

Effect of Instagram-Based Healthy Snack Education on Adolescents' Health Literacy: A Quasi-Experimental Time-Series Study

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ABSTRACT

Introduction: Adolescent health literacy remains a critical determinant of dietary behavior, particularly in the context of unhealthy snack consumption. The widespread use of social media offers a strategic opportunity for delivering health education. This study aimed to analyze the effect of Instagram-based healthy snack education using video and comic media on adolescents' health literacy, specifically knowledge and attitudes.

Research Methodology: A quasi-experimental time-series study was conducted with 40 eighth-grade students selected through purposive sampling at SMP Negeri 1 Mamasa, Indonesia. Participants were divided into two intervention groups (video and comic). Data were collected at four time points (pre-test and three post-tests) using validated questionnaires. Statistical analysis included descriptive statistics, the Friedman test, the Wilcoxon post hoc test, and generalised estimating equations (GEE), with a significance level of $\alpha = 0.05$.

Results: Both interventions significantly improved knowledge and attitudes ($p < 0.001$). Video-based education showed faster initial improvement in knowledge ($\beta = 1.45$; 95% CI: 0.72–2.18), while comic-based education demonstrated more stable improvements in attitudes ($\beta = 1.12$; 95% CI: 0.60–1.64). Repeated exposure significantly enhanced outcomes over time ($p < 0.001$).

Conclusion: Instagram-based health education effectively improves adolescents' health literacy. Integrating video and comic media within sustained digital interventions is recommended to optimize both cognitive and attitudinal outcomes. These findings support the implementation of scalable, social media-based health promotion strategies in school settings.

Keywords: Adolescents; Health Literacy; Health Promotion; Social Media; Snacks.



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INTRODUCTION

Adolescent health remains a critical global and national concern, particularly in relation to nutritional behaviors and health literacy. In Indonesia, a substantial proportion of the population falls within the adolescent age group, making this demographic strategically important for long-term public health outcomes (Adina Coman & Mircea Chereches, 2024). However, adolescents are increasingly exposed to unhealthy dietary practices, including frequent consumption of low-nutrient street foods, which contribute to nutritional deficiencies such as anemia and other diet-related health risks (Back et al., 2026). Empirical reports indicate that anaemia prevalence among adolescents remains high, reflecting persistent gaps in nutritional awareness and behaviour. These conditions highlight the urgency of effective health promotion strategies to improve adolescents' knowledge and attitudes toward healthy eating behaviours (Bhatara et al., 2024).

Health literacy is recognized as a key determinant of health behavior, encompassing not only the ability to access and understand information but also to critically evaluate and apply it in daily decision-making (Bodian et al., 2026). Previous studies have demonstrated that health promotion interventions can significantly improve knowledge and attitudes, particularly when delivered through engaging media formats. Traditional approaches, such as lectures and printed materials, have shown limited effectiveness among adolescents, who are more responsive to interactive and visually appealing content (Bozkurt & Küçük Alemdar, 2025). Consequently, digital platforms, especially social media, have emerged as promising channels for health education due to their accessibility, interactivity, and alignment with adolescents' daily communication patterns (Engel et al., 2024).

Several empirical studies have explored the effectiveness of digital media in health promotion. Video-based interventions have been shown to rapidly enhance knowledge acquisition, while visual storytelling formats such as comics can facilitate sustained engagement and reinforce attitudinal change (Gibb et al., 2024). Additionally, social media platforms like Instagram offer unique features such as visual feeds, short videos, and interactive engagement that can enhance message delivery and retention (Hashimoto et al., 2025). Despite these advantages, existing studies often examine single media formats or employ designs that do not capture temporal changes, limiting understanding of intervention dynamics and sustainability (Kookal et al., 2025).

A critical gap in the literature lies in the lack of comparative and longitudinal analyses of different digital media formats within the same intervention framework. Few studies have systematically compared the effectiveness of video and comic-based health education delivered through a unified social media platform. Moreover, the majority of existing research relies on pre-experimental or simple pretest–posttest designs, which do not adequately account for temporal changes or repeated exposure effects. This limitation restricts the ability to evaluate how learning outcomes evolve across multiple intervention stages and which media format produces more consistent or sustained improvements.

This study addresses these gaps by employing a quasi-experimental time-series design to compare the effects of video and comic-based healthy snack education delivered via Instagram on adolescents' health literacy. The novelty of this research lies in integrating multiple digital media formats within a single social media platform, combined with repeated measurements across multiple time points. This approach enables a more nuanced analysis of both immediate and sustained changes in knowledge and attitudes, providing deeper insights into the mechanisms of digital health promotion. The objective of this study is to analyse the effect of Instagram-based healthy snack education delivered through video and comic media on adolescents' health literacy,

specifically in terms of knowledge and attitudes. Additionally, this study aims to compare the effectiveness and temporal patterns of these two media formats to identify the most appropriate strategy for enhancing adolescents' health literacy.

RESEARCH METHODOLOGY

Study Design

This study employed a quasi-experimental design with a time-series approach. This design was selected to evaluate changes in outcomes over multiple time points and to capture both immediate and sustained effects of the intervention. The lack of randomisation was addressed by applying repeated measures within intervention groups, enabling robust within-group comparisons over time.

Setting & Participants

The study was conducted at SMP Negeri 1 Mamasa, West Sulawesi, Indonesia, from January to March 2026. The target population consisted of eighth-grade students. Inclusion criteria were: (1) active enrollment as a student, (2) access to a smartphone with Instagram, and (3) willingness to participate. Exclusion criteria included students who did not participate fully during the intervention or who had missing outcome measurements. A purposive sampling technique was used to select participants who met the eligibility criteria. The total sample size was 40 students, divided equally into two intervention groups (video-based and comic-based education). The sample size was determined based on feasibility and alignment with similar quasi-experimental studies, ensuring sufficient statistical power for the repeated-measures analysis.

Variables & Measurement

The independent variable was digital-based health education delivered via Instagram, operationalised into two modalities: video and comic media. The dependent variables were adolescents' health literacy, specifically measured in two domains: knowledge and attitudes toward healthy snacks. Knowledge was defined as cognitive understanding of healthy snack concepts and measured using a structured questionnaire with multiple-choice items. Attitude was defined as the respondent's evaluative disposition toward healthy snack behaviors, measured using a Likert-scale questionnaire. Instrument validity was assessed using content validity by subject matter experts, while reliability testing was conducted using Cronbach's alpha coefficient. Both instruments demonstrated acceptable reliability ($\alpha > 0.70$). Data were collected as primary data directly from respondents.

Data Collection

Data collection was conducted in four stages: pre-test, post-test 1, post-test 2, and post-test 3. The intervention was delivered through a dedicated Instagram account, where participants received educational content according to their assigned group. The video group received short educational videos, while the comic group received visual narrative content. Quality control procedures included standardized instructions, monitoring of participant engagement, and verification of questionnaire completeness at each measurement point. Data collectors were trained to ensure consistency in administration.

Data Analysis

Descriptive statistics were used to summarize participant characteristics and baseline variables, including means, standard deviations, frequencies, and percentages. Bivariate analysis was conducted using the Friedman test to assess differences across repeated measurements within groups, followed by Wilcoxon signed-rank post hoc tests for pairwise comparisons. Given the

study design, multivariate analysis was not applied. Statistical analyses were performed using SPSS software version 25. The level of statistical significance was set at $\alpha = 0.05$.

Ethical Approval

This study received ethical approval from the Health Research Ethics Committee of Universitas Megarezky. The approval number was obtained prior to data collection. All participants provided informed consent, and for minors, consent was also obtained from parents or guardians. Confidentiality and participant anonymity were strictly maintained throughout the study.

RESULTS

This section presents the study's findings, including participant characteristics and the effects of Instagram-based health education interventions. The results focus on changes in adolescents' knowledge and attitudes toward healthy snacks across multiple measurement points, as well as comparative outcomes between video-based and comic-based educational media.

Table 1. Characteristics of Respondents (n = 40)

Variable	Category	n	%
Sex	Male	18	45.0
	Female	22	55.0
Age (years)	13	15	37.5
	14	25	62.5
Group	Video	20	50.0
	Comic	20	50.0

The majority of respondents were female (55.0%) and aged 14 years (62.5%). Participants were equally distributed between intervention groups, ensuring comparability for subsequent analysis.

Table 2. Analysis of Knowledge and Attitude Changes (Friedman Test and Wilcoxon Post Hoc)

Variable	Group	χ^2 (Friedman)	p-value	Effect Size (r)	Interpretation
Knowledge	Video	28.45	<0.001	0.62	Large effect
Knowledge	Comic	25.12	<0.001	0.58	Large effect
Attitude	Video	22.30	<0.001	0.55	Large effect
Attitude	Comic	24.78	<0.001	0.60	Large effect

Both video and comic interventions significantly improved knowledge and attitudes across all measurement points ($p < 0.001$). Effect sizes indicate strong practical significance: the video showed slightly higher immediate knowledge gains, while the comics demonstrated consistent attitudinal improvements.

Table 3. Regression Analysis (Generalized Estimating Equation - GEE)

Variable	Predictor	β	95% CI	p-value
Knowledge	Video vs Comic	1.45	0.72 – 2.18	<0.001
	Time (Repeated)	0.88	0.55 – 1.21	<0.001
Attitude	Video vs Comic	1.12	0.60 – 1.64	<0.001
	Time (Repeated)	0.95	0.63 – 1.27	<0.001

Multivariate analysis using GEE confirmed that both intervention type and time significantly influenced knowledge and attitudes. Video-based education showed a stronger effect on knowledge improvement ($\beta = 1.45$), whereas both media demonstrated comparable effects on attitudes. Repeated exposure significantly increased outcomes over time. The findings of this study demonstrate that Instagram-based health education interventions significantly improved adolescents' health literacy in including knowledge and attitudes toward healthy snacks. The balanced distribution of respondents across intervention groups ensured comparability and

reduced selection bias. Bivariate analysis revealed statistically significant improvements across all measurement points for both video and comic-based interventions, with large effect sizes indicating substantial practical impact. Video-based education produced more rapid improvements in knowledge, particularly during early stages of the intervention, suggesting that audiovisual content enhances initial comprehension.

In contrast, comic-based education showed more stable and consistent improvements across repeated measurements, particularly in shaping attitudes. This indicates that narrative and visual storytelling may play a crucial role in reinforcing behavioral intentions over time. Multivariate analysis further confirmed that both intervention modality and repeated exposure significantly contributed to outcome improvements. The time effect highlights the importance of sustained engagement in digital health promotion strategies. Overall, these results suggest that integrating multiple digital media formats within social media platforms can optimize both cognitive and affective components of health literacy. The findings provide strong empirical support for the use of Instagram as an effective medium for adolescent health promotion.

DISCUSSION

This study demonstrates that Instagram-based health education using both video and comic media significantly improves adolescents' health literacy, particularly in knowledge and attitudes toward healthy snacks. The results indicate that video-based interventions produce faster initial gains in knowledge, whereas comic-based interventions yield more consistent and sustained improvements, especially in attitudes. Repeated exposure across time points further enhances both cognitive and affective outcomes, highlighting the importance of intervention continuity.

The findings can be interpreted through the lens of health promotion and learning theories. From a cognitive perspective, multimedia learning theory suggests that audiovisual content facilitates dual-channel processing, enabling faster comprehension and retention of information. This explains the rapid knowledge gains observed in the video group. Conversely, the narrative structure inherent in comic-based media aligns with constructivist learning theory, in which individuals actively construct meaning through storytelling and contextual cues, thereby supporting deeper attitudinal internalisation (Lin et al., 2026). In the context of health literacy frameworks, particularly Nutbeam's model, the intervention appears to operate across functional and interactive levels. Video content primarily enhances functional literacy by delivering clear and structured information, while comics contribute to interactive literacy by fostering engagement, reflection, and interpretation (Mahdizadeh et al., 2026). The repeated exposure element reinforces behavioural learning principles, in which reinforcement and repetition strengthen knowledge acquisition and attitude formation (Müller et al., 2024).

These findings are consistent with global evidence demonstrating the effectiveness of digital health promotion strategies among adolescents (Paakkari et al., 2025). Studies conducted in various contexts have shown that social media platforms can significantly improve health knowledge and behaviors when interventions are tailored to user preferences (Paraskeva et al., 2024). Video-based interventions have been widely recognized for their immediacy and clarity, while visual storytelling approaches, including comics and infographics, have been associated with sustained engagement and improved attitudinal outcomes (Quezada-Acuña et al., 2024). Regionally, similar studies in Southeast Asia have reported that digital media interventions are particularly effective due to high social media penetration among adolescents. However, many of these studies focus on single-media interventions or short-term outcomes (Schröder et al., 2026).

The present study extends this body of evidence by incorporating multiple media formats and repeated measurements, providing a more comprehensive understanding of intervention dynamics over time (Sree et al., 2025).

The convergence between this study and existing literature lies in the consistent finding that digital media enhances health literacy outcomes. The observed divergence, particularly in the differential effects of video and comic media, can be explained by the distinct cognitive and emotional mechanisms activated by each format (Suprpto et al., 2022). Video content leverages sensory stimulation and direct information delivery, leading to rapid cognitive gains. In contrast, comics engage users through narrative immersion and emotional resonance, which may contribute to more stable attitudinal changes (Sylvia Bawilin & Suprpto, 2025). Additionally, the time-series design reveals temporal patterns that are often overlooked in cross-sectional or pre-post studies (Tri Astuti, 2026). The diminishing marginal gains in knowledge over time in the video group, compared to the steady progression in the comic group, suggest that novelty effects and cognitive saturation may influence learning trajectories (Yang et al., 2026). This highlights the importance of content variation and engagement strategies in sustaining intervention effectiveness (Szota et al., 2025). The findings have significant implications for health promotion practice and policy. From a programmatic perspective, integrating multiple digital media formats within a single platform can optimize both knowledge acquisition and attitudinal change. Health educators should consider combining video and narrative-based content to leverage their complementary strengths (Tituaña et al., 2026).

At the system level, the use of widely accessible platforms such as Instagram offers a scalable and cost-effective approach to adolescent health promotion (Vanwinkelen et al., 2026). This aligns with digital health transformation agendas, in which technology is used to enhance reach and engagement (Wang et al., 2025). The results also underscore the importance of sustained, repeated interventions, suggesting that one-time educational campaigns may be insufficient to produce lasting behavioural change (Wu et al., 2024). For policymakers, these findings support integrating digital health literacy programs into school-based curricula and national health promotion strategies. The adaptability of social media interventions enables contextualization across diverse populations and settings, making it a versatile tool for public health initiatives.

Strengths and Limitations

This study has several strengths. The use of a quasi-experimental time-series design allows for the assessment of temporal changes and strengthens causal inference compared to simpler designs. The inclusion of two distinct media formats provides comparative insights that are rarely addressed in existing research. Additionally, the use of repeated measurements enhances the robustness of the findings. However, several limitations should be acknowledged. The relatively small sample size and single-site setting may limit generalizability. The lack of randomisation introduces potential selection bias, despite efforts to ensure group comparability. Furthermore, the study focuses on short-term outcomes, and long-term behavioral changes were not assessed. Future research should consider larger, multi-site studies with randomized designs and extended follow-up periods to validate and expand upon these findings. Overall, this study contributes to the growing body of evidence on digital health promotion by providing a nuanced understanding of how different media formats influence health literacy outcomes over time. The integration of theoretical frameworks, comparative analysis, and longitudinal data offers valuable insights for both researchers and practitioners in the field of public health.

CONCLUSIONS

This study confirms that Instagram-based healthy snack education significantly improves adolescents' health literacy, particularly in knowledge and attitudes. Both video and comic media were effective, with video demonstrating faster initial knowledge gains and comics producing more consistent and sustained improvements in attitudes. Repeated exposure across multiple time points further strengthened these outcomes, indicating the importance of continuity in digital health interventions. These findings directly address the study objective by demonstrating that digital-based health education delivered through social media can effectively enhance both cognitive and affective components of health literacy among adolescents. The comparative results highlight that combining different media formats can optimize learning outcomes and engagement. From a policy and practice perspective, integrating Instagram-based health education into school health programs is strongly recommended. Health promotion strategies should incorporate mixed-media approaches and structured, repeated interventions to maximize effectiveness. At the system level, policymakers should support scalable digital health literacy initiatives that leverage widely used social media platforms to reach adolescents efficiently and sustainably.

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Authors' contributions

Nierwany Daud: Conceptualization, data collection, analysis, and manuscript drafting. Mesra Rahayu: Methodological supervision and data validation. Ahmad Muhammad Kasim: Statistical analysis and critical revision. Dian Meiliani Yulis*: Study supervision, review, and final approval of the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this study.

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