools play a crucial role in these preventive efforts, particularly given the generally low level of students' awareness regarding health practices and the rising global burden of cardiovascular risk factors, such as obesity and hypertension, which often originate in childhood.

For instance, many students neglect to wash their hands before eating, which increases the risk of disease transmission, and similarly, poor dietary choices in school canteens can contribute to the early development of unfavorable metabolic profiles. The primary goal of PHBS is to encourage behavioral changes among school members and the broader school community toward healthier lifestyles, thereby preventing illness, enhancing overall well-being, and contributing to the creation of a healthy school environment. Previous research has shown a significant relationship between snacking outside school and the incidence of diarrhea[3]. Therefore, encouraging students to consume healthy snacks is one key aspect of implementing PHBS in schools, a practice that also directly influences nutritional status and long-term cardiovascular health.

Interventions and educational efforts among students are strongly influenced by the role of teachers in shaping and reinforcing healthy habits. Unhealthy behaviors frequently arise from unfavorable environmental conditions, including inadequate cleanliness at home, school, or within the broader community[4]. Limited efforts to build students' awareness of PHBS have led to many elementary school students lacking knowledge about maintaining personal and environmental hygiene. This aligns with previous studies showing that some students still experience skin diseases, neglect hair and nail care, suffer from dental cavities, dress untidily, show little enthusiasm for morning exercises, dispose of trash irresponsibly, and consume unhygienic snacks[5]. Similarly, research has indicated that the low level of PHBS implementation in schools contributes to poor environmental quality and a high incidence of diseases among school-aged children[6]. These foundational habits of hygiene and nutrition are the very same behaviors that, if not established early, can evolve into modifiable risk factors for chronic diseases later in life.

The main issue in this study concerns the limited implementation of the PHBS program in public elementary schools. Implementing PHBS in schools provides multiple benefits, such as creating a cleaner and healthier environment, improving the teaching and learning process, and enhancing the overall well-being of students, teachers, and the school community. A critical gap exists in being able to predict which schools will successfully implement such programs, knowledge that is essential for efficient resource allocation and targeted interventions to ensure these primary prevention strategies are effective.

This study aims to develop a predictive index to assess the success of the PHBS program in elementary schools under the jurisdiction of the Sikumana Health Center, Kupang City, East Nusa Tenggara. By identifying key predictors of success, the findings are expected to offer valuable insights into the current implementation of PHBS in these schools. Ultimately, this tool can serve as a basis for maintaining and improving the sustainability of the program in the future, thereby strengthening a foundational component of public health strategy aimed at primary prevention of cardiovascular and other chronic disease risk factors within the community.

Study Design

This study employed an analytic observational design with a case-control approach. This design is suitable for investigating the potential causal relationship between specific exposures (or risk factors) and an outcome, particularly when the outcome is rare or has already occurred[7]. In the context of this research, the outcome of interest was the success level of the School-Based Healthy Lifestyle Program (PHBS). The "case" group was defined as elementary schools where the PHBS program was deemed unsuccessful, while the "control" group consisted of schools where the program was successful. This design allows for the retrospective analysis of factors that may predict program success, aligning with the study's objective to develop a predictive index for primary prevention initiatives in school settings.

Study Setting and Period

The research was conducted in elementary schools within the working area of the Sikumana Health Center, Maulafa District, Kupang City, East Nusa Tenggara. The data collection period spanned from January 2020 to February 2021.

Population and Sample

The target population for this study was all 24 elementary schools under the jurisdiction of the Sikumana Health Center. The sampling frame was divided into two distinct groups based on the program outcome: a case population (unsuccessful PHBS implementation) and a control population (successful PHBS implementation).

The initial phase involved a comprehensive assessment of all 24 schools to classify their PHBS program success status. This assessment utilized structured observation sheets and teacher questionnaires to ensure an objective classification. Following this evaluation, 12 schools were classified as the case group, and 12 schools were classified as the control group, resulting in a total sample of 24 schools for the study. The specific schools in each group are detailed in Table 1.

Table 1. Research Sample

No	Case Group	No	Control Group
1	SD Tunas Mandiri	1	SD Oepura 4
2	SDK STA Familia	2	SD GMIT Oepura
3	MI Darul Hijra Madani	3	SD Bulge
4	SD GMIT Kolhua	4	SD Sikumana Branch
5	SD Sikumana 1	5	SD Nefosaka
6	SD Sikumana 3	6	SD Harmony
7	SD Generasi Bangsa	7	SD Oepura 3
8	SDI Bello	8	SD Fatukoa
9	SD Generasi Maju	9	SD CIPS
10	SD Pethuk Kholhua	10	SD Oepura 1
11	SD Sikumana 2	11	SD Anugrah
12	SD Oepura 2	12	SD Naikoten 2

Data Collection and Variables

Within each of the 24 selected schools, data were collected from two sources:

Students: A sample of fifth-grade students (ages 9-12) from each school responded to questionnaires. The total sample included 120 students from the case group and 122 students from the control group. The questionnaires assessed key predictor variables, including students' **knowledge**, **attitudes**, and **actions** related to PHBS principles.

Teachers: The teacher in charge of the School Health Unit (UKS) or the fifth-grade homeroom teacher in each school completed a separate questionnaire. This provided data on teacher-related factors (**knowledge**, **attitudes**, and **actions**) and contextual factors like parental and health center support.

Additionally, an **observation sheet** was used to objectively assess school-level variables, including the availability of **facilities and infrastructure** (e.g., handwashing stations, toilets, waste disposal systems, canteens) and overall **environmental cleanliness**. The **outcome variable** (PHBS program success) was already defined by the initial classification into case and control groups. The **predictor variables** analyzed for the index included student actions, teacher actions, and school facilities, among others.

Data Analysis

The data analysis aimed to identify significant predictors of PHBS program success and develop a predictive index. Initially, a bivariate analysis (using simple logistic regression) was conducted to assess the crude relationship between each predictor variable and the outcome. Variables with a p-value < 0.25 in the bivariate analysis were included as candidates in a multiple logistic regression model. This multivariate analysis identified the independent predictors of program success, controlling for other factors. The final model's coefficients were used to construct the predictive index formula. The discriminatory power and optimal cut-off point of the index were determined using Receiver Operating Characteristic (ROC) curve analysis.

Characteristics of Respondents

The study involved 242 fifth-grade students (aged 9-12) and 24 teachers from 24 elementary schools. The demographic profile of the respondents is summarized in Tables 2 and 3. The majority of student respondents were male (65.3%) and 11 years old (49.6%). Most teacher respondents were female (54.2%) and between 34-47 years old (75%).

Table 2. Profile of Student Respondents

Characteristic	n	%
Gender		
Male	158	65.3%
Female	84	34.7%
Age		
<11 years	113	46.7%
11 years	120	49.6%
>11 years	9	3.7%
Total	242	100.0%

Table 3. Profile of Teacher Respondents

Characteristic	n	%
Gender		
Man	11	45.8%
Woman	13	54.2%
Teacher's age		
≤ 34	9	37.5%
35 – 47	9	37.5%
>47	6	25.0%
Total	24	100.0%

Bivariate Analysis of Predictive Factors

Student Factors

As shown in Table 4, 52.5% of students had high knowledge, 55.8% had negative attitudes, yet 62.4% demonstrated good PHBS-related actions. The bivariate analysis (Table 5) revealed that only students' actions showed a statistically significant association with PHBS program success (p=0.014), with schools where students demonstrated good actions being significantly more likely to be in the successful group.

Table 4. Student Factor Results

Student Factor	Category	n	%
Knowledge	High	127	52.5%
	Low	115	47.5%
Attitude	Positive	107	44.2%
	Negative	135	55.8%
Actions	Good	151	62.4%
	Less	91	37.6%

Table 5. Influence of Student Factors on PHBS Success

Factor	PHBS Success	Total	p-value
Knowledge	5/7 (45.5%/53.8%)*	11/13	0.682
Attitude	6/6 (42.9%/60.0%)*	14/10	0.511
Actions	8/4 (88.9%/26.7%)*	9/15	**0.014**
*Case (Less Successful)/Control (Successful)			

Teacher Factors

Table 6 shows that 66.7% of teachers had high knowledge and positive attitudes, while actions were equally distributed (50% good, 50% less). Teacher actions were significantly associated with program success (p=0.020), as shown in Table 7.

Table 6. Teacher Factor Results

Teacher Factor	Category	n	%
Knowledge	High	16	66.7%
	Low	8	33.3%
Attitude	Positive	16	66.7%
	Negative	8	33.3%
Actions	Good	12	50.0%
	Less	12	50.0%

Table 7. Influence of Teacher Factors on PHBS Success

Factor	PHBS Success	Total	p-value
Actions	9/3 (75.0%/25.0%)*	12/12	**0.020**
*Case (Less Successful)/Control (Successful)			

School Support Factors

Most schools had adequate facilities and infrastructure (Table 8). Among school support factors, only facilities showed a significant association with PHBS success (p=0.022), where schools with good facilities were more likely to be successful (Table 9).

Table 8. School Environment Facilities and Infrastructure

School Support	Less Adequate	Good
Means	8 (33.3%)	16 (66.7%)
Handwashing facilities	3 (12.5%)	21 (87.5%)
Environmental Cleanliness	3 (12.5%)	21 (87.5%)

Table 9. Effect of School Support on PHBS Success

Factor	PHBS Success	Total	p-value
Facilities	7/5 (87.5%/31.3%)*	8/16	**0.022**
*Case (Less Successful)/Control (Successful)			

Parental and Health Center Support

Parental support was universally reported (100%) across all schools and showed no significant association with PHBS success. Similarly, support from the community health center (Puskesmas), while generally adequate (79.2%), did not show a significant relationship with program outcomes.

Multivariate Analysis and Predictive Index Development

Multiple logistic regression analysis incorporating the candidate variables (student actions, teacher actions, and facilities) identified student actions as the sole significant independent predictor of PHBS program success (p=0.043), with an odds ratio of 19.362 (95% CI: 1.093-343.068), as shown in Table 10.

Table 10. Multiple Logistic Regression Analysis

Variable	Coefficient (B)	P-value	OR (95% CI)
Student actions (Good)	2.963	**0.043**	19.362 (1.093-343.068)
Constant	-10.301	0.009	-

The predictive index for PHBS success was formulated as: **PHBS Success Index = -10.301 + 2.963 × (Student Actions Score)**.

ROC curve analysis demonstrated good predictive accuracy for this index (AUC = 79%, p=0.015), with a sensitivity of 66.7% and specificity of 90.9% at the optimal cut-off point of 11.20.

Specific PHBS Component Implementation

Analysis of specific PHBS components revealed that the lowest implementation rates were in healthy snacking (37.6% of students never brought meals from home) and dengue prevention (44.2% ignored stagnant water). Handwashing facilities showed the lowest adequacy among infrastructure (12.5%), followed by water supply infrastructure (12.5%).

PHBS Predictive Success Index Cutoff

Figure 1: ROC Curve of Student Actions on the Success of PHBS

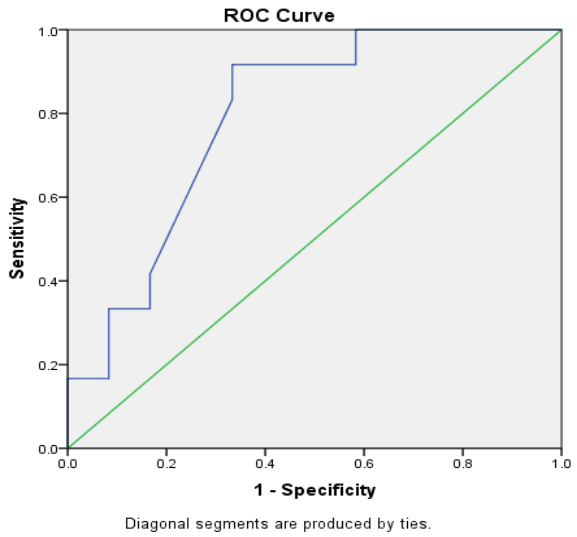

Figure 1 shows an accuracy rate of 79%, indicating that the model has a fairly good predictive quality for determining the success of PHBS in schools. The model achieved a p-value of 0.015, a sensitivity of 66.7%, and a specificity of 90.9%. The probability value was derived from a cut-off point of 11.20 based on the sensitivity and specificity values.

Discussion

This study successfully developed a predictive index for the success of the Clean and Healthy Living Behavior (PHBS) program in elementary schools, identifying student actions as the sole significant predictor. The finding that student behavior, rather than knowledge or attitudes, directly determines program effectiveness provides crucial insight for public health interventions. The multivariate analysis yielded a striking odds ratio of 19.362, indicating that schools where students demonstrate good PHBS practices are nearly twenty times more likely to successfully implement the program[8]. This underscores that actual behavioral implementation, not just theoretical understanding, drives meaningful health outcomes in school-based interventions.

The disconnect between knowledge, attitudes, and actions observed in our findings warrants careful examination. While 52.5% of students demonstrated high knowledge and 44.2% showed positive attitudes, these cognitive factors did not translate directly into program success. This paradox aligns with previous research by Notoatmodjo[7], who noted that knowledge formation requires repeated engagement and reinforcement. Our results suggest that students may understand PHBS concepts without internalizing them as habitual behaviors, particularly in specific components like healthy snacking and dengue prevention where implementation was weakest - findings consistent with Lina[9] who also identified healthy snacking as the least practiced PHBS indicator.

The dominant role of student actions over other factors carries significant implications for cardiovascular disease prevention. The specific behaviors measured—including handwashing, healthy snacking, proper waste disposal, and physical activity—represent foundational habits that directly impact long-term cardiovascular risk. Schools that successfully instill these practices are not merely creating cleaner environments but are actively contributing to primary prevention of future hypertension, obesity, and metabolic disorders. This connection positions school health programs as strategic investments in population-level cardiovascular health.

Interestingly, while teacher knowledge and attitudes were generally positive (66.7%), they did not significantly predict program success. However, teacher actions showed a notable association in bivariate analysis (p=0.020), suggesting that educators influence students primarily through modeling behavior rather than through instruction alone. This finding supports Diana et al.[6], who emphasized teachers' role as behavioral exemplars. Since children tend to imitate adult behavior, teachers serve as important role models whom students often ad-

mire and trust[6], though this influence appears to be mediated through student implementation rather than being a direct predictor.

The adequate infrastructure and parental support reported across schools failed to emerge as significant predictors, presenting another important insight. Despite 79.2% of schools reporting adequate facilities and 100% reporting parental support, these enabling factors alone proved insufficient to ensure program success. While school facilities are closely linked to PHBS implementation[10] and parental support plays a crucial motivational role[9], our findings challenge conventional assumptions that resource availability automatically translates to program effectiveness, suggesting that behavioral engagement mechanisms may be more critical than structural supports alone.

Our predictive model demonstrated robust discriminatory power with 79% accuracy, 66.7% sensitivity, and 90.9% specificity at the optimal cutoff of 11.20. This statistical performance indicates that the index based on student actions can reliably identify schools likely to succeed or struggle with PHBS implementation. The high specificity is particularly valuable for resource allocation, as it minimizes false positives and ensures interventions target schools most in need of support, ultimately contributing to more efficient public health resource utilization in cardiovascular disease prevention efforts.

These findings collectively emphasize that successful health promotion in schools requires moving beyond knowledge transmission to focus on behavior formation. The predictive index formula (-10.301 + 2.963x) provides a practical tool for health authorities to identify at-risk schools and tailor interventions accordingly. Future efforts should prioritize experiential learning, habit formation, and environmental cues that bridge the knowledge-action gap, particularly for behaviors with direct relevance to long-term cardiovascular health. By focusing on measurable actions rather than perceived knowledge or attitudes, health programs can achieve more sustainable impacts on student wellbeing and chronic disease prevention.

Conclusions

This study developed a predictive index for the success of the Clean and Healthy Living Behavior (PHBS) program in elementary schools. The key finding reveals that students' actual practices - not just knowledge or attitudes - emerged as the only significant predictor of program success. The predictive formula (-10.301 + 2.963 × student actions score) provides a practical tool with 79% accuracy for identifying schools needing intervention support. The research highlights a crucial knowledge-action gap: despite adequate student knowledge (52.5% high knowledge) and generally positive attitudes, these didn't guarantee successful implementation. This disconnect was most apparent in healthy snacking and dengue prevention practices. Similarly, good teacher attitudes and adequate infrastructure alone proved insufficient without students' consistent behavioral implementation.These findings carry important implications for cardiovascular disease prevention, as PHBS components like healthy snacking and physical activity represent foundational habits influencing long-term cardiovascular risk. We recommend shifting focus from knowledge delivery to active behavior formation, using the predictive index for targeted resource allocation. This approach represents a strategic investment in primary prevention of chronic diseases, ultimately contributing to more sustainable health outcomes in the community.

References

1. Abidah Y, Yulia, Nur, Huda A. Implementation of the Clean and Healthy Living Behavior (PHBS) Program in Special Schools. Journal of Ortopedagogia. 2018;4(2):87-93.
2. Mustar YS, Susanto IH, Bakti AP. Health Education: Clean and Healthy Living Behavior (PHBS) in Elementary Schools. JISIP (Journal of Social and Educational Sciences). 2018;2(2):1-8.
3. Anisah IN. The Relationship Between Children's Snacking Habits Outside School and the Incidence of Diarrhea Among Students at SD Negeri 3 Mudal Boyolali. [Thesis]. Faculty of Health Sciences, Muhammadiyah University of Surakarta; 2019.
4. Hamiyah N, Jauhar M. Introduction to Education Management in Schools. Bandung: Alfabeta; 2015:67-89.
5. Teguh A. Survey of School Health Unit Implementation and Healthy Lifestyle Patterns Among Fifth Grade Students in Gusek Bramasari, Leksono District, Wonosobo Regency, 2012. Yogyakarta State University; 2012:34-56.
6. Diana MF, Susanti F, Irfan A. Implementation of the Clean and Healthy Living Behavior (PHBS) Program at SD Negeri 01 Tanjung Balai Karimun. Andalas Journal of Public Health. 2013;8(1):45-60.
7. Notoatmodjo S. Health Behavior Science. Jakarta: Rineka Cipta; 2010:78-95.
8. Lina HP. Clean and Healthy Living Behavior (PHBS) Among Students at SDN 42 Korong Gadang, Kuranji District, Padang. Health Promotion Journal. 2016;4(1):23-35.
9. Suryani L. Factors Influencing Clean and Healthy Living Behavior (PHBS) Among Students at SD Negeri 37 Tampan District, Pekanbaru City. Abdurrab Nursing Journal. 2017;1(2):34-48.
10. Harahap TA, Saefudin A, Riani E, Indriyanto B. The Relationship Between Clean School Environment and Students' Clean Lifestyle Behavior In Indonesian Junior And Senior High Schools. International Journal of Scientific & Technology Research.