

Effectiveness of nursing-led microlearning with spaced reinforcement on sexual violence awareness among rural adolescents in Indonesia

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ABSTRACT

Sexual violence among adolescents remains a major public health concern, particularly in rural areas where access to prevention education is limited. This study evaluated the effectiveness of a nursing-led microlearning intervention with spaced reinforcement in improving adolescents' awareness of sexual violence. A repeated-measures experimental study was conducted among 120 adolescents aged 13–16 years from rural junior high schools. Participants received either microlearning with spaced reinforcement ($n = 60$) or leaflet-based education ($n = 60$). Awareness was assessed at baseline, post-intervention, and four-week follow-up. Data were analyzed using linear mixed-effects models and generalized estimating equations. Baseline awareness scores were comparable between groups. Compared with leaflet education, the microlearning group demonstrated significantly greater improvements immediately after the intervention ($\beta = 9.1$, 95% CI: 7.2–11.0, $p < 0.001$) and maintained higher scores at follow-up ($\beta = 8.6$, 95% CI: 6.5–10.7, $p < 0.001$). Sensitivity analyses confirmed consistent findings. Nursing-led microlearning with spaced reinforcement was more effective than leaflet-based education in improving and sustaining adolescents' awareness of sexual violence. This approach represents a feasible strategy for strengthening school.

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1. INTRODUCTION

Sexual violence against children and adolescents remains a pervasive public health and human rights problem, with consequences that can shape health and life opportunities long after the incident itself. Beyond immediate injury, survivors face elevated risks of mental health problems, chronic stress-related conditions, disrupted schooling, and impaired social functioning across the life course [1]. Recent global syntheses drawing on population-based evidence show that sexual harassment and contact sexual violence are common during childhood and adolescence, although prevalence varies substantially by region and country income level [1], [2]. Importantly, surveillance and national survey findings repeatedly indicate that

childhood sexual violence often occurs in ordinary, familiar settings, especially homes and schools, and is frequently perpetrated by someone known to the child [3], [4]. Yet disclosure and help-seeking remain consistently low, meaning many adolescents carry the experience in silence and do not reach formal protection, health, or psychosocial support services [4], [5]. These patterns strengthen the case for upstream, developmentally appropriate prevention education delivered before harm occurs that improves adolescents' recognition of sexual violence, protective knowledge, and readiness to seek help [6].

In Indonesia, sexual violence against adolescents has become an increasing concern, with national survey data indicating that many cases occur in familiar environments such as homes and schools and are frequently underreported because of fear, stigma, and limited access to confidential reporting systems [3]. Rural adolescents may experience additional barriers related to limited sexuality education, restricted access to adolescent-friendly health services, and sociocultural norms that discourage open discussion of sexual violence and help-seeking behaviors [7], [8]. These contextual challenges highlight the urgent need for accessible, developmentally appropriate, and sustainable prevention education strategies tailored for rural Indonesian adolescents.

Rural contexts may further intensify vulnerability through structural and sociocultural barriers that limit adolescents' access to accurate information, confidential support, and youth-friendly services. A systematic review of rural adolescents' reproductive health awareness (2019–2024) highlighted multilevel obstacles, myths and misconceptions, shame and fear, restrictive norms, limited parent–adolescent communication, service scarcity, and negative service experiences that collectively reduce awareness and delay timely help-seeking [7]. While this evidence is not specific to sexual violence alone, the implications translate directly: prevention education depends on the same enabling conditions credible information, psychologically safe learning spaces, and clear pathways to confidential support that are often weaker in rural settings [7], [8]. In addition, broader evidence on children's and adolescents' formal help-seeking suggests that even when young people recognize harm, uncertainty about where to go, fear of not being believed, and concerns about confidentiality can suppress disclosure barriers that may be amplified where services are distant or socially visible [8], [9]. As a result, programs designed for urban or resource-rich school environments may not transfer effectively to rural adolescents without adapting delivery methods for feasibility, privacy, stigma, and reinforcement needs [7], [9].

School- and community-based prevention programs have been widely implemented to strengthen knowledge, attitudes, and protective behaviors related to child sexual abuse and sexual violence. Recent syntheses generally report beneficial effects, but they also emphasize substantial heterogeneity across programs content, instructional style, and dose suggesting that outcomes are highly sensitive to how education is designed and delivered [10], [11]. In low- and middle-income settings, digital and mobile approaches are increasingly explored to expand reach and standardize content. For example, a cluster-randomized controlled trial in Indonesia found that a mobile application-based child sexual abuse prevention programs delivered over several weeks (with parent and teacher involvement) was feasible and improved prevention-related outcomes [12]. Even so, many interventions still rely on relatively "massed" learning (single-session or short-course delivery), which can lead to rapid knowledge decay, particularly when adolescents face competing school demands and limited opportunities for reinforcement [10], [11].

Learning science offers a mechanism-driven strategy to address retention and engagement: microlearning combined with spaced reinforcement. Microlearning delivers short, focused units that are easier to complete, repeat, and integrate into school routines. Evidence from health professions education shows microlearning can improve knowledge and confidence, while also noting practical concerns, including technology inequities and privacy that become especially important in resource-limited contexts [13]. Spaced digital education, where key concepts are revisited over time, has shown advantages for knowledge outcomes in systematic review evidence [14], and controlled studies of mobile spaced-repetition approaches demonstrate improved knowledge retention compared with conventional learning patterns [15]. Previous findings support a plausible prevention pathway: repeated, low-burden exposure to essential concepts may build more durable awareness, which matters for recognizing boundary violations, interpreting coercive situations, and initiating timely help-seeking [8], [9], [14].

In adolescent sexual and reproductive health education, audiovisual and leaflet-based approaches remain popular because they are scalable and generally acceptable in school settings. Recent intervention evidence indicates that video-based education and e-leaflets can improve knowledge and related outcomes, although effects can vary by modality and implementation context [16]. However, these modalities are often delivered as single exposures or short programs, leaving a practical question unanswered: do adolescents retain and apply knowledge weeks later, especially in rural settings where stigma and limited confidential support may still suppress disclosure even when awareness improves [7], [9], [16]. The research gap is not whether education can improve awareness in principle, but whether an education design grounded in retention science, but also microlearning combined with spaced reinforcement can produce more durable

improvements in adolescents' sexual violence awareness in rural contexts [7], [10], [14]. Prevention programs syntheses highlight delivery heterogeneity and do not yet establish optimal reinforcement schedules for sustained awareness outcomes [10], [11]. Moreover, despite growth in digital prevention programs (including LMIC-based trials) [12], rigorous experimental evaluations that explicitly operationalize microlearning with spaced reinforcement for sexual violence awareness tested among rural adolescents and assessed with repeated measurements to examine persistence remain limited in recent literature [7], [14], [16]. Addressing this gap is important because educational effects that fade quickly may have limited real-world preventive value.

Despite growing evidence supporting digital and school-based sexual violence prevention programs, few studies have specifically evaluated the effectiveness of microlearning combined with spaced reinforcement for improving sustained sexual violence awareness among rural adolescents in Indonesia [10], [12], [14]. In addition, previous interventions have predominantly focused on immediate post-intervention outcomes without examining whether awareness improvements are retained over time. Therefore, evidence regarding the long-term educational value of retention-based learning strategies in adolescent sexual violence prevention remains limited. Therefore, this study aimed to evaluate the effectiveness of a nursing-led educational intervention using microlearning with spaced reinforcement to improve adolescents' awareness of sexual violence in rural areas, using an experimental design with repeated outcome measurement to assess both immediate gains and short-term retention.

2. METHOD

2.1. Study design and setting

This study used an experimental, repeated-measures, two-arm design conducted in rural junior high schools. Outcomes were assessed at baseline (T0), immediately after the core learning phase (T1), and at four weeks after completion (T2) to evaluate both immediate learning gains and short-term retention under a spaced reinforcement approach. The study was implemented in rural school catchment areas characterized by limited access to youth-friendly information and services, where school-based health education remains a primary channel for prevention messaging.

2.2. Participants and sampling

The target population was adolescents enrolled in grades 8–9 (approximately 13–16 years). Eligibility criteria were: enrolled as an active student at the participating school; able to read and understand *Bahasa Indonesia*; had access to a phone (personal or shared within the household) sufficient to receive short learning content; and provided written assent with written parental/guardian consent. Students were excluded if they reported current severe psychological distress requiring immediate referral at screening by the school counselor/teacher (per safeguarding protocol), had participated in a structured sexual violence prevention program within the past six months, or were absent during baseline assessment.

A multi-stage cluster sampling technique was applied. Four rural junior high schools were selected from two rural subdistricts based on accessibility, willingness to participate, and similarity of school characteristics. Schools were allocated into intervention and comparison conditions to minimize contamination between participants within the same educational environment. Two schools were assigned to the microlearning intervention group and two schools to the leaflet comparison group. Approximately 30 eligible students were recruited from each school cluster, resulting in a total sample of 120 participants. Rural schools meeting inclusion criteria were first identified in collaboration with local education authorities; schools were then selected purposively to reflect rural access constraints and feasibility for follow-up. Within each selected school, eligible students were invited consecutively until the target sample size was achieved. Because participants were embedded within school clusters and repeatedly measured, the analysis plan explicitly accounted for within-student and within-school correlation.

A priori sample size estimation was conducted using GPower (version 3.1) to determine the minimum number of participants required to detect a group-by-time interaction for repeated-measures outcomes with adequate statistical power. Consistent with guidance on using GPower for health research planning, assumptions were specified for a mixed repeated-measures effect (two groups, three measurement occasions), two-sided $\alpha = 0.05$, power $(1 - \beta) = 0.80$, and a moderate standardized effect size ($f = 0.25$) [17]. The within-subject correlation was conservatively set at 0.50 with no sphericity correction $\epsilon = 1.00$. The minimum required sample was inflated to accommodate anticipated attrition at follow-up in rural settings and potential clustering effects; therefore, the final recruitment target was increased by approximately 15%, yielding a planned total sample of 120 adolescents (60 per arm).

2.3. Intervention and comparison condition

The intervention was a nursing-led microlearning program with spaced reinforcement designed to enhance adolescents' awareness of sexual violence in a feasible, low-burden format appropriate for rural settings. Microlearning was operationalized as brief, focused learning units delivered in short sessions to support engagement and reduce cognitive overload, consistent with evidence that microlearning can improve knowledge outcomes while maintaining feasibility in health education contexts [13], [18]. The core content consisted of six microlearning modules (3–5 minutes each) delivered over two weeks via a mobile-friendly format. Modules addressed: recognizing sexual violence and coercion; consent and boundaries; online and peer-related risks; myths and normalization; safe responses and refusal skills; and help-seeking pathways and trusted adults.

Spaced reinforcement was implemented through scheduled booster prompts and retrieval-style checks at increasing intervals (e.g., day 3, day 7, and day 14 following key modules). Reinforcement included short recap cards and two to three application questions with immediate corrective feedback. This approach was aligned with evidence that spaced learning models can improve retention and performance compared with massed delivery [19], and with broader findings that prevention program effectiveness can be influenced by instructional dose and delivery structure [20].

The comparison group received standard school health education materials in print form (leaflet) covering the same core topics. The materials were delivered once in a single session without scheduled reinforcement. Both arms had access to the same safeguarding information (e.g., contacts for the school counselor and local referral services) to ensure ethical parity for safety.

2.4. Instruments

The primary outcome was adolescents' awareness of sexual violence. Awareness was measured using the sexual violence awareness questionnaire—adolescents (SVAQ-A), developed for this study based on contemporary prevention frameworks and rural feasibility considerations. Item development followed an evidence-informed content specification and expert review consistent with COSMIN-oriented principles emphasizing relevance, comprehensiveness, and comprehensibility for the target population [21]. The preliminary item pool was reviewed by a panel of experts (community/public health nursing, adolescent health, school counseling, and child protection). After revisions, the final SVAQ-A contained 24 items across four domains: recognition of sexual violence and coercion, consent and boundaries, myth rejection and normalization, and help-seeking readiness. Content validity was quantitatively assessed using the content validity index (CVI). Expert ratings demonstrated acceptable item-level content validity ($I-CVI \geq 0.78$) and satisfactory scale-level validity. Construct validity was evaluated during pilot testing using item-total correlation analysis, with all retained items meeting the minimum acceptable correlation threshold ($r > 0.30$). Internal consistency reliability testing demonstrated good reliability for the final instrument (Cronbach's $\alpha = 0.86$).

Items were scored on a 4-point Likert scale (0 = strongly disagree to 3 = strongly agree). Negatively keyed items were reverse-scored. Total scores ranged from 0 to 72, with higher scores indicating greater awareness and preparedness to recognize sexual violence and identify appropriate help-seeking actions. Scores were interpreted using distribution-based cut points (tertiles) to classify low, moderate, and high awareness for descriptive reporting.

Because the questionnaire was administered in Bahasa Indonesia and was intended for rural adolescents, language clarity was prioritized. If any items were adapted from English sources, translation and cultural adaptation procedures followed recent methodological recommendations for translation, cultural adaptation, and validation of health-related instruments, including iterative review with target users and reconciliation of semantic and cultural equivalence [22]. A pilot test was conducted with a small group of students from a non-participating school to assess comprehensibility and completion time. Reliability was evaluated as internal consistency. In pilot testing, SVAQ-A demonstrated acceptable internal consistency (Cronbach's $\alpha \geq 0.70$), and reliability was re-estimated using baseline data in the full study sample. In addition, a brief acceptability and usability form (5 items; 4-point response options) captured perceived clarity, comfort, usefulness, and willingness to recommend the learning approach to peers.

2.5. Procedures

Recruitment was conducted through coordinated school announcements and parent information letters. Data collection occurred in supervised classroom settings to ensure privacy and minimize peer influence. Trained research assistants were available to clarify item meanings without leading participants' responses.

At T0, participants completed the baseline questionnaire. The intervention arm then received microlearning modules over two weeks, followed by scheduled spaced reinforcement boosters. The comparison arm received the leaflet session at baseline without follow-up boosters. Immediate post-

intervention assessment (T1) was conducted within one week after completing the core learning phase. Follow-up assessment (T2) was conducted four weeks after completion to evaluate retention. To incorporate participant feedback, a short debrief was conducted after T1 in both groups, focusing on clarity of content, perceived relevance, and suggestions for improving delivery in rural school contexts. Feedback was summarized for iterative refinement of the educational package.

2.6. Data analysis

Data were analyzed using a pre-specified plan suitable for correlated repeated measures and clustering by school. Descriptive statistics summarized participant characteristics and baseline scores. Group equivalence at baseline was assessed using appropriate tests (t-test or Mann–Whitney U for continuous variables; χ^2 for categorical variables), with emphasis on standardized differences. Primary effectiveness analysis used linear mixed-effects modeling to estimate the intervention effect over time while accounting for within-student correlation (repeated measures) and potential clustering within schools. Models included fixed effects for group (microlearning vs leaflet), time (T0, T1, T2), and the group-by-time interaction (primary parameter of interest). Random intercepts were specified for participants, and a school-level random effect was added when supported by the data structure. Mixed models were selected because they can provide valid inference under missing-at-random assumptions using maximum likelihood estimation and are appropriate for unbalanced repeated-measures designs common in field-based intervention studies [23]. Sensitivity analyses were conducted using generalized estimating equations (GEE) with robust standard errors to assess whether conclusions were consistent under a population-averaged approach for correlated outcomes [24]. Covariates considered a priori included age, sex, grade level, and prior exposure to general reproductive health education. Effect sizes were reported as estimated marginal mean differences and standardized mean differences with 95% confidence intervals. Statistical significance was set at $p < 0.05$.

3. RESULTS

The participant recruitment, allocation, follow-up, and analysis procedures are summarized in Figure 1. Baseline demographic characteristics of participants are presented in Table 1. The mean age of participants was 14.6 years (SD = 1.1), and 54.2% were female. No statistically significant differences were observed between the intervention and control groups in terms of age, sex distribution, grade level, or prior exposure to general reproductive health education ($p > 0.05$), indicating baseline comparability.

Mean sexual violence awareness scores at baseline (T0), immediate post-intervention (T1), and four-week follow-up (T2) are summarized in Table 2. At baseline, mean awareness scores did not differ significantly between groups ($p = 0.621$). Following the intervention, the microlearning group demonstrated a marked increase in awareness scores at T1, which was sustained at T2. In contrast, the leaflet group showed a modest increase at T1 with partial decline at T2 (Table 2).

The primary effectiveness analysis was conducted using linear mixed-effects modeling with fixed effects for group, time, and group-by-time interaction, and random intercepts for participants. The results are presented in Table 3. A statistically significant group-by-time interaction was observed ($p < 0.001$), indicating that changes in awareness scores over time differed significantly between the two groups. Compared with the leaflet group, participants in the microlearning group demonstrated significantly greater increases in awareness scores at T1 ($\beta = 9.1$, 95% CI: 7.2–11.0) and maintained significantly higher scores at T2 ($\beta = 8.6$, 95% CI: 6.5–10.7), after adjustment for age, sex, grade level, and prior health education exposure.

Table 1. Demographic characteristics of participants by study group (N = 120)

Characteristic	Microlearning group (n = 60)	Leaflet group (n = 60)	p-value
Age, mean $\pm$ SD (years)	14.7 $\pm$ 1.0	14.5 $\pm$ 1.1	0.312
Female, n (%)	33 (55.0)	32 (53.3)	0.854
Grade 8, n (%)	31 (51.7)	29 (48.3)	0.713
Grade 9, n (%)	29 (48.3)	31 (51.7)	
Prior reproductive health education, n (%)	18 (30.0)	20 (33.3)	0.694

Table 2. Sexual violence awareness scores over time by study group

Time point	Microlearning group (mean $\pm$ SD)	Leaflet group (mean $\pm$ SD)
Baseline (T0)	41.2 $\pm$ 6.8	40.7 $\pm$ 7.1
Post-intervention (T1)	56.9 $\pm$ 6.2	47.8 $\pm$ 6.9
4-week follow-up (T2)	54.8 $\pm$ 6.5	44.9 $\pm$ 7.3

In practical terms, the observed increase in awareness scores suggests that adolescents receiving the microlearning intervention demonstrated improved ability to recognize inappropriate behaviors, identify coercive situations, and understand appropriate help-seeking pathways. The sustained improvement observed at the four-week follow-up further indicates that the intervention may support retention of protective knowledge. This suggests that the benefits of the intervention extend beyond immediate exposure.

The GEE analysis showed results consistent with the primary mixed-effects models. There was no significant baseline difference between groups ($\beta = 0.5$, $p = 0.536$). Awareness scores increased significantly over time at both post-intervention (T1: $\beta = 6.5$, $p < 0.001$) and four-week follow-up (T2: $\beta = 4.6$, $p < 0.001$). Significant group-by-time interactions indicated that the microlearning group achieved greater improvements than the leaflet group at T1 ($\beta = 8.9$, $p < 0.001$) and maintained higher scores at T2 ($\beta = 8.2$, $p < 0.001$) (Table 4).

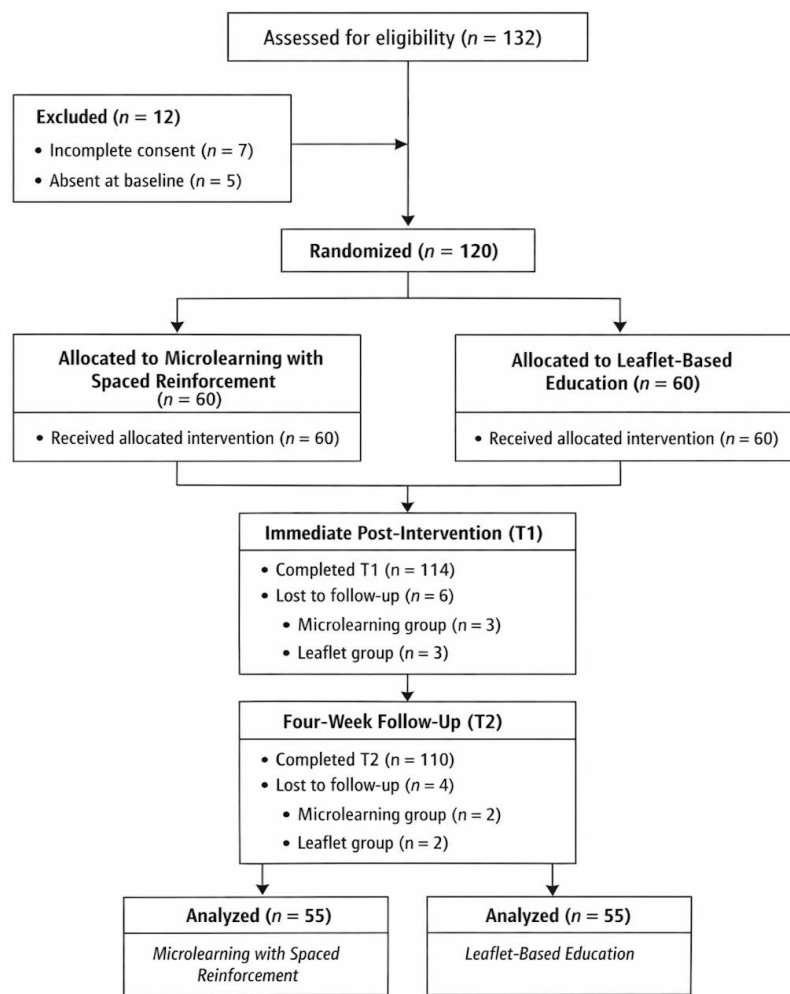


Figure 1. Study flow chart

Table 3. Linear mixed-effects model for sexual violence awareness scores

Predictor	β (estimate)	SE	95% CI	p-value
Group (microlearning vs leaflet)	0.6	0.9	-1.2 to 2.4	0.514
Time (T1 vs T0)	6.8	0.7	5.4 to 8.2	<0.001
Time (T2 vs T0)	4.9	0.8	3.3 to 6.5	<0.001
Group $\times$ Time (T1)	9.1	1.0	7.2 to 11.0	<0.001
Group $\times$ Time (T2)	8.6	1.1	6.5 to 10.7	<0.001

Table 4. Sensitivity analysis of sexual violence awareness scores using generalized estimating equations (GEE)

Predictor	β (estimate)	SE	95% CI	p-value
Group (microlearning vs leaflet)	0.5	0.8	-1.1 to 2.1	0.536
Time (T1 vs T0)	6.5	0.6	5.3 to 7.7	<0.001
Time (T2 vs T0)	4.6	0.7	3.2 to 6.0	<0.001
Group $\times$ Time (T1)	8.9	0.9	7.1 to 10.7	<0.001
Group $\times$ Time (T2)	8.2	1.0	6.2 to 10.2	<0.001

4. DISCUSSION

This experimental study demonstrated that a nursing-led microlearning intervention with spaced reinforcement produced significantly greater and more sustained improvements in adolescents' awareness of sexual violence in rural areas compared with conventional leaflet-based education. Baseline equivalence between groups in demographic characteristics and prior reproductive health education strengthens internal validity and supports the attribution of observed effects to the intervention rather than pre-existing differences. The consistent findings across linear mixed-effects models and generalized estimating equations further confirm the robustness of the intervention effect at both individual and population levels.

The marked increase in awareness scores observed immediately after the intervention (T1) and the sustained advantage at four-week follow-up (T2) in the microlearning group indicate that educational format and delivery structure play a critical role in determining not only immediate learning gains but also short-term retention. While both groups showed some improvement over time, reflecting the general benefit of exposure to sexual violence education, the magnitude and persistence of gains were substantially greater among adolescents receiving microlearning with spaced reinforcement. The significant group-by-time interactions observed in both analytic approaches underscore that the intervention effect was not transient and was resilient to alternative modeling assumptions. From a learning science perspective, these findings align with evidence that spaced educational exposure counteracts rapid forgetting and supports consolidation of knowledge into longer-term memory [25], [26]. These findings are also consistent with cognitive learning theories suggesting that repeated retrieval practice and distributed learning exposure improve memory consolidation and long-term retention compared with single-session educational delivery [27], [28]. Microlearning formats, characterized by short, focused content units, may also reduce cognitive overload and improve engagement, particularly among adolescents balancing academic demands and limited learning resources in rural settings [27]. Together, these mechanisms plausibly explain the superior retention observed in the intervention group compared with single-exposure leaflet education.

The present findings extend prior research on school- and community-based sexual violence prevention programs. Similar findings have also been reported in adolescent digital health education studies demonstrating that repeated and interactive educational exposure can improve engagement and knowledge sustainability among adolescents [29]. Meta-analytic evidence indicates that such programs can improve knowledge and protective outcomes but highlights substantial heterogeneity related to programmer intensity, instructional methods, and reinforcement strategies [28]. Many interventions rely on one-off or short-duration sessions, which may explain the attenuation of effects over time reported in several studies. Our results contribute to this literature by demonstrating that embedding reinforcement into the educational design can meaningfully enhance outcome durability.

Recent digital and mobile-based prevention interventions have shown promising effects on sexual abuse and violence awareness among children and adolescents, including studies conducted in low- and middle-income countries [29], [30]. However, most evaluations focus on feasibility or immediate post-intervention outcomes, with limited attention to retention beyond the initial exposure. By incorporating repeated measurements and spaced reinforcement, the present study provides empirical support for a theoretically grounded approach to improving durability of learning effects in adolescent sexual violence education.

Moreover, the rural focus of this study addresses an important contextual gap. Rural adolescents often face compounded barriers to information, confidentiality, and supportive services, which can limit both awareness and help-seeking behaviors [31]. Educational interventions designed for urban or resource-rich contexts may not translate effectively without adaptation. The observed effectiveness of a low-burden microlearning approach suggests that such strategies may be particularly well suited for rural settings where sustained, resource-intensive programming is difficult to implement. This finding supports previous evidence suggesting that flexible digital learning approaches may be particularly beneficial for adolescents in underserved and geographically isolated communities [30].

Nevertheless, increased awareness should not automatically be interpreted as direct behavioral change. Although improved recognition of sexual violence and help-seeking readiness are important preventive outcomes, adolescents may still face substantial barriers to disclosure and service utilization, particularly in rural settings characterized by stigma, fear of social consequences, and limited confidential support systems [8], [9]. Therefore, educational interventions alone may be insufficient without broader structural and psychosocial support mechanisms. Future interventions should consider integrating parental engagement, school safeguarding systems, and adolescent-friendly referral pathways to strengthen translation of awareness into protective behaviors and actual help-seeking practices.

4.1. Clinical and public health implications

The findings have several implications for nursing practice and public health programming. First, nurses serving as school and community health educators are well positioned to deliver microlearning-based interventions, integrating brief educational modules into existing school health activities without substantial disruption. Second, the use of spaced reinforcement offers a practical means to enhance retention without requiring prolonged contact time, which is especially valuable in rural and resource-limited contexts. At the systems level, the intervention model supports a shift from single-session awareness campaigns toward evidence-informed educational designs that prioritize retention and reinforcement. Incorporating microlearning and spaced reinforcement into adolescent health promotion strategies may strengthen early recognition of sexual violence, improve readiness to seek help, and ultimately contribute to upstream prevention. These approaches are also compatible with digital health and school-based platforms increasingly emphasized in public health strategies targeting adolescents [32].

4.2. Study limitations

Several limitations should be considered when interpreting these findings. First, although the experimental design and repeated measures strengthen causal inference, the study was conducted in selected rural schools, which may limit generalizability to urban settings or out-of-school adolescents. Second, awareness was measured using a self-report instrument, which may be subject to social desirability bias despite assurances of confidentiality. Third, the follow-up period was limited to four weeks, which restricts conclusions regarding long-term sustainability of learning retention and behavioral impact. It remains unclear whether awareness gains would persist over several months or translate into actual preventive behaviors, disclosure practices, or increased utilization of support services. Finally, while sensitivity analyses supported the robustness of the findings, the study was not powered to explore subgroup effects (e.g., by sex or prior exposure to violence), which should be examined in future research. Previous studies have shown that short-term educational gains do not always translate into sustained behavioral change without ongoing reinforcement and supportive environmental factors [31].

5. CONCLUSION

In conclusion, this study provides evidence that a nursing-led microlearning intervention with spaced reinforcement is more effective than conventional leaflet-based education in improving and sustaining adolescents' awareness of sexual violence in rural areas. By integrating principles from learning science into public health education, this approach offers a feasible, scalable, and context-sensitive strategy for strengthening adolescent sexual violence prevention efforts. Future studies should examine longer-term outcomes and explore integration with broader safeguarding and help-seeking pathways to maximize public health impact.

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C : Conceptualization

M : Methodology

So : Software

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R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ETHICAL APPROVAL

Ethical approval was obtained from the institutional review board (IRB) of the investigators' institution prior to data collection (No. C.144/KEPK/FKIK/IX/2025). Permissions were secured from the district education office and school principals. A safeguarding protocol was established in collaboration with school counselors, including referral pathways and confidential reporting procedures for participants who disclosed distress or experiences requiring support. Written parental/guardian consent and student assent were obtained before baseline assessment. After T2, students in the comparison arm were offered access to the microlearning materials as an ethical benefit.

DATA AVAILABILITY

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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