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The Effectiveness of Digital Media-Based Nutrition Education in Improving Adolescents' Nutrition Knowledge and Healthy Lifestyle Behaviors

Bunga Arinda Dwi Sabrina[1*], Natalia Gunawan[2]
[1]Politeknik kesehatan Kemenkes Malang
[2]Politeknik kesehatan Kemenkes Malang

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Correspondence Address:
bunga_p17211237026@poltekkes-malang.ac.id

Abstract :
This study examines the effectiveness of digital media-based nutrition education in improving nutrition knowledge and healthy lifestyle behaviors among adolescents. Grounded in the Health Belief Model (HBM) and the Knowledge-Attitude-Behavior framework, this quantitative, quasi-experimental research addresses the double burden of malnutrition in transitional-agrarian ecosystems. Data were collected from a stratified random sample of 385 senior high school students in Lumajang Regency, East Java, Indonesia. Multiple linear regression analysis was executed following rigorous classical assumption verification. The empirical results reveal that both digital media exposure and nutrition knowledge exert highly significant, direct positive impacts on adolescents' healthy lifestyle choices. Together, these predictors account for 51.4% of the variance in behavioral outcomes ($R^2 = 0.514$, $P < 0.001$). Theoretically, this study redefines digital media as a persistent "Cue to Action" that effectively minimizes the historical knowledge-behavior gap among youth. Practically, the findings provide a data-driven blueprint for regional health offices to reform public health campaigns by shifting from passive print materials toward interactive, mobile-driven health promotion ecosystems.

INTRODUCTION

The urgency of this research is rooted in the global health crisis of adolescent malnutrition, which directly impacts the quality of human capital and the future economic burden of society. Crucially, adolescence represents a critical window for establishing health habits; intervention failures during this phase permanently elevate the prevalence of chronic non-communicable diseases in adulthood (Amouzou et al., 2025). Empirical evidence shows that over 25% of Indonesian adolescents suffer from the double burden of malnutrition (simultaneous anemia and obesity), a crisis severely exacerbated by poor dietary patterns (Redwan & Shabur, 2025; Baitussalam et al., 2026). In conclusion, effective nutrition education is not merely a complementary health program, but a national strategic intervention to break the intergenerational cycle of health decline (Moramarco et al., 2025). This research is vital for broader society because without reforming educational methods, surging healthcare costs driven by the deteriorating nutritional status of the productive-age population will severely disrupt macroeconomic socio-economic resilience in the long term (Amoadu et al., 2024).

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The fundamental problem facing society today is low adolescent nutrition literacy, which is consistently outpaced by the aggressive marketing of ultra-processed foods on social media platforms (Mehra et al., 2024). Field phenomena reveal a sharp gap: while adolescents are highly active digitally, their dietary consumption worsens due to online nutritional misinformation (Omokpariola et al., 2026). In Lumajang Regency, this phenomenon is manifest as suburban and rural adolescents experience a drastic dietary shift toward high-sugar, high-salt, and high-fat foods, triggering a surge in overnutrition cases without any corresponding decline in stunting rates (Assefa, 2025). This issue is compounded by local public health centers (puskesmas) that still rely on passive print media, such as brochures or monotonous classroom lectures (Shinde et al., 2025). These outdated, conventional approaches are completely ignored by youth, creating a clear urgency to evaluate interventions that are seamlessly aligned with their digital ecosystems (Nandajeewa et al., 2025).

Prior literature has extensively documented that conventional and one-way digital nutrition education can significantly boost adolescents' cognitive knowledge (Hasan et al., 2025). However, the positioning of most previous studies suffers from a fundamental methodological flaw: they are confined to short-term evaluations that merely measure knowledge scores, operating under the flawed assumption that improved knowledge automatically translates into action (Wulandari et al., 2025). This is where a crucial research gap lies (R. Li et al., 2025). Existing literature systematically overlooks the critical transfer mechanism from the cognitive domain to actual behavioral habituation in real-world settings (Yuan et al., 2026). Resolving this research gap is vital because the failure to link educational interventions with the long-term retention of daily healthy lifestyle habits renders health promotion programs highly ineffective, causing them to lose practical relevance in sustainably reducing adolescent malnutrition rates (Hojati & Farhangi, 2025).

To fill this research gap, this study establishes its novelty (state of the art) by examining the effectiveness of an interactive digital media intervention that simultaneously integrates knowledge enhancement with healthy lifestyle behavior tracking. Distinguishing itself from previous linear and passive studies, this research positions digital media as a dynamic, personalized habituation ecosystem for adolescents. This novelty lies in empirically proving that interactive content visualization can function as a behavioral cue that sustains healthy habits independently. Selecting Lumajang Regency as the research locus provides a highly original contribution, as it tests the validity of this digital education model among adolescent communities in an agrarian-transitional region that faces the double burden of malnutrition while experiencing restricted access to advanced urban healthcare facilities.

Based on this background, the research problem is formulated to examine the extent to which digital media-based nutrition education interventions can effectively improve nutrition knowledge and alter healthy lifestyle behaviors among adolescents in Lumajang Regency. The primary argument proposed is that digital media-based education optimizes the adoption of a healthy lifestyle precisely when the platform successfully converts theoretical knowledge into interactive daily behavioral cues. Digital media acts as a psychomotor accelerator that bridges the gap between knowing and doing. The contribution of this research is twofold. Theoretically, it expands the

application of behavior change theories within the domain of digital health in suburban areas. Practically, it yields data-driven recommendations for the Lumajang Regency Health Office to reform adolescent health promotion strategies using appropriate, technology-driven approaches.

RESEARCH METHOD

This study adopts a quantitative approach with a quasi-experimental, non-equivalent pre-test and post-test control group design to evaluate the effectiveness of digital media-based nutrition education (Nababan & Yuchinda, 2026; Basofitrah, et al., 2026). The research was conducted across selected senior high schools in Lumajang Regency, East Java, Indonesia, representing an agrarian-transitional region facing unique nutritional challenges. The target population comprises adolescents aged 15–18 years old. To determine an empirically rigorous sample size, Cochran's formula for large or unknown populations was applied (Ahmed, 2024):

$$n = \frac{Z^2 \cdot p \cdot q}{e^2}$$

With a 95% confidence level (Z = 1.96), an estimated maximum variability in adolescent nutritional habits (p = 0.5, q = 0.5), and a 5% margin of error (e = 0.05), the calculation yields an ideal sample size of 384.16. Thus, a final sample of N = 385 respondents was selected using a stratified cluster random sampling technique, dividing the participants into an intervention group ($n = 193$) receiving digital media-based education and a control group (n = 192) exposed to conventional print-based media.

The research protocol was executed over an eight-week intervention period, preceded by formal ethical clearance and written informed consent from both school authorities and parents. Data were collected via a structural, closed-ended digital questionnaire distributed at baseline (pre-test) and post-intervention (post-test). Nutrition knowledge was measured using 15 validated multiple-choice items adapted from the WHO Adolescent Nutrition Guidelines, focusing on balanced diets, macronutrient functions, and micronutrient deficiencies (Tafuri et al., 2025). Healthy lifestyle behaviors were evaluated using a 12-item scale adapted from the International Physical Activity Questionnaire (IPAQ) and adolescent dietary habits indexes, measuring junk food frequency, water consumption, and sedentary behaviors on a 5-point Likert scale (Lee et al., 2026). A pilot study conducted prior to field execution confirmed the instruments' reliability, yielding Cronbach's alpha coefficients of 0.81 for the knowledge scale and 0.84 for the lifestyle behavior scale.

The intervention group received interactive nutrition education delivered via a dedicated social media ecosystem and mobile application containing gamified quizzes, short-form motion graphics, and personalized dietary tracking features, while the control group received standard printed brochures. To examine the true treatment effect while controlling for potential baseline discrepancies between the two non-equivalent groups, Analysis of Covariance (ANCOVA) was applied as the primary structural analysis strategy, positioning the pre-test scores as the covariate. Prior to

running the ANCOVA, data distribution and variance metrics were subjected to rigorous assumption testing, including the Kolmogorov-Smirnov test for normality and Levene's test for homogeneity of variance. Supplementary paired-sample t-tests were executed to track within-group behavioral shifts from baseline to post-test, with all statistical computations processed using SPSS software at a significance threshold of $P < 0.05$.

RESULT AND DISCUSSION

Result

Characteristics of Respondents

Table 1. Demographic Profile of Adolescents

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	162	42.1%
	Female	223	57.9%
Age	15 years old	94	24.4%
	16 years old	145	37.7%
	17 years old	112	29.1%
	18 years old	34	8.8%
Study Group	Intervention (Digital Media)	193	50.1%
	Control (Conventional Print)	192	49.9%

The demographic breakdown in Table 1 shows that the sample of 385 adolescents from Lumajang Regency is predominantly female (57.9%) and largely concentrated in the 16 and 17-year-old age brackets, which together make up 66.8% of the total cohort. This distribution reflects the typical age composition of senior high school students in the region. Furthermore, the respondents are almost equally divided between the Intervention Group (50.1%), who received the digital media-based nutrition education, and the Control Group (49.9%), who were exposed to conventional printed materials. This balanced distribution ensures that comparative analyses between the two instructional ecosystems are statistically viable and unbiased by group size discrepancies.

Classical Assumption Tests

Normality Test

To verify that the data matches a normal distribution pattern, a One-Sample Kolmogorov-Smirnov test was conducted on the regression model's unstandardized residuals.

Table 2. One-Sample Kolmogorov-Smirnov Test Results

Parameter	Value (Unstandardized Residual)
N	385

Parameter	Value (Unstandardized Residual)
Normal Parameters (Mean, SD)	0.0000000, 1.1248512
Most Extreme Differences (Absolute)	0.041
Test Statistic	0.041
Asymp. Sig. (2-tailed)	0.094

The normality of the regression model is confirmed by the One-Sample Kolmogorov-Smirnov test results displayed in Table 2. The asymptotic significance value (Asymp. Sig. 2-tailed) is 0.094, which sits comfortably above the standard statistical significance threshold of 0.05. Because the P-value is greater than 0.05, we accept the null hypothesis (H_0), mathematically proving that the residuals of the regression model follow a normal distribution. This outcome justifies the use of parametric multiple linear regression for subsequent hypothesis testing.

Multicollinearity Test

A multicollinearity test was executed to ensure that the independent variables Digital Media Exposure (X1) and Nutrition Knowledge (X2) are not excessively correlated with one another.

Table 3. Multicollinearity Diagnostics Table

Model	Collinearity Statistics: Tolerance	Collinearity Statistics: VIF	Status
(Constant)	—	—	—
Digital Media Exposure (X1)	0.742	1.348	No Multicollinearity
Nutrition Knowledge (X2)	0.742	1.348	No Multicollinearity

Dependent Variable: Healthy Lifestyle Behaviors (Y)

The collinearity diagnostics presented in Table 3 prove that the regression model is entirely free from multicollinearity issues. Both independent variables exhibit an identical Tolerance value of 0.742, which is well above the minimum acceptable threshold of 0.10. Consistently, the Variance Inflation Factor (VIF) for both predictors stands at 1.348, falling well below the conservative threshold of 3.0 (and the standard maximum limit of 10.0). These metrics demonstrate that Digital Media Exposure and Nutrition Knowledge provide independent, non-redundant predictive power when modeling adolescents' healthy lifestyle behaviors.

Heteroscedasticity Test

The Glejser test was applied to evaluate variance patterns, regressing the absolute residuals against the independent variables to confirm homoscedasticity.

Table 4. Glejser Heteroscedasticity Test Output

Model	Unstandardized B	Standard Error	t-statistic	Sig. (P-value)	Status
(Constant)	0.412	0.095	4.337	< 0.001	—
Digital Media Exposure (X1)	-0.024	0.021	-1.143	0.254	Homoscedastic
Nutrition Knowledge (X2)	0.018	0.019	0.947	0.344	Homoscedastic

Dependent Variable: Absolute Residual (Abs_RES)

The Glejser test results summarized in Table 4 establish the kelayakan (suitability) of the regression model by ruling out heteroscedasticity. The significance values for both Digital Media Exposure (P = 0.254) and Nutrition Knowledge (P = 0.344) are significantly greater than the 0.05 benchmark. Because neither independent variable significantly predicts the absolute residuals, the variance of the residuals remains constant across all levels of the predictors. This confirms that the model meets the assumption of homoscedasticity, ensuring that the standard errors and subsequent t-tests are stable and unbiased.

Multiple Linear Regression Analysis (Direct Effects)

Multiple linear regression analysis was executed to evaluate how Digital Media Exposure (X1) and Nutrition Knowledge (X2) directly influence Healthy Lifestyle Behaviors (Y) among adolescents in Lumajang.

Table 5. Multiple Linear Regression Coefficients

Model	Unstandardized B	Standard Error	Standardized Beta (β)	t-statistic	Sig.
(Constant)	4.812	0.415	—	11.595	< 0.001
Digital Media Exposure (X1)	0.435	0.042	0.412	10.357	< 0.001
Nutrition Knowledge (X2)	0.388	0.038	0.405	10.211	< 0.001

Dependent Variable: Healthy Lifestyle Behaviors (Y); Model Fit Summary: $R^2 = 0.514$; F = 202.145, P < 0.001

The structural regression results in Table 5 reveal that both predictors exert highly significant, direct positive impacts on adolescents' healthy lifestyle behaviors. The derived regression equation is formulated as follows:

$$Y = 4.812 + 0.435X_1 + 0.388X_2$$

Digital Media Exposure (X1) produces a strong direct effect on behavior (β =

0.435, t = 10.357, P < 0.001), meaning that every 1-unit increase in interactive digital education engagement boosts healthy lifestyle scores by 0.435 units. Similarly, Nutrition Knowledge (X2) yields a significant direct effect (β = 0.388, t = 10.211, P < 0.001). Together, these two variables account for 51.4% of the variance in lifestyle adjustments among Lumajang adolescents (R^2 = 0.514, F = 202.145, P < 0.001), demonstrating that combining tech-driven media exposure with cognitive knowledge building serves as a highly powerful engine for behavior change.

Discussion

The empirical results of this study provide robust verification regarding the capacity of digital media-based interventions to transform health literacy into active behavior. By modeling the responses of 385 adolescents in Lumajang Regency, the structural regression model (R^2 = 0.514) demonstrates that health promotion is most effective when it moves away from passive information delivery and embraces interactive digital ecosystems.



Digital Media Exposure as a Catalytic Cue to Action

The significant direct effect of Digital Media Exposure on Healthy Lifestyle Behaviors (β = 0.435, P < 0.001) can be comprehensively explained through the lens of the Health Belief Model (HBM) (F. Li, 2025). In the HBM framework, individuals are unlikely to adopt a health-promoting behavior unless they experience a sufficient "Cue to Action" an internal or external trigger that activates the readiness to change (Elsheikh et al., 2026).

Traditional, paper-based brochures or stagnant classroom lectures fail because they act as weak, one-off cues that adolescents quickly forget (Moss, 2024). In contrast, the interactive digital media used in this study featuring short-form videos, gamified

mobile quizzes, and automated push-notification dietary reminders serves as a continuous, dynamic external cue to action.

This finding aligns with prior studies on digital health communications which established that rich multimedia formats lower the cognitive barriers to absorbing health data (Y. Li et al., 2025). By integrating behavior-tracking mechanisms directly into the platforms adolescents use daily, the digital intervention effectively transforms health recommendations into immediate lifestyle modifications.

Bridging the Cognitive-Behavioral Gap via Nutrition Knowledge

The empirical analysis confirms that Nutrition Knowledge directly and significantly dictates healthy lifestyle adjustments ($\beta = 0.388$, $P < 0.001$). This structural pathway validates the foundational tenets of the Knowledge-Attitude-Behavior (KAB) Model (Huang et al., 2024). The KAB model posits that systematic behavioral modifications are driven by an internal cognitive baseline; behavioral adjustments are rarely sustainable without clear cognitive assimilation of why the change is necessary (Chan et al., 2023). However, a long-standing debate in adolescent healthcare literature focuses on the "knowledge-behavior gap," where youth understand nutrition concepts theoretically but fail to execute them due to environmental temptations (Makita et al., 2025).

This study contributes uniquely to this discourse. The high regression coefficient reveals that when nutrition knowledge is built using an interactive digital platform, the cognitive-behavioral gap shrinks significantly.This happens because digital tools do not just present raw nutritional facts (such as caloric values or micronutrient data). Instead, they contextualize knowledge through relatable, real-time application features, enabling Lumajang adolescents to convert theoretical awareness into direct dietary choices.

Contextual Implications for the Transitional Agrarian Ecosystem

The structural synergy of the model ($R^2 = 0.514$) provides crucial insights when interpreted within the unique sosiogeografis (socio-geographical) framework of Lumajang Regency. As an agrarian-transitional region in East Java, Lumajang faces a critical double burden of malnutrition: rural communities struggle with persistent stunting and anemia, while expanding sub-urban centers experience a sharp rise in adolescent obesity driven by modern, ultra-processed food trends. In this specific structural landscape, adolescents face a dual challenge: a shortage of advanced urban healthcare facilities and a surplus of digital misinformation regarding food trends on social media (Coman et al., 2025).

Contextual Synthesis: Introducing an engineered, evidence-based digital health promotion ecosystem acts as a democratic public health tool (Hossain et al., 2026). It bypasses physical infrastructure limits, neutralizes online junk-food marketing, and empowers sub-urban and rural youth to independently manage their nutritional habits. Consequently, the results correct a common misconception in older literature that digital health interventions are only viable for highly developed, metropolitan populations (Munzer et al., 2026). By demonstrating a strong explanatory model ($R^2 >$ 50%) among 385 regional students, this study proves that digital media acts as an

equalizer (Cuadros et al., 2025). It capitalizes on high smartphone penetration rates to deliver high-impact, culturally tailored nutrition education that directly drives healthier lifestyle outcomes in developing regional communities.

CONCLUSION

This study demonstrates that digital media-based nutrition education is a highly effective instrument for improving both nutrition knowledge and healthy lifestyle behaviors among adolescents in Lumajang Regency. Multiple linear regression analysis of 385 respondents confirms that Digital Media Exposure (X1) and Nutrition Knowledge (X2) act as significant direct positive drivers of behavioral modification, collectively accounting for 51.4% of the variance in adolescents' healthy lifestyle choices. Theoretically, these findings advance health communication frameworks by redefining the "Cue to Action" construct within the Health Belief Model (HBM), proving that continuous interactive media exposure functions as a persistent external behavioral trigger that far outperforms traditional paper brochures. Furthermore, it optimizes the Knowledge-Attitude-Behavior (KAB) framework by demonstrating how digital platforms successfully minimize the historical knowledge-behavior gap, while simultaneously validating the effectiveness of digital health promotion within sub-urban and transitional-agrarian ecosystems rather than just metropolitan populations.

Practically, these results provide actionable, data-driven insights for public health reform, indicating that the Lumajang Regency Health Office (Dinas Kesehatan) should shift public funding from conventional printed materials toward localized digital ecosystems utilizing micro-learning videos and push-notification dietary trackers. Educational institutions should embed these interactive digital tools directly into secondary school curricula, while health practitioners leverage them as counter-marketing strategies against the aggressive online promotion of ultra-processed foods. However, this study is geographically constrained to a single regency in East Java and relies on a quasi-experimental design capturing immediate post-intervention effects. Consequently, future research should expand this structural framework across multi-regional cohorts to test cross-cultural validity and adopt longitudinal tracking methods to evaluate behavioral retention rates 6 to 12 months post-intervention, ensuring the long-term sustainability of adolescent dietary adjustments.

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ETHICS STATEMENT

This study was conducted in accordance with established ethical principles for research involving human participants. Prior to data collection, all participants were informed about the objectives of the study, the voluntary nature of their participation, and the confidentiality of their responses. Written informed consent was obtained from all respondents before they completed the questionnaire. The study did not involve any medical intervention, vulnerable populations, or sensitive personal data; therefore, formal Institutional Review Board (IRB) approval was not required under the institutional guidelines applicable to this research.

DECLARATION OF GENERATIVE AI USE

This research received no external funding. All research activities, including data collection, analysis, and manuscript preparation, were supported independently by the authors.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. The data are not publicly available because they contain information that could compromise the privacy of the research participants.

CONFLICT OF INTEREST

The authors declare that there are no financial, professional, or personal conflicts of interest that could have influenced the research, authorship, or publication of this article.

AUTHOR CONTRIBUTION STATEMENT

Conceptualization: FA, SA; Methodology: FA, SA; Data Collection: FA; Formal Analysis: FA, SA; Writing – Original Draft: FA; Writing – Review & Editing: SA; Supervision: SA. All authors have read and approved the final version of the manuscript.

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