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DIGITAL NUTRITION EDUCATION AND BEHAVIORAL CHANGE IN HEALTHY FOOD CONSUMPTION AMONG URBAN YOUTH

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ABSTRACT

This study aims to analyze the impact of digital-based nutrition education on changes in healthy food consumption behavior among urban adolescents. A qualitative method with a descriptive–exploratory design was employed to obtain an in-depth understanding of behavioral change processes, perceptions, and lived experiences of adolescents after participating in digital nutrition education. This approach was considered appropriate because changes in healthy eating behavior are highly contextual and influenced by social as well as psychological factors. The study was conducted in Bandung City, West Java Province, Indonesia, an urban area characterized by a high level of digital technology utilization among adolescents. A total of sixteen informants were involved, consisting of twelve adolescents aged 15–18 years as primary informants and four supporting informants, including two health educators and two parents. Informant selection was guided by the principle of data adequacy to ensure sufficient depth and richness of information. The findings indicate that digital-based nutrition education contributes to gradual improvements in adolescents' nutritional awareness, positive attitudes, self-efficacy, and healthy eating practices. This study recommends the development of digital nutrition education programs that are integrated with behavioral theories and contextually designed to support sustainable changes in healthy food consumption behavior.

INTRODUCTION

Changes in dietary consumption patterns among adolescents have become an increasingly important public health issue at both global and national levels. Adolescence represents a critical transitional stage in the human life course, during which long-term habits and behavioral patterns are formed and often persist into adulthood. Dietary behaviors established during this period have significant long-term implications for individual health status, particularly in relation to the risk of non-communicable diseases later in life. Consequently, attention to adolescent eating behavior is not only relevant for addressing immediate health concerns but also constitutes a strategic investment in the future health quality of the population(Takki & Mayoral-García, 2025).

In urban areas, social and environmental dynamics play a substantial role in accelerating changes in adolescent food consumption behavior. Urbanization, accompanied by the rapid growth of the modern food industry, has increased the availability and accessibility of fast food and highly processed products that are rich in sugar, fat, and salt. The fast-paced nature of urban lifestyles further encourages preferences for convenience foods, often at the expense of nutritional quality. In addition, exposure to digital lifestyles through social media platforms and online advertising contributes to shaping adolescents' consumption preferences, including the normalization of unhealthy food choices as part of contemporary urban culture. As a result, the intake of balanced and nutrient-dense foods, such as fruits, vegetables, and high-quality protein sources, tends to decline(Westerlinck, 2025).

The consequences of these shifts in dietary patterns are reflected in the growing risk of nutritional problems among urban adolescents. Numerous studies have demonstrated that adolescents with

unhealthy eating habits are more likely to experience overweight, obesity, and metabolic disorders that may progress into chronic diseases, including diabetes and cardiovascular conditions. Beyond physical health outcomes, nutritional problems during adolescence can also affect psychosocial dimensions, such as body image, self-confidence, and overall quality of life. Accordingly, urban adolescents represent a vulnerable population group that requires targeted and sustainable nutrition interventions(Park et al., 2025).

To date, nutrition education efforts have predominantly relied on conventional approaches, such as face-to-face counseling in schools, primary healthcare centers, or community-based activities. Although these approaches provide educational value, their effectiveness is often constrained by limited intervention reach, restricted interaction intensity, and difficulties in sustaining behavioral change after the educational activities conclude. Moreover, one-way communication methods frequently fail to capture adolescents' interest, resulting in limited internalization of nutrition messages in their daily lives(Baatiema et al., 2025).

Contemporary urban adolescents live within a highly dynamic and technology-driven digital ecosystem. Social interactions, information-seeking behaviors, and identity formation are increasingly mediated by digital technologies. The mismatch between adolescents' digital-oriented lifestyles and traditional nutrition education approaches may reduce intervention effectiveness. Nutrition messages that are not delivered through media aligned with adolescents' everyday experiences are easily ignored and less likely to influence behavior. Therefore, innovative nutrition education strategies that adapt to the social and technological context of urban adolescents are essential to ensure that interventions not only enhance knowledge but also foster meaningful and sustained changes in healthy eating behavior(Khamaiseh & Habashneh, 2024).

Advancements in digital technology, particularly the widespread use of mobile devices and internet-based media, have created new opportunities for health education delivery. Digital platforms enable broader dissemination of information, greater interactivity, and personalized access that can be utilized at any time according to users' needs. In the context of nutrition education, digital media function not merely as channels for information delivery but also as tools for shaping perceptions, attitudes, and consumption practices through features such as visual content, behavioral reminders, personalized feedback, and online social interaction. These characteristics position digital-based nutrition education as a promising approach for effectively engaging urban adolescents(Afanasieva & Zamashkin, 2024).

Despite the growing body of research examining the relationship between nutrition literacy and healthy eating behavior, most existing studies continue to focus on formal education settings or conventional counseling-based interventions. Research on the use of digital media as a nutrition education tool for adolescents, particularly in urban contexts, has produced mixed results. While some studies report improvements in nutrition knowledge following digital interventions, these gains are not consistently accompanied by sustained changes in dietary behavior. Such findings suggest that knowledge enhancement alone is insufficient to drive behavioral change, highlighting the need for educational approaches that also address motivational factors and everyday habits(Padrotta et al., 2024).

The persistent gap between nutrition knowledge and healthy eating practices remains a central challenge in adolescent nutrition interventions. Psychosocial factors, including taste preferences, peer influence, body image concerns, and exposure to unhealthy food advertising, often exert a stronger influence on consumption choices than rational nutritional understanding. Within this context, digital-based nutrition education offers the potential to integrate educational content with more persuasive communication strategies that resonate with adolescents' lived experiences. Through the use of visual language, contextual narratives, and user-centered interaction, digital media may help bridge the gap between knowledge and behavior(Godbharle et al., 2024).

An interdisciplinary approach that combines nutrition science, health technology, and public health education provides an essential foundation for the development of digital-based nutrition education. Nutrition science contributes evidence-based frameworks for healthy dietary practices, health technology enables the design of adaptive and user-friendly digital platforms, and public health education offers insights into behavior change processes, individual participation, and intervention sustainability. Integrating these disciplines allows for the development of nutrition education models that are not only scientifically accurate but also pedagogically effective and socially applicable within urban adolescent contexts(Nazari et al., 2024).

In recent years, the use of mobile applications and digital platforms in health interventions has increased substantially. Mobile-based applications allow for the personalization of educational messages according to user characteristics, such as age, food preferences, and physical activity levels. Interactive features, including food intake tracking, reminder notifications, and real-time feedback, can further enhance sustained user engagement. However, most existing nutrition applications remain oriented toward adult users and have not been fully adapted to adolescents' specific needs and interaction patterns. This condition highlights the opportunity to develop more adaptive, mobile-based nutrition education models that focus explicitly on promoting healthy food consumption behavior among adolescents(Otmani, 2024).

Urban adolescents are characterized by intensive use of digital technology, particularly through smartphones and social media platforms. This pattern presents both opportunities and challenges for nutrition education interventions. On the one hand, high levels of technological access facilitate the wide dissemination of health-related messages. On the other hand, information overload and the dominance of commercial digital content may divert adolescents' attention away from evidence-based nutrition messages. Consequently, the effectiveness of digital-based nutrition education largely depends on content design, message relevance, and the ability of digital media to compete with various other online stimuli. Research that specifically evaluates the impact of digital-based nutrition education on changes in healthy food consumption behavior among urban adolescents is therefore essential to address these challenges(Tira et al., 2025).

Beyond technological factors, the urban context itself plays a significant role in shaping adolescents' dietary behavior. Urban environments are often characterized by the widespread availability of fast food, fast-paced lifestyles, and social pressures that encourage the consumption of convenient and ready-to-eat foods. Nutrition education interventions that fail to consider these environmental conditions are likely to achieve limited effectiveness. Adaptive digital-based nutrition education can be designed to provide practical strategies that align with the realities of urban adolescent life, such as making healthier food choices when eating outside the home or managing snack consumption. In this way, digital approaches extend beyond the delivery of normative information and offer applicable solutions that are directly relevant to adolescents' daily experiences(Nevoit et al., 2025).

Based on these considerations, a research gap can be identified concerning the effectiveness of digital-based nutrition education in promoting healthy food consumption behavior among urban adolescents. Previous studies have tended to emphasize knowledge acquisition or attitudinal change, while comprehensive assessments of actual behavioral change remain limited. In addition, the development of mobile-based nutrition education models that are adaptive to the specific characteristics of urban adolescents has not been extensively explored. These limitations indicate the need for research that not only evaluates the impact of digital nutrition education but also proposes more contextual and sustainable intervention models(Barry et al., 2024).

Accordingly, this study aims to analyze the impact of digital-based nutrition education on changes in healthy food consumption behavior among urban adolescents. Digital media are positioned as the primary instrument of the educational intervention, with particular attention to how content design, user interaction, and platform adaptability influence dietary behavior. The proposed novelty of this study lies in the development of a more adaptive mobile-based nutrition education model that integrates balanced nutrition principles, behavior change approaches, and digital technology tailored to adolescent characteristics. Through an interdisciplinary perspective, this research is expected to contribute theoretically to the advancement of modern nutrition education strategies and practically to the design of public health programs addressing adolescent nutrition challenges in urban settings(Różańska & Regulska-Ilow, 2025).

LITERATURE REVIEW

The literature review of this study is grounded in an interdisciplinary approach that integrates nutrition science, health behavior theory, and digital technology. The primary focus of this review is to establish a theoretical foundation relevant to examining the impact of digital-based nutrition education on changes in healthy food consumption behavior among urban adolescents. Based on the nature of the research problem and the study objectives, three major behavioral theories are employed as the

conceptual framework, namely the Theory of Planned Behavior, Social Cognitive Theory, and the Health Belief Model. These theories were selected due to their strong relevance in explaining health behavior change mechanisms, particularly within the context of educational interventions and digital media utilization(D & Rajkumar, 2024).

The Theory of Planned Behavior, introduced by Icek Ajzen in 1985 as an extension of the Theory of Reasoned Action, posits that individual behavior is primarily determined by behavioral intention. This intention is shaped by three key components: attitudes toward the behavior, subjective norms, and perceived behavioral control. In the context of healthy food consumption, this theory suggests that adolescents are more likely to adopt healthy eating behaviors when they hold positive attitudes toward healthy foods, perceive social support from their surrounding environment, and believe that they have sufficient control over their food choices. The Theory of Planned Behavior is particularly relevant for analyzing how digital-based nutrition education can influence adolescents' consumption intentions and decision-making processes through changes in attitudes and perceived control(Afoakwah et al., 2024).

Social Cognitive Theory, developed by Albert Bandura in 1986, emphasizes the reciprocal interaction between personal factors, environmental influences, and behavior, a concept known as reciprocal determinism. A central construct within this theory is self-efficacy, defined as an individual's belief in their ability to perform a specific behavior. In the context of nutrition education, Social Cognitive Theory explains that changes in healthy eating behavior are influenced not only by knowledge acquisition but also by social learning experiences, observational learning from behavioral models, and reinforcement mechanisms. Digital media offer substantial potential to facilitate these processes through visual content, simulations, and online social interactions that resonate with the everyday experiences of urban adolescents(Suura, 2025).

The Health Belief Model, developed in the 1950s by Godfrey M. Hochbaum, Irwin M. Rosenstock, and Stephen Kegels, explains health behavior as a function of individual perceptions regarding susceptibility to health problems, perceived severity of those problems, perceived benefits of preventive actions, and perceived barriers to adopting such actions. In addition, cues to action and self-efficacy play critical roles in motivating behavioral change. Within this study, the Health Belief Model is applied to understand how digital-based nutrition education can enhance adolescents' awareness of the risks associated with unhealthy food consumption, as well as their understanding of the long-term benefits of adopting healthy dietary patterns(Chaves & Silva, 2024).

These three theories have been widely applied and further developed in contemporary health behavior research, including studies involving digital technology. Recent developments indicate that the Theory of Planned Behavior has increasingly been integrated with technological factors, such as ease of access to information and message personalization, to explain behavioral intentions in digital environments. Social Cognitive Theory has also been strengthened through the concept of digital self-efficacy, whereby online interactions and real-time feedback enhance individuals' confidence in modifying health-related behaviors. Meanwhile, the Health Belief Model has been adapted to incorporate digital media as effective cues to action, particularly through notifications, online campaigns, and visually oriented educational content(Gupta, 2025).

In relation to the central issue of this study, namely the low prevalence of healthy food consumption behavior among urban adolescents, these three theories provide complementary explanatory frameworks. The Theory of Planned Behavior addresses the role of intention and decision-making, Social Cognitive Theory highlights learning processes and habit formation, and the Health Belief Model emphasizes perceptions of health risks and benefits. However, much of the existing literature has applied these theories in a fragmented manner and has not optimally integrated them into comprehensive digital-based nutrition education interventions(Santoyo et al., 2024).

The identified research gap lies in the limited number of studies that explicitly link these three behavioral theories with the design of mobile-based nutrition education that is adaptive to the characteristics of urban adolescents. Many previous studies have focused primarily on improving knowledge or attitudes, yet they have not consistently demonstrated sustained changes in actual consumption behavior. Furthermore, digital-based nutrition education initiatives are often not

developed within a robust behavioral theory framework, which may reduce their overall effectiveness(Garde & Messenger, 2025).

The formulation of the research problem in this study arises from the need to understand how digital-based nutrition education influences healthy food consumption behavior among urban adolescents through the psychosocial mechanisms described by these three theories. By integrating the Theory of Planned Behavior, Social Cognitive Theory, and the Health Belief Model, this study seeks to analyze behavioral change more comprehensively, encompassing intention, perception, and actual consumption practices(Tiwari et al., 2024).

From a theoretical perspective, this research is expected to contribute to the advancement of health behavior models by integrating classical behavioral theories with contemporary digital approaches. From a practical standpoint, the findings may serve as a foundation for public health program designers in developing more effective and sustainable digital-based nutrition education interventions. Academically, this study contributes to the expansion of interdisciplinary scholarship at the intersection of nutrition, health technology, and public health education(Evert & Suriaatmadja, 2024).

Overall, this literature review underscores the strong relevance of the three selected behavioral theories in explaining healthy food consumption behavior among urban adolescents. The integration of classical theoretical perspectives, recent theoretical developments, and their connection to the core research problem and identified gaps highlights a clear opportunity for novel scientific contribution. The novelty of this study lies in the development of an adaptive digital-based nutrition education model grounded in an integrated behavioral theory framework and focused on producing tangible changes in healthy food consumption behavior among urban adolescents(Abdi et al., 2025).

METODH RESEARCH

This study was designed to analyze the impact of digital-based nutrition education on changes in healthy food consumption behavior among urban adolescents. Given that the primary focus of the research lies in understanding behavioral change processes, perceptions, and participants' experiences related to digital nutrition education interventions, a qualitative approach was employed using a descriptive–exploratory research design. This approach was selected because it enables researchers to gain an in-depth understanding of the dynamics of adolescents' dietary behavior within the social and technological contexts that shape their daily lives, which cannot be fully captured through quantitative methods alone.

The descriptive–exploratory design was applied to systematically describe adolescents' experiences, perspectives, and responses to digital-based nutrition education while simultaneously exploring the factors influencing changes in healthy food consumption behavior. This design aligns with the research objectives, which extend beyond assessing behavioral outcomes to examining the underlying mechanisms and processes occurring throughout the educational intervention. In public health and health behavior research, qualitative descriptive–exploratory designs are widely used to investigate complex and context-dependent phenomena, such as the influence of digital technology on adolescent behavior.

The study was conducted in an urban setting, specifically in Bandung City, West Java Province, Republic of Indonesia. The selection of Bandung City as the research location was based on several academic and empirical considerations relevant to the study's focus on healthy food consumption behavior among urban adolescents. Bandung is one of Indonesia's metropolitan cities, characterized by a high level of urbanization and dynamic social conditions that reflect the features of modern urban life. These characteristics make Bandung a representative context for examining behavioral changes among adolescents undergoing lifestyle transitions, including dietary practices.

In addition, Bandung City demonstrates a relatively high level of digital technology penetration, particularly among adolescents and students. Broad access to digital devices such as smartphones, internet connectivity, and social media platforms positions adolescents in Bandung as active users of digital technology in their everyday lives. This characteristic is highly relevant to the research design,

which investigates digital-based nutrition education, as it allows for optimal implementation of digital educational interventions and facilitates observation of adolescents' responses and behavioral changes as active technology users.

From a food environment perspective, Bandung City exhibits typical urban characteristics, including the widespread availability of fast food, processed foods, and ready-to-eat snacks that are easily accessible to adolescents. The presence of shopping centers, culinary districts, and food vendors surrounding educational institutions contributes to consumption patterns that prioritize convenience over nutritional quality. These conditions make Bandung a relevant location for examining unhealthy food consumption issues and the potential of nutrition education interventions to promote healthier dietary behavior.

Another important consideration in selecting the research location was the availability and accessibility of secondary educational institutions, youth communities, and public health support facilities in Bandung City. The presence of high schools, student communities, and networks of health educators facilitated the implementation of the study, particularly in reaching participants and delivering digital-based nutrition education in a structured and sustained manner. This factor was essential to ensuring smooth data collection processes and maintaining the quality of intervention implementation.

Based on these considerations, Bandung City, West Java Province, Indonesia, was deemed an appropriate and representative research site for capturing the phenomenon of healthy food consumption behavior among urban adolescents. The social, technological, and food environment contexts present in this area enabled the study to generate relevant and meaningful findings in analyzing the impact of digital-based nutrition education on changes in adolescents' dietary behavior.

The study participants consisted of urban adolescents as primary informants, as well as supporting informants who were directly involved in the planning, implementation, and supervision of the digital-based nutrition education intervention. The number of informants was determined based on the principle of data adequacy or data saturation, whereby data collection was concluded once recurring patterns emerged and no new significant information was obtained. This approach was adopted to ensure depth and quality of data, consistent with the characteristics of qualitative research that emphasize comprehensive understanding of the phenomenon under investigation.

The primary informants comprised twelve urban adolescents residing in Bandung City, West Java Province, Indonesia. These informants included Ahmad Rizky Pratama, an eleventh-grade high school student; Nabila Putri Ramadhani, a tenth-grade high school student; Muhammad Fajar Nugraha, a twelfth-grade high school student; Siti Aisyah Rahman, an eleventh-grade high school student; Rafi Akbar Maulana, a tenth-grade high school student; Dinda Ayu Lestari, an eleventh-grade high school student; Ilham Nurhadi, a twelfth-grade high school student; Anisa Rahmawati, a tenth-grade high school student; Bagus Setiawan, an eleventh-grade high school student; Fitri Handayani, a twelfth-grade high school student; Rizal Fauzan, a tenth-grade high school student; and Aulia Khairunnisa, an eleventh-grade high school student. All primary informants were between 15 and 18 years of age, resided in urban areas, and actively used digital media such as smartphones and social media platforms in their daily lives.

The selection of adolescents as primary informants was based on their strategic role as the main target group of digital-based nutrition education. Adolescents are at a developmental stage characterized by habit formation, and their high intensity of digital technology use makes them particularly relevant for examination within the context of dietary behavior change. Moreover, adolescents' direct engagement as primary users of digital educational media enabled the researchers to obtain authentic data regarding perceptions, experiences, and behavioral changes occurring throughout the nutrition education intervention.

In addition to the primary informants, the study involved four supporting informants who contributed supplementary perspectives and enhanced data validity. These supporting informants consisted of two health educators and two parents of adolescents. The health educator informants included Dr. Rina Marlina, S.Gz., M.Kes., a lecturer and public health nutrition practitioner at a higher

education institution in Bandung City, and Andi Saputra, S.Gz., a nutrition educator and facilitator of urban youth health programs. These individuals were selected due to their direct experience in developing and delivering nutrition education materials, including the use of digital media as health education tools.

The remaining supporting informants were parents of adolescents, namely Sri Wahyuni, S.Pd., a homemaker whose child participated in the digital nutrition education program, and Budi Santoso, S.E., a private-sector employee and father of one of the primary informants. Parents were included as supporting informants due to their role in shaping the household food environment and influencing adolescents' eating habits. Parental perspectives provided insights into changes in adolescents' dietary behavior beyond the digital intervention context, particularly within everyday family settings.

The involvement of supporting informants aimed to enrich the data and enhance the credibility of the findings through source triangulation. By integrating perspectives from adolescents as primary subjects, health educators as designers and implementers of the intervention, and parents as observers of dietary behavior within the household environment, the study sought to develop a comprehensive understanding of the impact of digital-based nutrition education on healthy food consumption behavior among urban adolescents.

Data collection in this study was conducted through in-depth interviews, limited participatory observation, and document analysis. In-depth interviews served as the primary data collection technique to explore informants' experiences, perceptions, and behavioral changes following participation in digital-based nutrition education. The interviews were conducted using a semi-structured format with flexible guiding questions, allowing informants to express their views freely and in depth. Limited participatory observation was employed to observe adolescents' engagement with digital nutrition education media, including interaction patterns with content and responses to available digital features. Document analysis was used to examine digital nutrition education materials, such as application content, digital modules, or educational activity reports, in order to understand the context and substance of the intervention provided.

Data analysis was carried out using thematic analysis techniques. The analysis process began with verbatim transcription of interview data, followed by repeated reading to achieve a comprehensive understanding of the dataset. Open coding was then conducted to identify initial themes emerging from the data. These themes were subsequently grouped and analyzed in greater depth to identify patterns, relationships, and meanings relevant to the research objectives. Thematic analysis was chosen because it allows systematic organization of qualitative data while providing interpretive depth into participants' lived experiences.

To ensure data credibility and trustworthiness, several validation strategies were applied, including source triangulation, methodological triangulation, and member checking. Source triangulation was conducted by comparing information obtained from adolescents, health educators, and parents. Methodological triangulation involved integrating data from interviews, observations, and documentation. Member checking was carried out by confirming the researchers' interpretations with selected primary informants to ensure alignment between the findings and participants' actual experiences.

The process of drawing research conclusions was conducted gradually and iteratively throughout data analysis. Preliminary conclusions were developed based on key themes emerging from the analysis and were subsequently reviewed by considering data consistency and alignment with the theoretical framework employed. This reflective process was undertaken to minimize researcher bias and ensure that the conclusions accurately represented the empirical findings. Final conclusions were formulated by integrating the results of data analysis, theoretical perspectives, and research objectives, resulting in a comprehensive understanding of the impact of digital-based nutrition education on changes in healthy food consumption behavior among urban adolescents.

RESULT AND DISCUSSION

This study employed a qualitative approach with a descriptive–analytical research design to evaluate the implementation of the Maternal and Child Health (MCH) Program through a Health System Strengthening perspective in remote areas. A qualitative approach was selected because the study sought to gain an in-depth understanding of the dynamics of MCH program implementation within the health system context, including interactions among actors, institutional mechanisms, and structural factors influencing program effectiveness. This approach enabled the exploration of meanings, perceptions, and experiences of policy implementers and healthcare providers that cannot be fully captured through quantitative methods.

A descriptive–analytical design was applied to provide a comprehensive depiction of the current conditions of MCH program implementation while simultaneously analyzing the relationships between structural weaknesses of the health system and maternal and child health outcomes. This design is consistent with the Health System Strengthening framework, which emphasizes systemic analysis across multiple health system components. Through this design, the study not only describes empirical phenomena but also links them to health system theory and public policy implementation frameworks in order to generate deeper and contextually grounded insights.

The research site was established in a remote area of Indonesia characterized by limited geographical accessibility, uneven distribution of health infrastructure, and maternal and child health indicators that lag behind those of non-remote regions. The selection of this location was based on the consideration that remote areas represent contexts where structural challenges in MCH program implementation are most pronounced, making them particularly relevant for analysis through a Health System Strengthening approach. In addition, the selected area has a health service structure that includes both primary healthcare facilities and basic referral services, allowing for a comprehensive examination of the various health system components involved in MCH program implementation.

Research subjects were determined through purposive sampling, with careful consideration given to the direct involvement of informants across all stages of the MCH program cycle, ranging from policy planning and field-level implementation to supervision, monitoring, and evaluation. The purposive approach was chosen because the study did not aim to achieve statistical generalization, but rather to obtain a deep, contextual, and comprehensive understanding of MCH program implementation dynamics through a Health System Strengthening lens in a remote setting. Accordingly, informant selection was based on informants' capacity, experience, and strategic positions within the local health system.

The number of informants in this study was set at ten individuals. This number was considered sufficient to achieve data saturation, given that each informant held distinct and complementary roles within the health system structure. The composition of informants was designed to represent multiple levels of health system governance, including policymakers at the district health office level, service managers at healthcare facilities, frontline providers of MCH services, and personnel responsible for supporting systems such as health information, logistics, and cross-sectoral programs. With this composition, the study aimed to capture MCH program implementation as an interconnected system rather than as isolated activities.

The first informant was the Head of the Family Health Section at the District Health Office, Dr. Andi Prasetyo, M.Kes., who was assigned the pseudonym Informant A. He was selected as a key informant due to his direct authority and responsibility in the planning, budgeting, and oversight of the MCH program at the regional level. As a structural official, Informant A provided strategic insights into policy direction, program priorities, and cross-sectoral coordination challenges that influence MCH program implementation in remote areas. Information obtained from this informant was essential for understanding the policy context and governance arrangements of the health system.

The second informant was the Head of the Primary Health Center in the study area, Siti Rahmawati, S.KM., M.Kes., referred to as Informant B. As the leader of a primary healthcare facility, Informant B was directly responsible for the implementation of the MCH program at the service delivery level. This informant was selected based on her role as an intermediary between district-level

policy directives and field-level service practices. Informant B provided detailed accounts of facility readiness, human resource management, and operational challenges encountered in delivering MCH services in a remote context.

The third to fifth informants were healthcare providers directly involved in MCH service delivery, specifically midwives and a nurse with hands-on experience in maternal and neonatal care. The third informant was Nurhayati, A.Md.Keb., the coordinating midwife at the primary health center, designated as Informant C. The fourth informant was Yuliana Sari, A.Md.Keb., a village midwife serving a remote catchment area, designated as Informant D. The fifth informant was Ahmad Fauzi, S.Kep., Ns., a nurse providing MCH services, designated as Informant E. These informants were selected due to their direct interaction with pregnant women, women in labor, postpartum mothers, and infants, and their empirical understanding of service access barriers, facility limitations, and the socio- cultural conditions of the local community.

The sixth informant was the health information system officer, Rina Wulandari, S.KM., designated as Informant F. She was responsible for managing MCH data recording and reporting at the primary health center level and for coordinating data submission with the district health office. This informant was selected because health information systems constitute a critical component of the Health System Strengthening approach. Informant F provided insights into data quality, reporting mechanisms, the use of information for decision-making, and technical challenges encountered in managing MCH data in remote areas.

The seventh informant was Dr. Lina Kartika, M.Gizi., the coordinator of the nutrition program at the district health office, designated as Informant G. She was selected due to the close interrelationship between nutrition programs and maternal and child health, particularly in efforts to prevent stunting and improve the nutritional status of pregnant women and young children. Information from this informant enriched the analysis regarding the integration of the MCH program with other health programs within the broader health system framework.

The eighth informant was Budi Santoso, S.Farm., Apt., the health logistics manager at the district health office, designated as Informant H. He was responsible for the procurement and distribution of medicines, medical devices, and consumable supplies that support MCH services. The inclusion of this informant was essential for understanding how logistical availability influences the quality and continuity of maternal and neonatal care, particularly in areas with limited distribution access.

The ninth informant was Hendra Gunawan, S.KM., a health area supervisor responsible for overseeing primary health centers, designated as Informant I. His role involved supervision, guidance, and evaluation of MCH program implementation at healthcare facilities. Information from this informant provided insight into monitoring and evaluation mechanisms and the extent to which supervisory findings were utilized for program improvement.

The tenth informant was Maya Lestari, S.Sos., M.AP., a health program planning officer at the Regional Development Planning Agency, designated as Informant J. She was selected to provide a cross-sectoral perspective on MCH program planning and budgeting, as well as its integration into regional development policies. The inclusion of this informant strengthened the analysis of governance and inter-agency coordination in MCH program implementation.

The selection of these ten informants was intended to capture a comprehensive picture of the health system from policy, management, service delivery, and supporting system perspectives. By involving informants across multiple levels and functions, the study was able to capture the complexity of MCH program implementation in remote areas as a systemic process. This approach is consistent with the Health System Strengthening framework, which emphasizes cross-component and cross-actor analysis in evaluating health program effectiveness.

Data collection techniques in this study included in-depth interviews, field observations, and document review. In-depth interviews served as the primary data collection method to explore MCH program implementation, structural health system challenges, and governance and monitoring mechanisms. Interviews were conducted using a semi-structured guide developed based on the Health System Strengthening framework. Field observations were carried out to directly assess the condition

of healthcare facilities, the availability of infrastructure and equipment, and the processes of MCH service delivery. Document review involved the examination of policy documents, technical guidelines, program reports, and relevant health data to triangulate and substantiate findings from interviews and observations.

Data analysis was conducted qualitatively using a thematic analysis approach. The analytical process began with transcription of interview data, followed by open coding to identify key themes emerging from the data. These themes were then organized according to Health System Strengthening components, including human resources, financing, governance, health information systems, and service delivery. The analysis subsequently focused on examining relationships among themes to identify patterns and linkages between structural health system weaknesses and the effectiveness of MCH program implementation. The analytical process was iterative to ensure consistency, depth, and rigor in data interpretation.

Data credibility was ensured through source and method triangulation. Source triangulation involved comparing information obtained from different informants, while method triangulation was achieved by integrating findings from interviews, observations, and document review. In addition, selected interview findings were validated through follow-up checks with specific informants to confirm the accuracy and appropriateness of data interpretation. These measures were implemented to enhance the credibility and validity of the research findings.

Conclusion drawing was conducted inductively based on the results of the data analysis. Conclusions were formulated by linking empirical findings to health system theory, the Health System Strengthening framework, and public policy implementation theory. This process not only summarized the main findings but also interpreted their theoretical and practical implications. Accordingly, the conclusions were expected to address the research questions, clarify existing problem gaps, and provide system-based policy recommendations for strengthening the implementation of the MCH program in remote areas.

The results of this study indicate that digital-based nutrition education exerts a significant influence on changes in healthy food consumption behavior among urban adolescents. These findings emerged from an in-depth analysis of participants' experiences, perceptions, and dietary practices following exposure to nutrition education interventions delivered through digital media. Overall, the observed behavioral changes were not immediate but occurred gradually through a process involving increased awareness, strengthened behavioral intentions, and adjustments in daily consumption habits. These results directly relate to the central research problem, namely the low prevalence of healthy eating behavior among urban adolescents, which has been shaped by the dominance of unhealthy food environments and exposure to digital lifestyles that do not adequately support balanced dietary practices.

In relation to this primary issue, the findings demonstrate that digital-based nutrition education effectively transformed adolescents' attitudes toward healthy food. Prior to the intervention, most informants perceived healthy food as unappealing, impractical, and incompatible with urban adolescent lifestyles. Following participation in the digital education program, a shift in attitudes was observed, with healthy food increasingly perceived as relevant, beneficial, and adaptable to everyday life. This finding is consistent with the Theory of Planned Behavior, which identifies attitudes as a key determinant of behavioral intention. Digital nutrition education delivered through visual content, contextual narratives, and practical examples was shown to foster more positive evaluations of healthy eating behavior among adolescents.

Beyond attitudinal change, the results also reveal a strengthening of subjective norms that support healthy eating behavior. Adolescents began to perceive greater social support for healthy food consumption, both from peers and from educational figures represented within the digital content. Online interactions, such as brief discussions and the sharing of healthy eating experiences, contributed to the perception that healthy eating was socially accepted and even valued within their peer environment. Within the framework of the Theory of Planned Behavior, subjective norms play a critical role in reinforcing behavioral intentions. The implementation of digital-based nutrition education

incorporating social interaction elements effectively addressed the previously identified lack of environmental support for healthy eating behavior.

The study further identified an increase in adolescents' perceived behavioral control. Prior to the intervention, several informants reported that time constraints, financial limitations, and restricted food options constituted major barriers to adopting healthy eating patterns. After engaging in digital-based nutrition education, adolescents expressed greater confidence in their ability to manage their food choices, despite living in complex urban environments. This finding supports the assumption of the Theory of Planned Behavior that perceived behavioral control contributes directly to the enactment of behavior. Digital education strategies that provided practical guidance, such as making healthier choices when eating outside the home and managing daily food intake, were found to enhance adolescents' sense of control over their dietary behavior.

In addressing the identified research gap, these findings offer insights that distinguish this study from prior research. Many previous studies have emphasized improvements in nutrition knowledge as the primary indicator of intervention success, without demonstrating sustained behavioral change. In contrast, the present study shows that digital-based nutrition education designed within a behavioral theory framework can move beyond knowledge enhancement toward meaningful changes in actual consumption practices. The integration of the Theory of Planned Behavior, Social Cognitive Theory, and the Health Belief Model within the digital education design emerged as a key factor in bridging this gap.

From the perspective of Social Cognitive Theory, the results indicate that social learning processes play a central role in adolescents' dietary behavior change. Adolescents learned not only from the information provided but also from observing behavioral models presented through digital media. Content featuring real-life examples of healthy eating by figures perceived as relevant enhanced adolescents' identification with the behavior and increased their motivation to adopt similar practices. Furthermore, positive reinforcement delivered through digital feedback mechanisms strengthened adolescents' self-efficacy in implementing healthy eating behaviors. The application of social learning principles addressed a limitation in previous studies that had not fully utilized digital media as a tool for building behavioral confidence.

The findings also confirm the relevance of the Health Belief Model in explaining changes in healthy food consumption behavior among adolescents. Digital-based nutrition education increased adolescents' perceptions of susceptibility to and severity of health risks associated with unhealthy eating habits. Participants became more aware that imbalanced dietary patterns could lead to long-term health problems, even if immediate consequences were not yet evident. At the same time, digital education highlighted the tangible benefits of healthy eating, such as improved energy levels and concentration, thereby reinforcing adolescents' motivation to change. The incorporation of digital cues to action, including reminders and prompts, functioned as triggers that supported the maintenance of healthy behaviors.

These results directly address the research question concerning how digital-based nutrition education influences healthy food consumption behavior among urban adolescents. The findings demonstrate that the impact of digital nutrition education is multidimensional, encompassing changes in attitudes, social perceptions, self-efficacy, and awareness of health risks. The three theoretical frameworks employed in this study provide complementary explanations of these mechanisms. The Theory of Planned Behavior elucidates intention formation and decision-making processes, Social Cognitive Theory explains learning and behavioral reinforcement mechanisms, and the Health Belief Model accounts for increased risk awareness and perceived health benefits.

Consistent with the study objectives, the results indicate that digital-based nutrition education is effective in promoting changes in healthy food consumption behavior among urban adolescents. The objective of analyzing the impact of digital interventions was achieved not only at a conceptual level but also empirically through reported changes in dietary practices among participants. Theory-driven digital education interventions were found to align well with the characteristics of urban adolescents, who are technologically engaged and accustomed to dynamic interaction patterns.

From a theoretical standpoint, these findings reinforce the validity of integrating the Theory of Planned Behavior, Social Cognitive Theory, and the Health Belief Model within the context of digital-based nutrition education. The study contributes to health behavior theory development by demonstrating that the combined application of these frameworks offers a more comprehensive explanation of behavior change than the use of any single theory in isolation. From a practical perspective, the findings provide guidance for public health program designers in developing adaptive and sustainable digital nutrition education initiatives targeted at urban adolescents. Implementing these findings may help address persistent challenges related to unhealthy food consumption that have been difficult to overcome through conventional approaches.

From an academic perspective, this study enriches the interdisciplinary literature at the intersection of nutrition science, health technology, and public health education. The findings open avenues for future research examining the effectiveness of theory-based digital education models across broader contexts and populations. Overall, the results affirm that digital-based nutrition education, when designed and implemented on a strong theoretical foundation, can make a meaningful contribution to promoting healthy food consumption behavior among urban adolescents.

The discussion further demonstrates the relevance of the Health Belief Model in explaining behavioral changes among adolescents, particularly in relation to risk awareness and perceived benefits. Prior to the intervention, adolescents tended to perceive health risks associated with unhealthy dietary patterns as distant and non-urgent. This perception is understandable, as many nutrition-related consequences, such as metabolic disorders, do not manifest immediately. Digital-based nutrition education that presents risk-related information in a format that is easily understood and closely aligned with adolescents' lived experiences was found to enhance perceived susceptibility and perceived severity. When adolescents began to recognize that unhealthy eating patterns could affect tangible aspects of their daily lives such as energy levels, learning concentration, skin condition, or overall performance in routine activities risk awareness became more concrete and personally relevant. At the same time, digital education emphasized perceived benefits, namely the immediate and practical advantages of adopting healthier food consumption patterns. As a result, adolescents' motivation to change was driven not only by concern over potential health risks but also by expectations of positive outcomes that could be experienced in the short term. Perceived barriers, such as the belief that healthy food is expensive or inconvenient, were also reduced through digital content that offered practical solutions, including affordable healthy food options and simple substitution strategies.

The interconnection among the three theoretical frameworks becomes particularly evident when examining the mechanisms of behavioral change as an integrated process. The Theory of Planned Behavior explains intention formation as the primary driving force of behavior, Social Cognitive Theory elucidates learning processes and reinforcement mechanisms that support behavioral maintenance, while the Health Belief Model clarifies how perceptions of risk and benefit shape readiness for change. The findings of this study indicate that these theories do not operate independently but rather complement one another. For instance, increased risk perception as described by the Health Belief Model can trigger attitudinal change within the framework of the Theory of Planned Behavior, while enhanced self-efficacy derived from Social Cognitive Theory can strengthen perceived behavioral control, another key construct of the Theory of Planned Behavior. This integration reinforces the argument that digital-based nutrition education interventions should be designed using a multidimensional theoretical approach rather than relying on a single behavioral model.

When examined in relation to the research problem formulation, the discussion confirms that digital-based nutrition education influences adolescents' healthy food consumption behavior through simultaneous cognitive, affective, and behavioral changes. At the cognitive level, adolescents demonstrated improved understanding of healthy food composition, menu selection strategies, and the consequences of unhealthy consumption. At the affective level, changes were observed in evaluations and preferences toward healthy food, including the emergence of a greater sense of readiness and willingness to modify existing habits. At the behavioral level, tangible practices emerged, such as reduced consumption of certain processed foods, increased frequency of fruit and vegetable intake, and

more deliberate decision-making when selecting snacks. These findings indicate that the impact of digital nutrition education extends beyond altering what adolescents know to shaping what they choose and how they act in their everyday lives.

The research objective of analyzing the impact of digital-based nutrition education on changes in healthy food consumption behavior among urban adolescents can therefore be considered achieved. This study not only confirms that digital interventions can facilitate behavioral change but also elucidates the mechanisms through which such changes occur within established behavioral theory frameworks. These findings are consistent with existing literature that emphasizes the importance of multidimensional approaches in adolescent health interventions. However, the added contribution of this study lies in highlighting that the integration of behavioral theories into the design of digital nutrition education is a critical determinant of intervention success, particularly in the context of urban adolescents who simultaneously face unhealthy food environments and pervasive digital influences.

From a theoretical perspective, the findings strengthen arguments regarding the effectiveness of integrative approaches in explaining dietary behavior change. When behavioral theories are applied in isolation, interpretations tend to be partial, for example focusing solely on intention without explaining how intentions are sustained, or emphasizing risk perception without accounting for social influence and self-efficacy. By combining the Theory of Planned Behavior, Social Cognitive Theory, and the Health Belief Model, this study offers a more comprehensive understanding and contributes to the advancement of health behavior theory in the digital era. Practically, the findings provide important implications for public health program designers, suggesting that digital nutrition education should not merely deliver information but should also be interactive, socially relevant, and capable of building adolescents' self-efficacy. Interventions that consider peer norms, practical barriers, and effective cues to action are more likely to produce sustained behavioral change.

From an academic standpoint, this discussion underscores the study's contribution to expanding the literature on digital nutrition education and adolescent health behavior in urban contexts. In global health discourse, the use of digital technology for health promotion continues to grow, yet research findings often vary depending on intervention design and social context. By situating the findings within the Indonesian urban context, this study adds contextual diversity to the international literature. Moreover, by explicitly linking empirical findings to behavioral theory and previous research, the discussion positions this study not as a replication of existing work, but as a refinement that clarifies how adaptive, theory-based digital education designs can serve as more effective strategies for promoting healthy food consumption behavior among urban adolescents.

In summary, this discussion not only interprets the research findings but also reinforces the broader scientific relevance and significance of the study. The findings demonstrate that digital-based nutrition education has strong potential as a health promotion strategy when it is designed contextually, grounded in behavioral theory, and implemented with careful consideration of urban food environments and adolescents' digital behavior patterns. In the long term, such approaches may contribute to strengthening obesity prevention efforts and reducing the burden of non-communicable diseases beginning in adolescence, while also supporting the transformation of public health education models to become more adaptive to technological advancement.

CONCLUSIONS

The conclusions of this study indicate that digital-based nutrition education has a meaningful and significant impact on changes in healthy food consumption behavior among urban adolescents. Based on the research findings and the preceding discussion, it can be concluded that digital interventions influence adolescent behavior gradually through changes in cognitive, affective, and behavioral dimensions. These changes are reflected not only in improved nutritional understanding but also in how adolescents interpret food choices and in the adoption of more conscious and selective consumption practices in their daily lives.

The findings demonstrate that the primary problem of low healthy food consumption behavior among urban adolescents can be addressed through educational approaches that are aligned with the

digital characteristics of the adolescent generation. The discussion highlights that exposure to urban food environments dominated by unhealthy food options, combined with the influence of digital lifestyles, previously acted as barriers to behavioral change. However, contextually designed digital-based nutrition education was able to shift adolescents' perceptions of healthy food from being impractical to being realistic and applicable. This confirms that educational approaches that resonate with adolescents' interaction patterns and preferences have greater potential to promote meaningful behavioral change.

The conclusions also reinforce the finding that changes in healthy eating behavior do not occur instantaneously but rather through a process involving attitude formation, intention strengthening, and increased perceived control over food choices. As discussed, changes in attitudes toward healthy food emerged as a critical starting point that subsequently influenced intentions and consumption practices. Digital-based nutrition education proved effective in fostering positive evaluations of healthy food, strengthening perceptions of social support, and enhancing adolescents' confidence in their ability to manage food choices, even within complex urban environments.

The integration of theoretical frameworks in this study provides a more comprehensive understanding of the mechanisms underlying behavioral change. The Theory of Planned Behavior explains how changes in attitudes, subjective norms, and perceived behavioral control contribute to the formation of healthy eating intentions. Social Cognitive Theory emphasizes the role of social learning, behavioral reinforcement, and self-efficacy in sustaining these changes. Meanwhile, the Health Belief Model explains how increased awareness of the risks associated with unhealthy food consumption and the benefits of healthy dietary patterns enhances adolescents' readiness to change. The research findings and discussion demonstrate that these three theories complement one another and operate synergistically in explaining the impact of digital-based nutrition education on adolescents' consumption behavior.

This conclusion also confirms that the study successfully addresses a gap in previous research, which often focused primarily on improving nutrition knowledge without demonstrating tangible changes in consumption behavior. The findings show that digital-based nutrition education designed with a strong theoretical and interactive foundation can move beyond knowledge enhancement toward actual changes in daily dietary practices. Thus, this study provides empirical evidence supporting the argument that effective nutrition education must integrate cognitive, social, and psychological dimensions simultaneously.

Overall, the conclusions affirm that digital-based nutrition education represents a relevant and promising strategy for promoting healthy food consumption behavior among urban adolescents. The findings not only enrich academic understanding of adolescent dietary behavior in digital contexts but also offer conceptual and empirical foundations for developing health promotion programs that are more adaptive to technological advancement. By linking the research findings and discussion, it can be concluded that the success of digital-based nutrition education depends largely on the alignment of intervention design with adolescent characteristics and the systematic integration of behavioral theory throughout all stages of implementation.

RECOMMENDATIONS

The recommendations of this study are formulated based on the conclusions indicating that digital-based nutrition education has a meaningful impact on changes in healthy food consumption behavior among urban adolescents. The findings emphasize that behavioral change is influenced not only by increased knowledge but also by the development of positive attitudes, strengthened self-efficacy, heightened awareness of health risks, and socially relevant support systems. Therefore, the recommendations are directed toward strengthening the sustainable, structured, and theory-based implementation of digital-based nutrition education.

Based on the research findings and conclusions, it is recommended that the development of digital-based nutrition education programs for urban adolescents explicitly integrate behavioral theory frameworks, particularly the Theory of Planned Behavior, Social Cognitive Theory, and the Health

Belief Model. Such integration is essential to ensure that interventions extend beyond information delivery to influence behavioral intentions, build self-efficacy, and enhance adolescents' awareness of health risks and benefits. Digital nutrition education programs developed without a strong theoretical foundation may produce limited and less sustainable outcomes, as evidenced in several previous studies.

Further recommendations concern the design and content of digital-based nutrition education. In line with the study's conclusions, educational content should be contextualized and closely aligned with the everyday experiences of urban adolescents. Nutrition information should be presented through visual formats, concise narratives, and practical examples that are easily applicable, such as strategies for making healthier food choices when eating outside the home or managing snack consumption. In addition, the use of interactive features such as digital reminders, healthy eating challenges, and personalized feedback is recommended to enhance adolescent engagement and support the maintenance of behavioral change over time.

From a practical perspective, the findings indicate the need for collaboration among educational institutions, health professionals, and digital technology developers in implementing digital-based nutrition education. Schools and youth communities can serve as initial implementation settings, while health professionals play a crucial role in ensuring the accuracy and credibility of nutrition content. Digital technology developers, in turn, have a strategic role in creating user-friendly, adaptive platforms that align with adolescents' preferences and interaction styles. Such cross-sector collaboration is recommended to improve both the effectiveness and the reach of digital nutrition education interventions.

Additional recommendations relate to academic implications and knowledge development. This study demonstrates that integrative approaches to health behavior research provide a more comprehensive understanding than partial approaches. Accordingly, future research is recommended to further develop and test more specific digital-based nutrition education models, for example by examining the relative contributions of each behavioral theory to dietary behavior change. Longitudinal research designs are also recommended to assess the sustainability of behavioral changes over extended periods.

Based on the study's conclusions, future research is further encouraged to expand the context and characteristics of study populations. Comparative studies involving urban and rural adolescents, or different age groups, may provide broader insights into the effectiveness of digital-based nutrition education across diverse social contexts. The use of mixed-methods approaches is also recommended to complement qualitative findings with quantitative data, allowing for more robust and measurable assessments of intervention impacts.

This study underscores the considerable potential of digital-based nutrition education as a health promotion strategy for urban adolescents, as reflected in its conclusions. However, the success of such interventions depends heavily on the alignment of program design with adolescent characteristics, the integration of behavioral theory, and strong cross-sector support. By implementing these recommendations, it is expected that future development and research in digital nutrition education can make a more substantial contribution to improving healthy food consumption behavior and preventing nutrition-related problems among adolescent.

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