The Open Public Health Journal
DOI: 10.2174/0118749445413816250914015542, 2025, 18, e18749445413816
ISSN: 1874-9445
1

RESEARCH ARTICLE **OPEN ACCESS**

Developing a School-based Wellness Program to Prevent NCDs: A Mixed-Methods Study in Indonesian Elementary Schools

Tri Siswati[1,*], Weni Kurdanti[1], Almira Sitasari[1], Siti Budi Utami[1] and Indah Suci Widyahening[2,3]

[1]*Nutrition Department, Poltekkes Kemenkes Yogyakarta, Sleman, Yogyakarta, 55293, Indonesia*
[2]*Southeast Asian Ministers of Education Organization, Regional Centre for Food and Nutrition (SEAMEO-RECFON), Universitas Indonesia, Jakarta, Indonesia*
[3]*Department of Community Medicine, Faculty of Medicine, Universitas Indonesia, Jakarta, 10320. Indonesia*

Abstract:

Introduction: Non-communicable diseases (NCDs) are the leading cause of morbidity and mortality worldwide. Schools are strategic settings for health promotion, and empowering teachers may contribute towards prevention of NCD . This study aimed to develop the School Wellness Program (SWeP) as a strategy to strengthen teacher capacity in health promotion.

Methods: A research and development design with mixed-method approaches was applied through five phases: needs assessment, baseline, intervention, endline, monitoring, and evaluation. The study involved 164 employees, 35 teachers, and 12 elementary schools in Klaten District, Central Java, Indonesia, in 2023. Data collection included assessment of schools' needs regarding NCD prevention, pre- and post-tests of teacher knowledge, training interventions, monitoring, and program evaluation.

Results: Teachers' knowledge increased significantly by 21.9±20.2 points (p <0.001). Teachers used applied standard operating procedures to measure students' height (83.33%), weight (93.59%), blood pressure (76.22%), and blood sugar (95.45%). Risk factors identified included smoking (9.1%), low fruits and vegetables intake (70.7%), insufficient physical activity (56.1%), alcohol consumption (3%), and sleep-related problems (22.6%). Program sustainability was supported through collaboration with health professionals.

Discussion: The findings demonstrated that teacher empowerment can enhance early NCD risk detection and health promotion in schools. Integrating structured training and monitoring ensures program feasibility and aligns with global efforts to address NCDs in low-resource settings. However, longer-term evaluation is required to assess behavioural changes among students and community-wide impact.

Conclusion: Teacher-based wellness programs are effective for school-based NCD prevention and have potential for broader scalability when supported by health professionals.

Keywords: Non-communicable diseases, Prevention, School, Teacher, Training.

*Address correspondence to this author at the Nutrition Department, Poltekkes Kemenkes Yogyakarta, Sleman, Yogyakarta, Indonesia; Tel: +62-87739666204; E-mail: tri.siswati@poltekkesjogja.ac.id

Cite as: Siswati T, Kurdanti W, Sitasari A, Utami S, Widyahening I. Developing a School-based Wellness Program to Prevent NCDs: A Mixed-Methods Study in Indonesian Elementary Schools. Open Public Health J, 2025; 18: e18749445413816. http://dx.doi.org/10.2174/0118749445413816250914015542

Received: June 24, 2025
Revised: July 21, 2025
Accepted: July 30, 2025
Published: September 17, 2025

1. INTRODUCTION

Non-communicable diseases (NCDs) remain a global health problem. The primary survey results in Indonesia showed that the prevalence of hypertension in individuals aged ≥ 18 years has increased from 25.8% in 2013 [1] to 34.1% in 2018 [2]. Likewise, the prevalence of diabetes mellitus in people aged ≥ 15 has risen from 6.9% in 2013 to 8.5% in 2018 [2]. In Klaten regency, Central Java, NCDs are silently crippling, with cases doubling in just three years. There were 6,136,532 new cases of NCDs in 2022 [3], compared to 3,074,607 cases in 2019 [4]. In addition, the prevalence of NCDs in Klaten exceeds the prevalence in Central Java [5], with particularly high prevalence of diabetes mellitus (2.39%), hypertension (34.16%), and stroke (52.33%). NCDs contribute to costing the country billions in healthcare, lost productivity, and tend to affect their offspring because of the inherited lifestyle [6]. In addition, NCDs can potentially cause economic losses of 0.003% to 0.004% of Indonesia's total gross domestic product [7].

Lifestyle choices such as unhealthy eating habits and physical inactivity are key contributors to NCDs [8, 9]. Some examples of unhealthy eating habits include emotional eating, eating late, snacking too much or eating mindlessly, poor meal planning, overconsuming processed food, larger portions, high-calorie drinks, and unbalanced meals [10]. In contrast, lack of exercise refers to insufficient physical activity or a sedentary lifestyle, where individuals fail to engage in regular moderate to vigorous physical activities that promote health and fitness. For example, sedentary jobs, screen time, motorized transportation, and modern conveniences like elevators, escalators, and household appliances have significantly reduced the need for physical exertion in daily tasks [11, 12].

Teachers play a crucial role in shaping health behaviors and preventing NCDs. They can educate students, promote healthy lifestyles through the curriculum, be a role model of healthy behaviours, identify at-risk students, create supportive learning environments, and shape students' lifestyles. Unlike health cadres or nurses who typically operate within community or clinical settings, teachers are uniquely positioned to influence children's health behaviors on a daily and sustained basis within the school environment. Their direct, routine contact with students allows them to integrate health promotion into the learning process, observe early behavioral risk indicators, and act as consistent role models for healthy living [13].

Furthermore, teachers' involvement in both curricular and extracurricular activities provides an unmatched platform for reinforcing preventive health messages. Their social capital within school communities also enables them to engage with parents and other stakeholders, thus amplifying the reach and sustainability of school-based wellness initiatives. Therefore, trainings on preventing NCDs for teachers is critical. The training will provide a foundation of deeper knowledge about NCD risk factors, screening, and effective prevention strategies [14, 15]. Evidence from earlier studies has shown that school health programs can positively influence health behaviors among students and staff [16]. Recent umbrella reviews also highlight the role of physical activity not only in preventing NCDs but also in mitigating mental health complications, thereby reinforcing the need for integrated approaches in school settings that addressess physical activity, diet, and sleep as interlinked health domains [17]. However, most existing research has focused on student-centered interventions, with limited attention given to the implementation of wellness programs targeted at school staff, especially in low- and middle-income settings like Indonesia.

This study addresses the research gap by exploring the implementation and effectiveness of a School Wellness Program (SWeP) targeting school personnel, particularly teachers, as agents of change in NCDs prevention. The rationale for this study arises from the urgent need to develop sustainable, school-based strategies for combating NCDs through preventive health promotion. Using the Theoretical Framework of Acceptability (TFA), the study assesses the perceived effectiveness, ethical alignment, implementation burden, and sustainability of the SWeP training program. To complement this, Social Cognitive Theory (Bandura**)** informed the assessment of individual-level behavioral change among teachers, while the Consolidated Framework for Implementation Research (CFIR) was applied to examine organizational-level facilitators and barriers for implementation. This study aimed to design, implement, and evaluate the SWeP training program in elementary schools in Klaten Regency to support the early detection and prevention of NCDs within school communities.

2. METHODS

2.1. Design

We conducted a multi-design research and development study, including quantitative and qualitative research. Quantitative research included: a) a quasi-experimental study to find out the influence of SWeP training on teachers' knowledge, b) a one-shot case study to find out the effect of SWeP training on teachers' skills, and c) a cross-sectional study to find out the risk of NCDs among program beneficiaries. In comparison, qualitative research uses a phenomenology design to determine teachers' acceptance of SWeP and program evaluations.

The research was carried out in 5 stages: 1) needs assessment, designing and developing training of SWeP; 2) baseline; 3) training intervention; 4) end line, and 5) monitoring and evaluation. Qualitative research was carried out during stages 1 and 5. Meanwhile, quantitative research was carried out during stages 2, 3, and 4 (pre-test, intervention, and post-test).

2.2. Settings

This research was applied in elementary schools in Klaten Regency, Central Java, during June-September 2023. For this selection, schools that had already imple-

mented the Nutrition Goes to School program were considered. The NGTs programme is a school-based, multisectoral initiative that aims to improve students' academic performance and classroom engagement by promoting excellent nutrition, sanitation, and hygiene. As many as 39 districts in 20 provinces and 100,620 students in Indonesia received the NGTs program [18]. Specifically, in Klaten Regency, Central Java, there are 704 public elementary schools, but only 12 schools have received the NGTS program. The school was then recruited for SWeP intervention research. The consideration of teachers participating in SWeP training is to improve the quality of education through the prevention of NCDs, recognising the symptoms and signs of NCDs, and being skilled in assessing nutritional status both anthropometrically, vital signs, and biomedically. In this case, teachers have an essential role as educators, actors, motivators, and role models for optimal nutritional status, so enriching teachers' knowledge and skills in detecting dietary problems, including NCDs, is important. Another evidence-based national health survey in 2018 revealed that Klaten Regency has a high prevalence of NCDs. Based on these criteria, 12 elementary schools were eligible to participate in this research.

2.3. Participants

The number of participants in this research was different at each stage:

2.3.1. Stage 1-Need Assessment

Stage 1 aims to address the needs of school workers in preventing NCDs and design suitable training and training materials. Informants included school heads, primary health service programmers, and staff officers. Prior to data collection, participants were informed about the aims of the research, the researchers' institutional affiliation, and their role in school-based health promotion. However, personal motivations and research interests were not explicitly disclosed to avoid biasing responses. We applied offline FGD for collecting the data with 14 participants. The duration of FGD is about 90-120 minutes.

2.3.2. Stages 2-4: Baseline, Intervention, and Endline

In stage 2, the baseline assesses the knowledge of the teacher; in stage 3, the intervention occurs through training for skill transfer, and in stage 4, the endline measures the knowledge and skills of the teacher after the training has been completed.

The study involved 36 participants appointed by 12 school principals to participate in a SWeP training, 3 people from each school. The inclusion criteria: teachers who are interested and commanded by the principal/head school to be participants in SWEP training. Hereinafter referred to as NCD teachers.

The program was developed from the Posyandu Book Guidance of NCDs [19] and was taught through 6-hour training practice using slide presentations, training modules, and anthropometric tools.

2.3.3. Stage 5: Monitoring and Evaluation

The monitoring and evaluation process aimed to identify NCD risk factors, including all school employees, both teachers, administrative, and non-administrative staff, as many as 164 employees from 12 schools. The exclusion criteria were incomplete data. Monitoring and evaluation were for identifying program acceptance, implementation obstacles, and program sustainability analysis. To complete information about the SWeP implementation experience, we conducted face-to-face in-depth interviews for 30-60 minutes with several officers and staff, as well as heads of schools.

The number of informants was limited until there was no new information to be obtained. All qualitative interviews and FGDs were conducted by the principal investigator and co-authors with extensive backgrounds in community nutrition and public health education. The researchers held a neutral stance and practiced reflexivity to minimize assumptions or biases during data collection.

No participants declined or withdrew from the study at any stage. All invited individuals gave informed consent and completed the required procedures.

2.4. Instrument

We applied many instruments regarding the type of research and outcome. Various instruments were used to collect both quantitative and qualitative data in the study. For the quantitative data, a quasi-experimental design was implemented to measure the impact of SWeP training on knowledge of participants, using structured questionnaires which were administered through a face-to-face interviews. A one-shot case study design was employed to assess the skills acquired from the SWeP training, with observations conducted to evaluate participants' performance. Additionally, a cross-sectional design was used to identify the prevalence of risk factors for NCDs, with data collected through structured questionnaires and face-to-face observations. For the qualitative data, an exploratory study was carried out to investigate the need for NCD prevention programs, desired program models, recruitment systems, and program sustainability, using focus group discussions (FGDs) and face-to-face interviews. Two evaluation studies were also conducted: the first examined the effectiveness of SWeP training, focusing on practical attitudes, ethics, innovation, opportunity costs, and self-efficacy, while the second evaluated the implementation of SWeP, identifying potential obstacles and analyzing the sustainability of the program, both using face-to-face interviews. We use an audiovisual recorder and field notes to increase data validity.

2.5. Analysis

Quantitative data analysis involved a multivariate t-test to assess the impact of SWeP training on teacher knowledge, a descriptive study of teacher compliance with operational standards, and prevalence analysis of NCDs and their risk factors. In contrast, qualitative data were analyzed manually without the aid of qualitative analysis software. The thematic evaluation using Theoretical

Framework Analysis (TFA) includes NCD prevention programs, recruitment systems, program sustainability, and training. Thematic coding was conducted by two independent coders, and discrepancies in code interpretation were resolved through discussion to ensure reliability. The coding tree was structured into four major thematic domains: (1) perceived need for NCD prevention, (2) recruitment and training feasibility, (3) program acceptability and effectiveness, and (4) sustainability challenges. Subthemes emerged inductively within each domain. Transcripts or findings were not returned to participants for validation due to time constraints and resource limitations. However, the use of direct quotations and field notes helped to ensure accurate representation of views of the participants' .

2.6. Ethics Consideration

This research was approved by the Ethics Committee Poltekkes Kemenkes Yogyakarta No.DP.04.03/e-KEPK.2/404/2023 dated March 29th, 2023. All respondents gave immediate approval after obtaining adequate explanations from the researcher.

3. RESULTS

The study findings revealed a strong alignment between the expressed needs of school stakeholders and the measured outcomes of the intervention. As shown in Table **1**, focus group discussions (FGDs) revealed that schools lacked structured NCD prevention initiatives for teachers and staff and expressed a strong desire for teacher-led, school-integrated wellness programs. While Table **2** revealed that most of the participants were productive age groups, predominantly women with adequate teaching experience and academic qualifications. Their background as teachers puts them in a strategic position to integrate SWeP knowledge in teaching and learning activities, thus becoming a strong foundation for the effectiveness and sustainability of the program in elementary schools.

In addition, this qualitative insight was quantitatively confirmed by the relatively low pre-training knowledge score among teachers ($\bar{x}$= 16.67, Table **3**), which significantly increased post-intervention to $\bar{x}$= 21.97, indicating a 31.8% improvement and large effect size (5.4; $p < 0.05$). Furthermore, teacher adherence to Standard Operating Procedures (SOPs) was generally high, exceeding 83% in key indicators such as height, weight, blood pressure, and blood glucose assessments (Table **4**), suggesting effective technical skill uptake. The qualitative findings during the evaluation phase further reinforced the program's perceived ethical appropriateness, feasibility, and sustainability (Table **5**). Stakeholders emphasized the program's alignment with Klaten's local health vision, its low ethical burden, and its adaptability to school routines, despite limited operational resources. These findings demonstrate that the SWeP intervention was not only statistically effective but also contextually appropriate and socially acceptable within the school environment.

Table 1. Need assessment themes and quotation.

Theme	Result	Quotation
The existence of NCDs prevention programs	Specifically none	"The school already has a School Health Unit, there are several health programs, but none for preventing NCDs"– (P1). "So far, the socialization of the School Health Unit and its officers is mostly from sport teachers, but not all schools have it. The obstacles is we have no health medical expertise." – (P2).
Desired program model	Integration with School Health Unit programs, healthy schools, while the beneficiaries are teachers, employees, parents, and the entire surrounding community	"Agreeing with Mr. N, NCDs prevention programs can also include healthy schools and School Business Unit" – (P4). "…teachers of SWeP may be sports teachers or other teachers who are interested and have been trained previously" – (P6). "School can send their team or a teacher candidate to be trained. Later, we take it as inventory"– (P3)".
Recruitment System	Voluntary or mandatory	"….Head School, please recruit candidates for SWeP Teachers, can be voluntary or mandatory …These teachers will be trained and supervised so they can run this program correctly, further NCDs can be prevented." – (P7).
Sustainability program	Together with/teachers, schools, and local health officers.	"It is necessary to build a team, maintenance facilities, a time schedule, resource persons, and targets." – (P2). "Therefore, the health office may give guidance, supervision and motivation routinely for the teachers, because it is strongly related to NCDs prevention that we have never received socialisation at all" - (P9). "In the future, we will ask for assistance from the health officer to foster, direct, supervise, and motivate so that the program can be maintained and sustained" – (P10).

Table 2. Samples characteristics.

Variable	Pre-test Score	*p*-value
Age (years old)		
20-39	56.24	0.345[a]
40-59	54.28	-
Sex		
Male	54.14	0.564[a]
Female	56.38	-
Work experience (years)		
< 5	53.84	0.324[a]
≥ 5	56.68	-
Education level		
Undergraduate	54.24	0.244[a]
Master program	56.28	-
Role		
Class teacher	55.24	0.567[b]
Religious teachers	52.12	-
Sport teacher	58.42	-

Note: [a]t-test, [b]anova.

Table 3. The effectiveness of training to enhance teachers' knowledge.

Variable	Knowledge
Pre-test	16.67 ± 3.05
Post-test	21.97 ± 3.41
Delta	5.3
% Increase	31.8%
Posttest-pretest	-
Size effect	5.4*
95% CI	16.2 – 24.8
Cons	71.83
QIC	189.87

Note: [1]adjusted coefficient(95%CI). [2]controlled variables of age, sex, work experience, education, and occupation. *p-value<0.05.

Table 4. The teacher's adherence to measuring standards.

Measurement	Result		Description
	Right (%)	Wrong (%)	
Body weight	83.33	16.67	The teachers did not reset the number 0 on the body weight scale.
Body height	93.09	6.91	The teachers do not ask/ensure participants remove footwear, sandals, shoes, and other items that affect body weight.
Blood pressure	86.22	13.78	The teachers did not take measurements 2 times with a time gap of 1-2 minutes. The teachers did not re-measure the results of observation when the difference between the first and second results was more than 10 mm/Hg.
Blood glucose	95.45	4.55	The teachers did not dry the fingertips after being swabbed with 70% alcohol and rushed to insert the test strip, even though the insert strip test sign had not appeared

Table 5. Monitoring and evaluation program using theoretical framework analysis (TFA).

Effective attitude	In schools, NCDs can be avoided after a programme has been implemented.
Burden	It is possible to reach a consensus on the service time during working hours. The burden of operational expenditures cannot be alleviated in any way.
Ethic	Aligns with the vision and mission of "Klaten Sehat (Klaten City Health)" and does not contradict established ethical standards.
Coherence of innovation	Programs can be elaborated with other programs to achieve Klaten Sehat (Klaten City Health)
Opportunity cost	To improve the services program, they require cholesterol and uric acid tools, and coaching and supervising of Puskesmas, and also the mechanism of the referral system, and healthy Behaviour changes in the context of NCD promotion and prevention
Perception of effectivenes	Training is effective in determining the risk of NCDs, but it needs continuous motivation for healthy living behaviours to prevent it
Self-efficacy	Caders are self-confident, skilled, and have a good understanding, allowing them to serve clients.

3.1. Need Assessment

According to the SWeP school needs analysis and need assessment findings, there haven't been any NCD prevention initiatives for staff members or instructors in schools. For this reason, NCD prevention efforts are required and should be further integrated with the School Health Unit. In detail, some of the items of information are unearthed, and the opinions of FGD informants are as follows (Table **1**).

3.2. Base Line, Intervention and Endline

3.2.1. Subject Characteristics

The training participants were all prospective SWeP officers from 12 elementary schools, as many as 35 people, mostly aged 20-39 years, women, with working experience for ≥ 5 years, having graduate education, and their role as class teachers. As detailed in Table **2**.

3.2.2. The Effectiveness of Training to Increase Teachers' Knowledge and Accuracy of Measurement

The training significantly increased teachers' knowledge by 5.3 points, or approximately 31.8%. This suggests that the training was not only effective in delivering content but also able to improve teachers' cognitive understanding of NCD prevention. As detailed in Table **3**.

To identify risk indicators it is essential to ensure that teachers follow the guidelines or assessment procedures . We found that there were still techniques of monitoring blood pressure, blood sugar, and blood glucose that did not adhere to standard operating procedures. As detailed in Table **4**.

3.3.3. Monitoring and Program Evaluation

By implementing SWeP, risk factors for NCDs were being monitored. Up to 164 individuals from 12 schools signed up as participants at this point. The majority of participants (71.8%) were married, 71.3%) were female (71.3%), and 90.2% had graduated from college. The behavioral risk factors for NCDs include smoking habits (9.1%), reduced fruits and vegetables consumption (70.7%), lack of physical activity (56.1%), alcohol consumption (3%), and sleep and eating disorders (22.6%). The teacher also considers an individual's personal and familial medical background, which contributes for the development of NCD medicines. The participants thereby subject themselves and their families to the risk of contracting NCDs.

Evaluation and monitoring were carried out to determine the achievement, effectiveness, and efficiency of the program. By conducting continuous surveillance and evaluation, an initiative can decrease the probability of failure and successfully achieve its goals. The results of the SWeP implementation were ascertained through a comprehensive examination of the theoretical framework (Table **5**).

4. DISCUSSION

In Central Java and across other regions in Indonesia, the growing prevalence of non-communicable diseases (NCDs) poses a significant threat to public health, contributing to increased disability-adjusted life years (DALYs) and premature mortality [20]. Adolescents and youth are particularly vulnerable, necessitating timely, school-based health promotion strategies [21]. The present study reinforces the relevance and timeliness of the SWeP, especially when teachers and staff are positioned as health promotion agents within their educational communities [22].

In this study, the SWeP training program revealed a statistically significant increase in teachers' knowledge, with a 31.8% increase. These results suggest that structured training interventions can effectively enhance teachers' capacity to serve as promotive and preventive actors in addressing NCDs [23, 24]. While qualitatively, informant reported improvements in self-efficacy, confidence, and awareness regarding the integration of healthy lifestyle practices into their professional roles. These findings are consistent with Bandura's Social Cognitive Theory (SCT), which highlights knowledge acquisition and self-efficacy as primary determinants of behavior change and personal agency in health contexts [25, 26].

However, observational assessments of technical skills during practice sessions identified inconsistencies in procedural accuracy. For instance, 13.78% of teachers failed to repeat blood pressure measurements after an

interval, and 6.91% neglected to ensure participants removed footwear when measuring height and weight. Lower adherence in height and weight procedures may be attributed to insufficient practice time during training, or the respondent did not want to bother taking off his shoes, especially lace-up shoes, because of the hassle. These findings suggest that while cognitive gains were made, technical proficiency has not yet been fully inter-nalized. This gap aligns with Rogers' Diffusion of Inno-vation Theory, emphasizing that adoption of innovation extends beyond awareness and requires reinforcement and contextual support for consistent application [27].

This study also found that teachers had a high affective attitude and strong ethical alignment with the program, indicating strong intrinsic motivation to participate. This finding aligns with the Theoretical Framework of Acceptability (TFA) that was employed to examine how the SWeP program was received by participants. However, time allocation challenges, particularly for physical activity integration and comprehensive anthropometric assessments, were noted as barriers. These constraints reflect a need to evaluate implementation burden and opportunity cost to ensure long-term sustainability [28].

Moreover, findings from the program's monitoring and evaluation phase involving 164 individuals from 12 schools underscore the high burden of unmet health needs. Most of them had inadequate fruits and vegetables con-sumption, were physically inactive, and some participants reported irregular sleep and eating patterns. These data reflect substantial modifiable risk factors for NCDs that remain unaddressed among school staff. According to Health Belief Model Theory, an individual's perception of disease severity and personal vulnerability influences behavior change [29]. Thus, enhancing risk perception and perceived benefits through education is critical for motivating lifestyle changes [30].

Physical inactivity among staff was often attributed to administrative burdens and scheduling constraints. The Consolidated Framework for Implementation Research (CFIR) [31] identified organizational barriers such as a lack of institutional support for physical activity during school hours. These findings echo the broader literature indicating that structural and environmental factors significantly influence health behaviors, as articulated in the Ecological Model of Health Behavior [32]. Sleep deprivation also emerged as a persistent concern, affec-ting metabolic, cardiovascular, and mental health out-comes [33-38]. This highlights the need for integrated approaches in school health programs that address diet, physical activity, and sleep as interconnected health domains.

Emerging technological innovations such as federated learning and IoT-based health monitoring systems offer promising avenues for sustaining school-based health promotion efforts while maintaining data privacy. These approaches may enhance continuous teacher training and real-time surveillance in future iterations of SWeP-like programs. Practically, this study underscores the impor-tance of viewing teachers not just as knowledge trans-mitters but as role models and implementers of school-based health promotion. Embedding healthy behaviors into the school curriculum can yield wide-ranging benefits. Previous research stated that integrating health education into curricula has a positive impact on study outcomes, including reduced absenteeism, improved cognitive func-tion, and strengthened student-teacher rapport [39-41]. Theoretically, this research also contributes to the field by integrating multiple frameworks, such as SCT (individual behavior), TFA (program acceptability), and CFIR (systemic context), offering a comprehensive model for evaluating and scaling health interventions in educational settings.

Lastly, teacher and school staff must adopt healthy lifestyles and integrate these practices into their teaching to effectively prevent NCDs. Beyond delivering knowledge, educators play a key role in promoting overall student and teacher well-being by incorporating healthy diet, exercise, and lifestyle habits into the curriculum. This holistic approach helps improve student and teacher progress, reduces absenteeism, boosts energy and concentration, enhances mental health, lowers stress, and strengthens teacher-student relationships [42, 14]. By encouraging early preventive actions, educators can also help reduce the long-term financial burden on the healthcare system, further emphasizing their vital role in fostering a healthier school environment and supporting public health [16, 22, 43, 44].

Moreover, future implementation of SWeP-like inter-ventions could benefit from leveraging digital health innovations. Recent reviews, such as one on federated learning in smart healthcare, suggest that integrating Internet of Things (IoT)-based systems can support conti-nuous teacher training, real-time health data monitoring, and secure data privacy management. These technological frameworks could enhance the sustainability and scalability of school-based health programs, especially in low-resource settings where in-person monitoring is limited.

Despite promising outcomes, several limitations war-rant attention including: 1) the absence of randomization and a control group limits the causal inference and the ability to attribute knowledge gains solely to the SWeP intervention, 2) for observed skill acquisition, this study used a one-shot case study which does not allow for a pre-post comparison or determination of actual competency growth, 3) Geographic limitation, that the study was conducted solely in Klaten Regency, which may limit the generalizability of the findings, 4) short-term evaluation, and there is no longitudinal follow-up was conducted to assess sustained behavioral change or institutional adop-tion, 4) single observation point, that skill assessments were not repeated post-training, so limiting insights into longer-term technical competence, 5) This study including small sample size and the restriction to 12 schools in Klaten Regency limit the statistical power and genera-lizability of the findings.

This research implies strengthening technical training quality through direct practice and regular supervision by

local health centers (Puskesmas), ensuring adequate health screening equipment, such as cholesterol and uric acid meters, and building a robust referral system, promoting intersectoral collaboration, integrating SWeP with national initiatives, and needs implementing longitudinal studies to assess sustained behavioral and institutional outcomes. Moreover, developing blended learning modules to enhance flexibility and self-paced teacher training, and scheduling physical activity for both teachers are important.

This study focuses on positioning teachers as health promoters, the SWeP may also help reduce stigma and increase trust in preventive health services, especially in rural or underserved communities. This represents a potential pathway for strengthening health literacy and intergenerational behavior change. In addition, when approached holistically, the SWeP model has the potential to become a replicable and scalable school-based NCD prevention intervention, particularly in resource-constrained settings across Indonesia. However, implementation of SWeP can vary in resource availability, institutional support, and health infrastructure across regions.

CONCLUSION

The School Wellness Program (SWeP) demonstrated promising outcomes in enhancing teachers' knowledge and procedural adherence related to the prevention of non-communicable diseases (NCDs) in elementary school settings. The significant increase in knowledge and relatively high adherence to SOPs for basic health screening suggest that trained teachers can serve as credible health promotion agents in schools. However, the absence of a control group and the short-term nature of the intervention limit causal inference and long-term impact assessment. Despite these limitations, the program aligns with global health promotion priorities and highlights the feasibility of leveraging teacher capacity for early health risk detection in low-resource educational environments. Future implementation should consider integrating the SWeP into formal teacher development curricula and aligning it with existing school health policies. Regular coaching by health professionals, provision of essential screening tools, and support through cross-sectoral collaboration are crucial to ensure sustainability. A cost-effectiveness analysis and longitudinal follow-up are recommended to assess the broader impact on student health outcomes and institutional adoption. Moreover, future adaptation of the program can explore the use of digital health tools (*e.g.*, mobile apps, federated learning platforms) to support continuous training, data monitoring, and scalability while preserving privacy and data integrity.

AUTHORS' CONTRIBUTIONS

The authors confirm contribution to the paper as follows: A.S.: Study conception and design; T.S., W.K., A.S., S.B.U.: Data collection; W.K., S.B.U., T.S.: Analysis and interpretation of results; T.S., I.S.W.: Draft manuscript. All authors reviewed the results and approved the final version of the manuscript.

LIST OF ABBREVIATIONS

NCD	=	Non-Communicable Diseases
SWeP	=	School Wellness Program
SOPs	=	Standard Operating Procedures
NGTs	=	Nutrition Goes to School
FGD	=	Focus Group Discussion
TFA	=	Theoretical Framework of Acceptability
SCT	=	Social Cognitive Theory
CFIR	=	Consolidated Framework for Implementation Research
DALYs	=	Disability-Adjusted Life Years
Puskesmas	=	Pusat Kesehatan Masyarakat *(Community Health Center)*
POSBINDU	=	Pos Pembinaan Terpadu *(Integrated Development Post)*
SEAMEO RECFON	=	Southeast Asian Ministers of Education Organization – Regional Centre for Food and Nutrition

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This research was approved by the Ethics Committee Poltekkes Kemenkes Yogyakarta No.DP.04.03/e-KEPK.2/404/2023 dated March 29th, 2023.

HUMAN AND ANIMAL RIGHTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

All participants provided written informed consent. No student or child health data were collected. Data privacy was safeguarded through anonymized coding, and abnormal findings (*e.g.*, high blood pressure, blood glucose, cholesterol) were referred to the local referral health provider or Puskesmas.

STANDARDS OF REPORTING

COREQ guidelines were followed

AVAILABILITY OF DATA AND MATERIALS

The data can be accessed through the link https://docs.google.com/spreadsheets/d/1PUB1A-1BxGxKOjbQxD9nAut4exBHTcLs/edit?usp=sharing&ouid=111643021375817039050&rtpof=true&sd=true

FUNDING

South East Asian Ministers of Education Organization, Regional Centre for Food and Nutrition (SEAMEO RECFON).

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

We are very grateful to the Klaten District Education Office, Health Office, school principals, teachers, and all employees from 12 elementary schools who have participated in this research. We also thank the South East Asian Ministers of Education Organization Regional Centre for Food and Nutrition (SEAMEO RECFON) for funding the publication of this article.

REFERENCES

[1] Basic health research. 2013. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/4519/1/Basic_Health_Research_Riskesdas.pdf

[2] Basic health research. 2018. Available from: https://repository.badankebijakan.kemkes.go.id/id/eprint/3514/1/Laporan%20Riskesdas%202018%20Nasional.pdf

[3] Central java health profile. 2022. Available from: https://dinkesjatengprov.go.id/v2018/dokumen/Buku_Profil_Kesehatan_2022/mobile/index.html

[4] Central java health profile. 2019. Available from: https://dinkesjatengprov.go.id/v2018/dokumen/profil2019/mobile/index.html#p=1

[5] Basic Health Research of Central Java. Jakarta, Indonesia: Ministry of Health 2018.

[6] Hanson M. The inheritance of cardiovascular disease risk. Acta Paediatr 2019; 108(10): 1747-56. http://dx.doi.org/10.1111/apa.14813 PMID: 30964948

[7] Renyoet BS, Martianto D, Iskandar D. The Estimation of economic loss potential in obese toddlers predicted to experience obesity in adulthood in Indonesia. Media Kesehat Masy Indones 2017; 13(1): 42. http://dx.doi.org/10.30597/mkmi.v13i1.1587

[8] Al-Jawaldeh A, Abbass MMS. Unhealthy dietary habits and obesity: The major risk factors beyond non-communicable diseases in the Eastern Mediterranean Region. Front Nutr 2022; 9: 817808. http://dx.doi.org/10.3389/fnut.2022.817808 PMID: 35369054

[9] Alasqah I, Mahmud I, East L, Usher K. Patterns of physical activity and dietary habits among adolescents in Saudi Arabia: A systematic review. Int J Health Sci 2021; 15(2): 39-48. PMID: 33708043

[10] Martínez-Vargas L, Vermandere H, Bautista-Arredondo S, Colchero MA. The role of social determinants on unhealthy eating habits in an urban area in Mexico: A qualitative study in low-income mothers with a young child at home. Appetite 2022; 169: 105852. http://dx.doi.org/10.1016/j.appet.2021.105852 PMID: 34890724

[11] Park JH, Moon JH, Kim HJ, Kong MH, Oh YH. Sedentary lifestyle: Overview of updated evidence of potential health risks. Korean J Fam Med 2020; 41(6): 365-73. http://dx.doi.org/10.4082/kjfm.20.0165 PMID: 33242381

[12] Kumari Ekanayake HD, Salibi DG, Tzenios N. Analysis of association between childhood overweight/obesity with screen time, sedentary life style and low levels of physical activity. SJMAS 2023; 1(6): 1-17. http://dx.doi.org/10.58676/sjmas.v1i6.40

[13] Leman MA, Claramita M, Rahayu GR. Predicting factors on modeling health behavior: A systematic review. Am J Health Behav 2021; 45(2): 268-78. http://dx.doi.org/10.5993/AJHB.45.2.7 PMID: 33888188

[14] Dadaczynski K, Hering T. Health promoting schools in germany. Mapping the implementation of holistic strategies to tackle ncds and promote health. Int J Environ Res Public Health 2021; 18(5): 2623. http://dx.doi.org/10.3390/ijerph18052623 PMID: 33807890

[15] Bassi S, Gupta VK, Park M, *et al*. School policies, built environment and practices for non-communicable disease (NCD) prevention and control in schools of Delhi, India. PLoS One 2019; 14(4): e0215365. http://dx.doi.org/10.1371/journal.pone.0215365 PMID: 30998714

[16] LeCheminant J, Merrill RM, Masterson TD. Changes in behaviors and outcomes among school-based employees in a wellness program. Health Promot Pract 2017; 18(6): 895-901. http://dx.doi.org/10.1177/1524839917716931 PMID: 28758507

[17] Rahmati M, Lee S, Yon DK, *et al*. Physical activity and prevention of mental health complications: An umbrella review. Neurosci Biobehav Rev 2024; 160: 105641. http://dx.doi.org/10.1016/j.neubiorev.2024.105641 PMID: 38527637

[18] Fernandez JC. Securing a health and nutrition-conscious young generation through the school and community education system for society 5.0. Available from: https://www.criced.tsukuba.ac.jp/math/seameo/2020/presentations/13Feb/13d-Jesus_C.F-2020.pdf

[19] Ministry of Health of the Republic of Indonesia. Smart Book for Posbindu Cadres. Jakarta: Ministry of Health of the Republic of Indonesia 2019.

[20] Lin X, Xu Y, Xu J, *et al*. Global burden of noncommunicable disease attributable to high body mass index in 195 countries and territories, 1990–2017. Endocrine 2020; 69(2): 310-20. http://dx.doi.org/10.1007/s12020-020-02352-y PMID: 32488838

[21] Malta DC, Duncan BB, Schmidt MI, Teixeira R, Ribeiro ALP, *et al*. Trends in mortality due to non-communicable diseases in the Brazilian adult population: National and subnational estimates and projections for 2030. Popul Health Metr 2020; 18(Suppl 1): 16. http://dx.doi.org/10.1186/s12963-020-00216-1

[22] Joshi V, Joshi NK, Suthar P, Jain YK. Non-communicable diseases risk factors among government school teachers in Jodhpur, Rajasthan. Int J Public Health Sci 2021; 10(4): 920-6. http://dx.doi.org/10.11591/ijphs.v10i4.20895

[23] Siswati T, Iskandar S, Pramestuti N, *et al*. Effect of a short course on improving the cadres' knowledge in the context of reducing stunting through home visits in Yogyakarta, Indonesia. Int J Environ Res Public Health 2022; 19(16): 9843. http://dx.doi.org/10.3390/ijerph19169843

[24] Schleiff MJ, Aitken I, Alam MA, Damtew ZA, Perry HB. Community health workers at the dawn of a new era: 6. Recruitment, training, and continuing education. Health Res Policy Syst 2021; 19(S3): 113. http://dx.doi.org/10.1186/s12961-021-00757-3 PMID: 34641898

[25] Bandura A. Social foundations of thought and action: A social cognitive theory. Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall, Inc. 1986.

[26] Bandura A. Self-efficacy: The Exercise of Control. New York: W. H. Freeman and Company 1997.

[27] Rogers EM. Diffusion of Innovation. New York: The Free Press 2003.

[28] Sekhon M, Cartwright M, Francis JJ. Acceptability of healthcare interventions: An overview of reviews and development of a theoretical framework. BMC Health Serv Res 2017; 17(1): 88. http://dx.doi.org/10.1186/s12913-017-2031-8 PMID: 28126032

[29] Alyafei A, Easton-Carr R. The health belief model of behavior change. StatPearls. Treasure Island (FL): StatPearls Publishing 2025.

[30] Wei Z, Zhang Z, Guo L, Zhou W, Yang K. Positive relationship between education level and risk perception and behavioral response: A machine learning approach. PLoS One 2025; 20(4): e0321153. http://dx.doi.org/10.1371/journal.pone.0321153 PMID: 40179062

[31] Keith RE, Crosson JC, O'Malley AS, Cromp D, Taylor EF. Using

the Consolidated Framework for Implementation Research (CFIR) to produce actionable findings: A rapid-cycle evaluation approach to improving implementation. Implement Sci 2017; 12(1): 15. http://dx.doi.org/10.1186/s13012-017-0550-7 PMID: 28187747

[32] McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. Health Educ Q 1988; 15(4): 351-77. http://dx.doi.org/10.1177/109019818801500401 PMID: 3068205

[33] Liu S, Wang X, Zheng Q, Gao L, Sun Q. Sleep deprivation and central appetite regulation. Nutrients 2022; 14(24): 5196. http://dx.doi.org/10.3390/nu14245196 PMID: 36558355

[34] Parameswaran G, Ray DW. Sleep, circadian rhythms, and type 2 diabetes mellitus. Clin Endocrinol 2022; 96(1): 12-20. http://dx.doi.org/10.1111/cen.14607 PMID: 34637144

[35] Morin V, Hozer F, Costemale-Lacoste JF. The effects of ghrelin on sleep, appetite, and memory, and its possible role in depression: A review of the literature. Encephale 2018; 44(3): 256-63. http://dx.doi.org/10.1016/j.encep.2017.10.012 PMID: 29395244

[36] Momayyezi M, Fallahzadeh H, Fakhravari L, Mirzaei M. The association between sleep pattern with lipid profile and obesity among adults in Yazd: Cross-sectional analysis of Shahedieh Cohort Study. J Nutr Food Secur 2022; 7(3): 10198. http://dx.doi.org/10.18502/jnfs.v7i3.10198

[37] Chaput JP, McHill AW, Cox RC, *et al*. The role of insufficient sleep and circadian misalignment in obesity. Nat Rev Endocrinol 2023; 19(2): 82-97. http://dx.doi.org/10.1038/s41574-022-00747-7 PMID: 36280789

[38] Tanvir M, Abida M, Nazeer M. A study of sleep duration, body mass index and blood pressure in an adult Kashmiri population. Int J Community Med Public Health 2023; 10(12): 4684-9. http://dx.doi.org/10.18203/2394-6040.ijcmph20233763

[39] Amahmid O, El Guamri Y, Rakibi Y, *et al*. Nutrition education in school curriculum: Impact on adolescents' attitudes and dietary behaviours. Int J Health Promot Educ 2020; 58(5): 242-58. http://dx.doi.org/10.1080/14635240.2019.1685399

[40] Ruiz LD, Radtke MD, Scherr RE. Development and pilot testing of a food literacy curriculum for high school-aged adolescents. Nutrients 2021; 13(5): 1532. http://dx.doi.org/10.3390/nu13051532 PMID: 34062865

[41] Follong BM, Verdonschot A, Prieto-Rodriguez E, Miller A, Collins CE, Bucher T. Nutrition across the curriculum: A scoping review exploring the integration of nutrition education within primary schools. Nutr Res Rev 2022; 35(2): 181-96. http://dx.doi.org/10.1017/S0954422421000111 PMID: 33926596

[42] Singh A, Bassi S, Nazar GP, *et al*. Impact of school policies on non-communicable disease risk factors – A systematic review. BMC Public Health 2017; 17(1): 292. http://dx.doi.org/10.1186/s12889-017-4201-3 PMID: 28376833

[43] Profili E, Rubio DS, Lane HG, *et al*. School wellness team best practices to promote wellness policy implementation. Prev Med 2017; 101: 34-7. http://dx.doi.org/10.1016/j.ypmed.2017.05.016 PMID: 28528173

[44] Jourdan D, Samdal O, Diagne F, Carvalho GS. The future of health promotion in schools goes through the strengthening of teacher training at a global level. Promot Educ 2008; 15(3): 36-8. http://dx.doi.org/10.1177/1025382308095657 PMID: 18784053