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The Effectiveness of Android App-Based Nutrition Education in Changing Vegetable and Fruit Consumption Behaviors Among Adolescents

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ABSTRACT

Low vegetable and fruit (VF) intake remains a persistent dietary problem among adolescents, and Android-based applications are increasingly used as a medium for nutrition education. This study aimed to synthesize recent evidence on the effectiveness of Android and smartphone app-based nutrition education in changing adolescents' VF consumption behavior and to identify the design features associated with success. A systematic literature review was conducted following the PRISMA 2020 guideline. Records were retrieved from a Consensus-based search and supplemented by Google Scholar, PubMed Central, DOAJ, and citation tracking, restricted to publications from 2022 to 2026 with active DOIs. Twenty-five sources met the inclusion criteria, comprising 14 empirical intervention studies and 11 reviews or contextual studies. The findings show a consistent pattern: app-based education reliably improves VF-related knowledge, whereas its effect on actual consumption is mixed. Interventions that combined personalized feedback, self-monitoring, gamification, and the involvement of teachers or school curricula produced more favorable behavioral outcomes, while stand-alone apps used for short periods frequently failed to change intake. User engagement emerged as the key mediator between exposure and behavior change. The study concludes that Android-based nutrition education is effective as a knowledge-building tool and becomes behaviorally effective when it is embedded in multicomponent, engagement-oriented programs designed together with adolescents.

INTRODUCTION

Adolescence is a nutritionally decisive stage of the life course. Rapid physical growth, pubertal maturation, and brain development raise the demand for energy and micronutrients, while the eating habits formed during this period tend to persist into adulthood (Norris et al., 2022). For this reason, adolescence has been described as a second window of opportunity in which well-designed nutrition actions can yield benefits for the individual's current health, future adult health, and even the health of the next generation (Hargreaves et al., 2022). Among the dietary behaviors that matter most in this window, the consumption of vegetables and fruit (VF) occupies a central place.

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Vegetables and fruit supply dietary fiber, vitamins, minerals, and bioactive compounds that protect against micronutrient deficiencies, constipation, overweight, and diet-related non-communicable diseases. Yet adolescents across very different settings consistently fall short of recommended intakes, and their diets tend to be dominated by energy-dense, nutrient-poor foods and sugar-sweetened beverages (Shatwan et al., 2023; Ahmed et al., 2023).

Indonesia reflects this global pattern. National survey data indicate that VF consumption in the Indonesian population remains below recommended levels, and school-age adolescents are among the groups whose intake is most inadequate (Purba et al., 2024). Low VF intake coexists with the double burden of malnutrition, in which undernutrition, micronutrient deficiencies, and rising overweight occur within the same communities. Adolescents' food choices are shaped not only by availability and price but also by knowledge, attitudes, taste preferences, peer influence, and the information environment in which they live. Nutrition education therefore remains one of the most widely recommended strategies to correct poor eating behavior in this age group (Fahrizki & Dwiriani, 2025; Medeiros et al., 2022).

Conventional nutrition education, delivered through lectures, leaflets, booklets, or counseling sessions, has documented benefits but also clear limitations. A meta-analysis of school-based food and nutrition education interventions found favorable effects on adolescents' food consumption, particularly when education was combined with environmental changes, family involvement, and longer program duration (Medeiros et al., 2022). A school-based education program in Bangladesh likewise increased VF consumption and reduced carbonated soft drink intake among adolescents (Ahmed et al., 2023). However, such programs are labor-intensive, depend heavily on facilitator capacity, and often struggle to sustain adolescents' attention after the sessions end. Community-based approaches face similar constraints related to reach, cost, and continuity (Sari et al., 2025). These limitations have encouraged researchers and practitioners to look for delivery channels that are closer to adolescents' everyday lives.

The smartphone is the most obvious of these channels. Adolescents are heavy users of mobile devices, and the Android operating system dominates the smartphone market in Indonesia and many other low- and middle-income countries, making Android applications an accessible and low-cost platform for health promotion. Digital media such as mobile applications, games, podcasts, and social media have been shown to improve nutrition knowledge and behavior in adolescents (Fahrizki & Dwiriani, 2025). Applications offer features that conventional media cannot easily provide: self-monitoring of daily intake, personalized feedback, reminders and push notifications, interactive quizzes, gamification, and the possibility of continuous exposure outside the classroom. These features correspond to established behavior change techniques (BCTs) such as goal setting, feedback on behavior, prompts, and rewards (Melo et al., 2025; van der Heijden et al., 2024). Adolescents themselves also use digital sources actively when searching for lifestyle and nutrition information, although they report difficulty judging its credibility (Raeside et al., 2022).

In Indonesia, a growing number of studies have developed and tested Android-based nutrition education media for adolescents. Educational games delivered through Android, combined with strengthening teachers' capacity, have been reported to increase VF consumption among junior high school students (Purba et al., 2024). Android applications for nutrition education have also been linked to improvements in adolescents' VF knowledge and behavior (Pratama & Saputra, 2025). At the same time, other

Indonesian trials show a more sobering picture: an Android-based food record application improved VF knowledge among junior high school students but did not produce statistically significant changes in vegetable or fruit consumption (Fauziah et al., 2023). Non-app digital media such as QR-code card games and augmented reality have also been explored, mainly with outcomes in knowledge rather than intake (Amia et al., 2026; Kurniawan et al., 2026).

International evidence is similarly mixed. Systematic reviews of mobile and web-based interventions report that digital tools, particularly game-based ones, show promise for promoting healthy dietary behaviors and nutrition knowledge in children and adolescents (Talens et al., 2025). A review focused on behavior change techniques found adherence rates between 63% and 85.5% in interventions that used personalized feedback or gamification, with improvements such as increased VF intake, yet emphasized that outcomes were inconsistent and long-term engagement was difficult to maintain (Melo et al., 2025). A broader scoping review of digital behavioral dietary interventions concluded that only 15% of experimental studies produced clearly favorable results, while 58% produced mixed results and 28% produced none (van der Heijden et al., 2024). Individual trials illustrate this variability. A six-week randomized trial of the MyPlate app among Saudi adolescents found no significant improvement in VF intake (Shatwan et al., 2023), and a large SMS chatbot trial involving 7,890 Danish adolescents found no effect on dietary habits in intention-to-treat analyses (Bjerregaard et al., 2024). By contrast, the PEGASO e-Diary showed that adolescents who engaged more intensively with the app increased their fruit and vegetable intake (Caon et al., 2022), and a gamified, artificial intelligence-based app improved diet quality scores among female adolescents in Vietnam (Braga et al., 2024).

These contrasting findings reveal a clear research problem. The question is no longer whether adolescents can use Android applications for nutrition education, since feasibility and acceptability are generally high (Gilliland et al., 2026; Proctor et al., 2025). The more important question is under what conditions app-based education actually changes VF consumption behavior, rather than merely increasing knowledge. Existing reviews tend to pool very different digital media, including websites, SMS, and serious games, and mix children with adolescents, and outcomes such as body weight with dietary intake (Kouvari et al., 2022; Talens et al., 2025). Indonesian studies, meanwhile, are mostly single-site quasi-experiments that have rarely been synthesized alongside international trials. As a result, practitioners have limited guidance on which features of an Android application, and which implementation settings, are most likely to translate knowledge gains into consumption change.

Novelty of the study

This article offers three contributions that distinguish it from previous reviews. First, it focuses specifically on vegetable and fruit consumption behavior among adolescents as the primary outcome, separating knowledge outcomes from behavioral outcomes rather than treating them as a single construct. This distinction exposes the knowledge–behavior gap that is often hidden when diverse outcomes are pooled. Second, it integrates recent Indonesian evidence on Android-based nutrition education, which is largely published in national journals, with international randomized and pilot trials published from 2022 to 2026, thereby positioning the Indonesian experience within the global evidence base. Third, it maps the specific design and implementation features of the interventions, such as self-monitoring, personalized feedback, gamification, teacher or curriculum integration, and co-design with adolescents, against the behavioral

outcomes reported, producing a practical framework for developing more effective Android-based nutrition education.

Based on this background, the study aims to (1) synthesize the evidence on the effectiveness of Android and smartphone app-based nutrition education in changing adolescents' VF consumption behavior, (2) distinguish its effects on knowledge from its effects on actual intake, and (3) identify the intervention features and contextual factors associated with successful behavior change.

METHODOLOGY

A. Research design

This study used a systematic literature review (SLR) design reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. A systematic review was chosen because the evidence on Android-based nutrition education is scattered across international journals and Indonesian national journals, uses different designs, and reports outcomes in different ways. The review question was formulated using the PICO framework: Population (adolescents aged 10–19 years), Intervention (nutrition education delivered through an Android or smartphone application, or closely related mobile digital media), Comparison (conventional education, a non-digital control, or a pre-intervention baseline), and Outcome (vegetable and fruit consumption behavior, with VF knowledge and engagement as secondary outcomes).

B. Data sources and search strategy

The search was carried out in two streams. The first stream used the Consensus academic search engine, from which two RIS exports were generated using the English and Indonesian versions of the article title as queries. The second stream consisted of supplementary searching in Google Scholar, PubMed Central, the Directory of Open Access Journals (DOAJ), the websites of Indonesian nutrition journals, and backward citation tracking of the included reviews. The main keywords were combinations of "Android application", "smartphone app", "mHealth", "nutrition education", "vegetable", "fruit", "adolescent", "remaja", "konsumsi sayur dan buah", and "edukasi gizi". The search covered publications from January 2022 to October 2026.

C. Eligibility criteria

Sources were included when they (1) were published between 2022 and 2026; (2) had an active Digital Object Identifier (DOI) that resolved to the publisher's page and was indexed in Google Scholar; (3) involved adolescents, or reviewed interventions that included adolescents; (4) evaluated digital or app-based nutrition education, or provided contextual evidence on adolescent nutrition and school-based nutrition education needed to interpret the effects; and (5) were written in English or Indonesian. Sources were excluded when they were study protocols without outcome data, trial registry records without a peer-reviewed publication, studies whose population or outcomes did not match the review question, or records whose DOI could not be retrieved.

D. Selection process

Figure 1 summarizes the selection process. The two Consensus exports yielded 26 records; after removing 8 duplicates, 18 unique records were screened. Two records were excluded because they were published before October 2021 and therefore fell outside the five-year window. The supplementary search identified 15 further records, of

which 6 were excluded for the reasons shown in the figure. In total, 25 sources were included: 14 empirical intervention or feasibility studies, 8 systematic or scoping reviews, and 3 contextual studies on adolescent nutrition and digital information use.

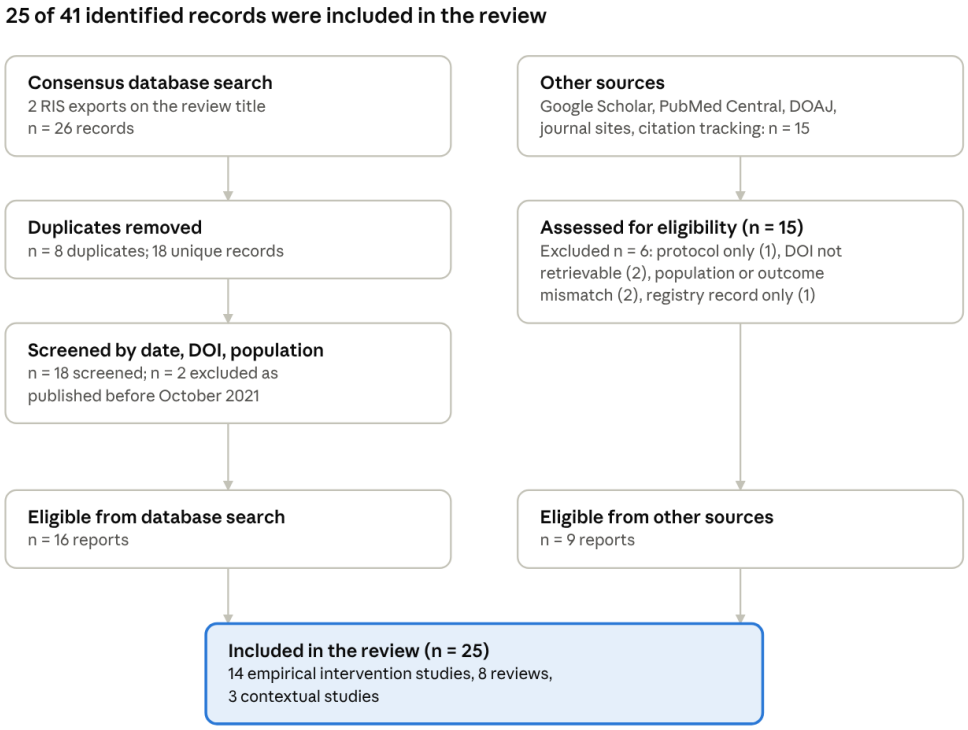


Figure 1: PRISMA 2020 flow diagram of source identification, screening, and inclusion

The left column traces the database stream and the right column the supplementary stream; both converge on the 25 included sources.

E. Data extraction and synthesis

For each empirical study, the following data were extracted into a standardized matrix: author and year, country, study design, sample size and age, type of application or digital medium, key features (self-monitoring, feedback, gamification, reminders, educational content, teacher or curriculum involvement), intervention duration, and outcomes for VF knowledge, VF consumption, and engagement or adherence. For reviews, the scope, number of included studies, and main conclusions were extracted. Because the designs, instruments, and outcome measures were heterogeneous, a statistical meta-analysis was not appropriate. The evidence was therefore analyzed through a narrative thematic synthesis. Study quality was considered by weighting the strength of each design, with randomized controlled trials given greater weight than pilot, quasi-experimental, and pre–post studies. Outcomes were classified as favorable, mixed, or null, and the knowledge and behavioral outcomes were analyzed separately to examine the knowledge–behavior gap.

RESULTS AND DISCUSSION

A. Characteristics of the included evidence

The 14 empirical studies were conducted in Indonesia (n = 5), Vietnam (n = 2), Saudi Arabia, Denmark, the United States, Canada, Bangladesh, and Europe (one multi-country and one Italian study). Designs ranged from large randomized controlled trials to small quasi-experiments and formative usability studies. Five studies used a randomized design, either individual or cluster, while the remainder were quasi-experimental, pilot, or pre–post studies. Most interventions lasted between four and twelve weeks, and only the PEGASO e-Diary followed users for six months (Caon et al., 2022). Table 1 summarizes their characteristics and outcomes.

Table 1
Characteristics and outcomes of the empirical studies included in the review

Study	Setting and design	Medium and key features	VF knowledge	VF intake or diet quality
Shatwan et al. (2023)	Saudi Arabia; RCT; n = 104, aged 13–18	MyPlate smartphone app, 6 weeks	Not measured	No significant change in fruit or vegetable scores
Bjerregaard et al. (2024)	Denmark; RCT; n = 7,890 adolescents	SMS chatbot education targeting VF, fish, sugary drinks	Not the primary outcome	No effect on dietary habits (intention-to-treat); 63% joined
Caon et al. (2022)	Europe, multi-country; cohort use over 6 months; n = 357	PEGASO e-Diary: food record, personalized meal suggestions, gamification	Not the primary outcome	Higher engagement linked with higher fruit and vegetable intake; usage declined after first weeks
Braga et al. (2024)	Vietnam; randomized pilot; n = 36 girls	FRANI AI app: photo food recognition, gamified nudges, 4 + 2 weeks	Not measured	Adherence 82%; diet quality score (ELDS) 9% higher than control; dietary diversity not significant
Braga et al. (2022)	Vietnam; formative usability study; adolescent girls	Gamified AI app prototype with individual and team goals	Not measured	Not measured; goals, interface, and design judged acceptable
Proctor et al. (2025)	United States (Hawaii); cluster-randomized pilot; n = 42, grades 6–8	PortionSize Ed app added to a 6-week SNAP-Ed curriculum; image-based feedback	Curriculum-embedded	Feasible and acceptable; preliminary healthy behavior change; attrition 2.4%
Gilliland et al. (2026)	Canada; pilot feasibility study; 59 enrolled, 54 completed	SmartAPPetite: time- and location-based healthy eating nudges, 8 weeks	Potential improvement reported	Potential to influence food purchasing and intake; full trial needed
Mancone et al. (2024)	Italy; school intervention study	Workshops plus MyFitnessPal app for food tracking and self-regulation	Increased food knowledge	Improved dietary habits and BMI
Ahmed et al. (2023)	Bangladesh; cluster RCT, 8 schools; n = 320	Weekly classroom education plus materials for parents (non-digital comparator), 12 weeks	Not the primary outcome	Daily fresh fruit intake more frequent (26% vs 3%); soft drinks down 25%

Study	Setting and design	Medium and key features	VF knowledge	VF intake or diet quality
Fauziah et al. (2023)	Indonesia (Cimahi); quasi-experiment; 20 per group	My Food Record Android app	Significant increase (40.33 to 48.00)	Vegetable 108.9 to 123.1 g/day; fruit 294.2 to 341.9 g/day; not significant
Purba et al. (2024)	Indonesia (Landak); quasi-experiment; 35 per group, grade 8	Android educational game delivered through strengthened teacher capacity	Not the primary outcome	VF consumption increased
Pratama and Saputra (2025)[a]	Indonesia; intervention study	Android application for nutrition education	Increase reported	Increase in VF behavior reported
Amia et al. (2026)[a]	Indonesia; intervention study	QR-code quartet card game linking to digital content	Primary outcome	Not assessed
Kurniawan et al. (2026)[a]	Indonesia; intervention study in elementary school children	My Plate education through augmented reality	Not the primary outcome	Vegetable consumption behavior examined (younger population)

Note. RCT = randomized controlled trial; VF = vegetables and fruit; ELDS = EAT-Lancet Diet Score. [a] Full text not accessible to the reviewers; classification is based on the bibliographic record and abstract and should be read as indicative.

B. Effects on vegetable and fruit knowledge

The most consistent finding is that app-based education improves knowledge. Every study that measured VF or nutrition knowledge reported an increase, including the Indonesian My Food Record trial (Fauziah et al., 2023), the multifaceted food literacy program that used a tracking app (Mancone et al., 2024), and the Android intervention reported by Pratama and Saputra (2025). This agrees with the review by Fahrizki and Dwiriani (2025), in which all included studies of digital nutrition education reported some positive outcomes on adolescents' knowledge and behavior, and with Talens et al. (2025), who found that digital tools, especially game-based ones, increase nutrition knowledge. Knowledge gains are plausible because applications deliver content repeatedly, in short interactive formats, and allow adolescents to revisit material at their own pace. Game-based media such as card games, quizzes, and augmented reality appear particularly suited to this cognitive objective (Amia et al., 2026; Kurniawan et al., 2026).

C. Effects on consumption behavior: the knowledge–behavior gap

The picture changes when the outcome is actual VF intake. Here the evidence is clearly mixed. The two largest randomized trials of stand-alone digital tools found no effect: neither the MyPlate app in Saudi Arabia (Shatwan et al., 2023) nor the SMS chatbot program offered to nearly 8,000 Danish adolescents (Bjerregaard et al., 2024) changed dietary habits. In Indonesia, the My Food Record app increased average vegetable and fruit intake by about 14 g and 48 g per day respectively, but these changes did not reach statistical significance in a small sample (Fauziah et al., 2023). The pattern matches the broader landscape described by van der Heijden et al. (2024), in which most experimental digital dietary interventions produced mixed rather than clearly favorable results.

This gap between knowledge and behavior is consistent with behavior change theory. Knowing that vegetables are healthy is a necessary but insufficient condition for eating them. Adolescents' intake also depends on the availability of VF at home and school, family food practices, taste preferences, cost, and peer norms (Norris et al., 2022;

Hargreaves et al., 2022). An application that only transmits information addresses the capability component of behavior but leaves opportunity and motivation largely untouched. Short exposure compounds the problem: six weeks of app use, as in the Saudi trial, may be too short for new eating habits to form, especially when usage declines after the first weeks, as observed with PEGASO (Caon et al., 2022).

Nevertheless, several studies show that behavioral change is achievable. The Android educational game in West Kalimantan increased VF consumption when it was delivered through trained teachers (Purba et al., 2024). The gamified FRANI app improved diet quality scores relative to a non-gamified version (Braga et al., 2024). Among PEGASO users, intake of fruit and vegetables rose in step with engagement (Caon et al., 2022). Mancone et al. (2024) reported improved dietary habits when an app was combined with workshops and self-regulation training. What these successful cases share is not the app itself but the way it was designed and embedded, which is examined next.

D. Features and conditions associated with behavioral change

Table 2 maps the intervention features against the direction of behavioral outcomes across the empirical studies and the reviews.

Table 2
Intervention features and conditions associated with changes in VF behavior

Feature or condition	Supporting evidence	Pattern observed
Sustained engagement and adherence	Caon et al. (2022); Braga et al. (2024); Melo et al. (2025)	Behavior improves in proportion to use; adherence of 63–85.5% accompanied improved intake in reviewed trials
Self-monitoring with personalized feedback	Caon et al. (2022); Proctor et al. (2025); Melo et al. (2025)	Food records and real-time feedback make intake visible and adjustable
Gamification and nudges	Braga et al. (2024); Talens et al. (2025); Gilliland et al. (2026)	Game elements raise diet quality and knowledge; location-based nudges target purchasing
Integration with teachers or curriculum	Purba et al. (2024); Proctor et al. (2025); Ahmed et al. (2023); Medeiros et al. (2022)	App used inside a school program outperforms stand-alone use; multicomponent programs work best
Co-design and adolescent-centered content	Braga et al. (2022); Han et al. (2023); Raeside et al. (2022)	Adolescents accept apps they helped shape and want credible, tailored information
Information-only, short, stand-alone delivery	Shatwan et al. (2023); Bjerregaard et al. (2024); Fauziah et al. (2023)	Knowledge may rise, but intake does not change significantly

Source: Author's synthesis of the reviewed literature

Five features stand out. The first is engagement. Engagement is the most consistent mediator between exposure and behavior. Melo et al. (2025) found that trials using personalized feedback and gamification achieved adherence rates between 63% and 85.5% together with improvements in VF intake, while noting that sustaining engagement over time remained the main challenge. The PEGASO data make the dose–response relationship explicit (Caon et al., 2022). For practitioners, this implies that engagement should be treated as a design target and monitored as an outcome, not assumed.

The second feature is self-monitoring with feedback. Applications that let adolescents record what they eat and receive immediate feedback, such as PEGASO, PortionSize Ed, and FRANI, translate abstract recommendations into personal, daily

targets (Caon et al., 2022; Proctor et al., 2025; Braga et al., 2024). The burden of recording, however, can undermine adherence, which favors simpler methods such as photo-based logging.

The third feature is gamification. Points, badges, challenges, and team goals turned out to be acceptable to adolescent girls in Vietnam (Braga et al., 2022) and were associated with better diet quality (Braga et al., 2024). Talens et al. (2025) likewise identified game-based tools as the most promising digital format. Gamification works best when the rewards are tied to the target behavior, such as servings of vegetables, rather than to app use alone.

The fourth feature is integration into a broader program. The clearest behavioral effects occurred where the app was part of a structured school program involving teachers or a curriculum (Purba et al., 2024; Proctor et al., 2025). This is consistent with the meta-analytic finding that school-based nutrition education is most effective when it is multicomponent, involves families, and lasts longer (Medeiros et al., 2022), and with the success of the non-digital school program in Bangladesh (Ahmed et al., 2023). Community-based interventions similarly benefit from involving local actors and settings (Sari et al., 2025). In practice, an Android application should be seen as an amplifier of school and family nutrition education rather than a substitute for it.

The fifth feature is co-design and credibility. Adolescents engage more with tools that reflect their preferences and that they perceive as trustworthy. Han et al. (2023) found limited evidence for chatbots in adolescent nutrition and highlighted adolescents' concerns about misleading information, recommending co-design. Raeside et al. (2022) showed that adolescents actively seek lifestyle information online but struggle to judge its quality. An Android application endorsed by schools, health workers, or nutrition professionals can fill this credibility gap.

E. Evidence from systematic and scoping reviews

The eight reviews broadly support the conclusions drawn from the individual studies. Fahrizki and Dwiriani (2025) and Talens et al. (2025) emphasize positive effects on knowledge and promising effects on behavior, especially for game-based tools, but both call for longer randomized trials. Melo et al. (2025) and van der Heijden et al. (2024) draw attention to inconsistent behavioral outcomes and to the importance of behavior change techniques and rigorous designs. Kouvari et al. (2022) show that digital interventions for children and adolescents can achieve modest benefits for weight outcomes, which indirectly reflects dietary change. Medeiros et al. (2022) and Sari et al. (2025) confirm that school-based and community-based programs improve adolescent food consumption, while Han et al. (2023) highlight the immaturity of conversational agents. Taken together, the reviews suggest that the field has moved beyond feasibility, where results are uniformly positive, toward a more demanding test of behavioral effectiveness, where results depend on design and context.

F. Implications for Indonesia and limitations

For Indonesia, these findings have direct implications. Android-based nutrition education is feasible, inexpensive, and suited to the country's mobile-first adolescent population. Yet the Indonesian studies reviewed are mostly small, single-site quasi-experiments with short follow-up, and the one that measured intake in grams found no significant change (Fauziah et al., 2023). The most promising local model is the one that combined an Android game with teacher capacity building (Purba et al., 2024). Future programs could integrate Android applications into school health activities and youth

health services, add self-monitoring and feedback features, use gamification tied to daily VF targets, and involve parents to address home food availability. Evaluations should use randomized designs, validated intake measures such as repeated 24-hour recalls or food records, and follow-up periods of at least three to six months.

This review has limitations. The included studies are heterogeneous in design, duration, and outcome measures, which precluded meta-analysis. Several Indonesian studies could be assessed only from their bibliographic records and abstracts. Most outcomes were self-reported, and the five-year publication window, chosen to capture current technology, excluded older trials. Finally, some included studies evaluated smartphone apps in general or SMS-based tools rather than Android-only applications, although the delivery principles are transferable.

CONCLUSION

Android app-based nutrition education is an effective means of improving adolescents' knowledge about vegetables and fruit, but its effect on actual consumption is conditional. Across the 25 sources reviewed, knowledge gains were consistent, while changes in VF intake were mixed: stand-alone, information-oriented apps used for a few weeks rarely changed what adolescents ate, whereas apps that sustained engagement and were embedded in broader programs produced measurable improvements in intake or diet quality.

Five features distinguish the more successful interventions: sustained engagement, self-monitoring with personalized feedback, gamification tied to the target behavior, integration with teachers or school curricula, and co-design with adolescents that builds credibility. Android applications should therefore be developed and implemented as one component of multicomponent nutrition programs rather than as stand-alone solutions.

For Indonesia, the evidence supports integrating Android-based VF education into school health activities and adolescent health services, with teachers and parents as active partners. Future research should use adequately powered randomized designs, validated dietary intake measures, engagement analytics, and follow-up of at least three to six months to establish whether app-based education can produce lasting changes in adolescents' vegetable and fruit consumption.

REFERENCES

Ahmed, K. R., Kolbe-Alexander, T., & Khan, A. (2023). Efficacy of a school-based education intervention on the consumption of fruits, vegetables and carbonated soft drinks among adolescents. *Public Health Nutrition, 26*(12), 3112–3121. https://doi.org/10.1017/S1368980023002094

Amia, H., Sumaryono, D., & Febryanti, A. (2026). The effect of the QR code quartet card game on knowledge of fruit and vegetable consumption among adolescents. *Jurnal Kesehatan Komunitas Indonesia, 6*(1). https://doi.org/10.58545/jkki.v6i1.696

Bjerregaard, A. A., Zoughbie, D. E., Hansen, J. V., Granström, C., Strøm, M., Halldórsson, Þ. I., Meder, I. K., Willett, W. C., Ding, E. L., & Olsen, S. F. (2024). An SMS chatbot digital educational program to increase healthy eating behaviors in adolescence: A multifactorial randomized controlled trial among 7,890 participants in the Danish National Birth Cohort. *PLOS Medicine, 21*(6), e1004383. https://doi.org/10.1371/journal.pmed.1004383

Braga, B. C., Nguyen, P. H., Aberman, N.-L., Doyle, F., Folson, G., Hoang, N., Huynh, P., Koch, B., McCloskey, P., Tran, L., Hughes, D., & Gelli, A. (2022). Exploring an artificial intelligence–based, gamified phone app prototype to track and improve food choices of adolescent girls in Vietnam: Acceptability, usability, and likeability study. *JMIR Formative Research, 6*(7), e35197. https://doi.org/10.2196/35197

Braga, B. C., Nguyen, P. H., Tran, L. M., Hoang, N. T., Bannerman, B., Doyle, F., Folson, G., Gangupantulu, R., Karachiwalla, N., Kolt, B., McCloskey, P., Palloni, G., Tran, T. H. T., Truong, D. T. T., Hughes, D., & Gelli, A. (2024). Feasibility of using an artificial intelligence-based telephone application for dietary assessment and nudging to improve the quality of food choices of female adolescents in Vietnam: Evidence from a randomized pilot study. *Current Developments in Nutrition, 8*(6), 102063. https://doi.org/10.1016/j.cdnut.2023.102063

Caon, M., Prinelli, F., Angelini, L., Carrino, S., Mugellini, E., Orte, S., Serrano, J. C. E., Atkinson, S., Martin, A., & Adorni, F. (2022). PEGASO e-Diary: User engagement and dietary behavior change of a mobile food record for adolescents. *Frontiers in Nutrition, 9*, 727480. https://doi.org/10.3389/fnut.2022.727480

Fahrizki, D. D., & Dwiriani, C. M. (2025). Digital-based nutrition education on nutrition knowledge and behaviors in adolescents: A systematic review. *BIO Web of Conferences, 153*, 02009. https://doi.org/10.1051/bioconf/202515302009

Fauziah, S., Surmita, Priawantiputri, W., Mutiyani, M., Mahmudah, U., & Mulyo, G. (2023). Efektivitas pendidikan gizi dengan aplikasi berbasis Android terhadap pengetahuan serta konsumsi sayur dan buah remaja. *Jurnal Gizi dan Dietetik, 2*(1), 13–24. https://doi.org/10.34011/jgd.v2i1.1283

Gilliland, J., Bowman, D., Cappuccitti, S., Caruso, O., Clark, A., Doherty, S., Haines, J., McEachern, L., Minaker, L., O'Connor, C., Sadler, R., Schaafsma, H., Seabrook, J., Stranges, S., Tobin, D., Woods, N., Wray, A., & Zhong, S. (2026). SmartAPPetite for Youth: Pilot and feasibility study of an adolescent smartphone nutrition intervention. *Pilot and Feasibility Studies, 12*. https://doi.org/10.1186/s40814-026-01767-0

Han, R., Todd, A., Wardak, S., Partridge, S. R., & Raeside, R. (2023). Feasibility and acceptability of chatbots for nutrition and physical activity health promotion among adolescents: Systematic scoping review with adolescent consultation. *JMIR Human Factors, 10*, e43227. https://doi.org/10.2196/43227

Hargreaves, D., Mates, E., Menon, P., Alderman, H., Devakumar, D., Fawzi, W., Greenfield, G., Hammoudeh, W., He, S., Lahiri, A., Liu, Z., Nguyen, P. H., Sethi, V., Wang, H., Neufeld, L. M., & Patton, G. C. (2022). Strategies and interventions for healthy adolescent growth, nutrition, and development. *The Lancet, 399*(10320), 198–210. https://doi.org/10.1016/S0140-6736(21)01593-2

Kouvari, M., Karipidou, M., Tsiampalis, T., Mamalaki, E., Poulimeneas, D., Bathrellou, E., Panagiotakos, D., & Yannakoulia, M. (2022). Digital health interventions for weight management in children and adolescents: Systematic review and meta-analysis. *Journal of Medical Internet Research, 24*(2), e30675. https://doi.org/10.2196/30675

Kurniawan, F., Ryadinency, R., & Maryani, H. (2026). The effect of My Plate nutrition education through augmented reality media on changes in vegetable consumption behavior in elementary school children. *HealthSmart: Jurnal Kesehatan Masyarakat*. https://doi.org/10.64146/gw4pw735

Mancone, S., Corrado, S., Tosti, B., Spica, G., Di Siena, F., Misiti, F., & Diotaiuti, P. (2024). Enhancing nutritional knowledge and self-regulation among adolescents: Efficacy of a multifaceted food literacy intervention. *Frontiers in Psychology, 15*, 1405414. https://doi.org/10.3389/fpsyg.2024.1405414

Medeiros, G. C. B. S. de, Azevedo, K. P. M. de, Garcia, D., Oliveira Segundo, V. H., Mata, Á. N. de S., Fernandes, A. K. P., Santos, R. P. dos, Trindade, D. D. B. de B., Morales Moreno, I., Guillén Martínez, D., & Piuvezam, G. (2022). Effect of school-based food and nutrition education interventions on the food consumption of adolescents: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health, 19*(17), 10522. https://doi.org/10.3390/ijerph191710522

Melo, G. L. R., Santo, R. E., Mas Clavel, E., Bosque-Prous, M., Koehler, K., Vidal-Alaball, J., van der Waerden, J., Gobiņa, I., López-Gil, J. F., Lima, R., & Agostinis-Sobrinho, C. (2025). Digital dietary interventions for healthy adolescents: A systematic review of behavior change techniques, engagement strategies, and adherence. *Clinical Nutrition, 45*, 176–192. https://doi.org/10.1016/j.clnu.2025.01.012

Norris, S. A., Frongillo, E. A., Black, M. M., Dong, Y., Fall, C., Lampl, M., Liese, A. D., Naguib, M., Prentice, A., Rochat, T., Stephensen, C. B., Tinago, C. B., Ward, K. A., Wrottesley, S. V., & Patton, G. C. (2022). Nutrition in adolescent growth and development. *The Lancet, 399*(10320), 172–184. https://doi.org/10.1016/S0140-6736(21)01590-7

Pratama, H., & Saputra, E. (2025). The influence of Android applications in nutrition education on increasing adolescent vegetable and fruit consumption knowledge and behavior. *Jurnal Gizi dan Teknologi Pangan: Nutrismart*. https://doi.org/10.64146/7snwj962

Proctor, E. S., Aveiro, K. H. L., Pagano, I., Wilkens, L. R., Park, L., Spencer, L., Butel, J., Martin, C. K., Apolzan, J. W., Novotny, R., Kearney, J., & Lozano, C. P. (2025). Integration of the PortionSize Ed app into SNAP-Ed for improving diet quality among adolescents in Hawaii: A randomized pilot study. *Nutrients, 17*(19), 3145. https://doi.org/10.3390/nu17193145

Purba, J. S. R., Nopriantini, N., Rafiony, A., & Petrika, Y. (2024). Pengaruh penyuluhan gizi dengan media game edukasi berbasis Android terhadap konsumsi buah dan sayur. *Media Penelitian dan Pengembangan Kesehatan, 34*(3). https://doi.org/10.34011/jmp2k.v34i3.2057

Raeside, R., Jia, S. S., Redfern, J., & Partridge, S. R. (2022). Navigating the online world of lifestyle health information: Qualitative study with adolescents. *JMIR Pediatrics and Parenting, 5*(1), e35165. https://doi.org/10.2196/35165

Sari, D., Hilmanto, D., Sunjaya, D., & Sari, P. (2025). Community-based interventions to improve adolescent nutrition: A scoping review. *BMC Public Health, 25*. https://doi.org/10.1186/s12889-025-25617-5

Shatwan, I. M., Alhefani, R. S., Bukhari, M. F., Hanbazazah, D. A., Srour, J. K., Surendran, S., Aljefree, N. M., & Almoraie, N. M. (2023). Effects of a smartphone app on fruit and vegetable consumption among Saudi adolescents: Randomized controlled trial. *JMIR Pediatrics and Parenting, 6*, e43160. https://doi.org/10.2196/43160

Talens, C., Da Quinta, N., Adebayo, F., Erkkola, M., Heikkilä, M., Bargiel-Matusiewicz, K., Ziółkowska, N., Rioja, P., Łyś, A., & Meinilä, J. (2025). Mobile- and web-based interventions for promoting healthy diets, preventing obesity, and improving health behaviors in children and adolescents: Systematic review of randomized controlled trials. *Journal of Medical Internet Research, 27*, e60602. https://doi.org/10.2196/60602

van der Heijden, Z., Lucassen, D., Faessen, J., Camps, G., Lu, Y., Schipper, H., Nijhof, S., & Brouwer-Brolsma, E. (2024). Digital behavioral dietary interventions to promote a healthy diet among children and adolescents: A scoping review of technologies, design, behavioral theory, and assessed outcomes. *Health Psychology and Behavioral Medicine, 12*(1), 2430965. https://doi.org/10.1080/21642850.2024.2430965