



## Does Technology Affect Nutrition Education Perspectives?

### Teknoloji Beslenme Eğitimi Perspektiflerini Etkiler mi?

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#### ABSTRACT

The importance of various prevention efforts, including implementing nutrition education especially among children and adolescents, is growing due to noncommunicable diseases like hypertension, obesity, and diabetes that are common among children and adults. Most studies conducted in the previous few decades have noted that using technology in learning environments—including computer-based software, web-based learning, and hardware—creates a remarkable learning and teaching environment. For health professionals like dietitians who provide nutrition education, the ease of data recording, easy transmission and re-accessibility increases the use of various technologies. These technologies present specific challenges, such as rising costs, user information needs, and age-specific unsuitability. Wearable and artificial intelligence technologies allow individuals to be monitored instantly. With distance education technologies, the opportunity to reach experts regardless of time and place makes it easier to get the correct information. The use of photography and automatic recognition methods in determining the amount of food supports reaching accurate food consumption records. With systems where individuals can see and follow their own data, it becomes easier for individuals to monitor behavior changes. It is stated that, nutritional applications could be more effective when guidance is established based on the attitudes, students' achievement, and experience. This review focused on the impacts of mobile and web-based nutrition education.

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#### ÖZET

Çocuklardan yetişkinlere kadar yaygın olan hipertansiyon, obezite ve diyabet gibi bulaşıcı olmayan hastalıklar, başta çocuk ve ergenler olmak üzere beslenme eğitiminin yaygınlaştırılması da dahil olmak üzere çeşitli önleme stratejilerinin önemini artırmaktadır. Son yıllarda, bilgisayar tabanlı, yazılım, web tabanlı öğrenme ve donanım dahil olmak üzere öğrenme ortamlarında teknolojinin kullanılmasının hem öğrenme hem de öğretmede olağanüstü bir deneyim kazandırdığı çoğu araştırma tarafından dile getirilmektedir. Beslenme eğitimi veren diyetisyenler gibi sağlık profesyonelleri için veri kaydının kolaylığı, iletilmesinin ve yeniden erişilebilirliğinin kolay olması çeşitli teknolojilerin kullanımını artırmaktadır. Ancak bu teknolojilerin kullanımında maliyetlerin artması, kullanıcılar için bilgi gereksinimlerinin artması, her yaş grubunda kullanıma uygun olmaması gibi zorluklar bulunmaktadır. Giyilebilir ve yapay zeka teknolojilerinin kullanılması bireylerin anlık olarak takip edilmesine olanak sağlamaktadır. Uzaktan eğitim teknolojileri ile zaman ve mekandan bağımsız olarak uzmanlara ulaşma olanağı, doğru bilgiye ulaşmayı kolaylaştırmaktadır. Besin miktarının belirlenmesinde fotoğraf ve otomatik tanıma yöntemlerinin kullanılması, doğru besin tüketim kayıtlarına ulaşmayı desteklemektedir. Bireylerin kendi verilerini görebildiği ve takip edebildiği sistemler ile bireylerin davranış değişikliklerini takip etmesi kolaylaşmaktadır. Öğrencilerin tutumlarına, başarılarına ve deneyimlerine göre rehberlik oluşturulduğunda beslenme uygulamalarının daha etkili olabileceği belirtilmektedir. Bu derlemede mobil ve web tabanlı beslenme eğitiminin etkilerine odaklanılmıştır.



## 1. Introduction

A healthy diet supplemented by frequent physical activity routines is the primary elements protecting human health throughout life. In light of increasing knowledge of the link between nutrition and chronic diseases, the ideal diet to maintain well-being has been investigated. It is generally recognized that nutrition can significantly alter a subject's risk profile in primary and/or secondary prevention. Therefore, nutrition education is essential to improve eating habits and adopt healthy food choices, especially in children and adolescents, for planning strategies to improve health in the long term in the adult population (1). Although face-to-face education is still more common, adopting digital technologies, particularly during the COVID-19 pandemic, has required practitioners and policy makers to explore unique educational approaches to support healthy practices (2). As digital natives, today's children and adolescents may find digital approaches to nutrition education more meaningful and impactful than traditional approaches. The internet, telehealth, gaming, social media and mobile apps are a few digital platforms used to promote health among these populations, with varied impacts. Thus, getting information from mobile applications or online environments and adapting it to daily lives make technology literacy increasingly important (3).

High-quality diets are critical in children to prevent chronic diseases, growth, development and academic success. Healthy eating habits primarily emerge during childhood, therefore promoting their early adoption is critical to ensure that they persist into maturity. Nutrition education interventions can modify a person's lifestyle behaviors by promoting healthy food choices and enhancing eating habits. However, nutrition education interventions successfully alter behavior, the treatments must pinpoint the desired behavior, offer advice on the best training intervals, and incorporate activities appropriate for the target demographic (4). The use of new technologies in nutrition education is an easily accessible, funny and interesting way to attract and engage children's long-term attention and it makes the knowledge more permanent (5). This review covers the effects of mobile and web-based technologies, technologies for distant learning, wearable technology, and augmented reality technologies on nutrition education methods—the ones most frequently utilized in the literature.

## 2. Mobile Applications

Many mobile applications claim to support nutrition and health behavior. In order to improve health and nutritional behavior, it is crucial to assess the acceptability of these applications for use and

make the right decision (6). Mobile applications allow users to monitor their daily food consumption and provide information about macronutrients and micronutrients. There are also apps designed to help users find recipes, create shopping lists, and plan meals that suit their health risks, food allergies, and dietary habits. Although most of these applications are still based on information acquisition and user input data, they are also used with mobile phone camera features and other visual data capture devices to obtain more objective data on food intake (7).

Despite the opportunities provided by mobile apps and smart gadgets, it is still required to pick which approaches will be employed correctly in which groups to meet educational objectives. How much, in which group, and how dietitians use these program features when delivering nutrition education or therapy are crucial to the training's success. The use of mobile phone-based technologies as an aid for education in groups receiving nutrition education may be beneficial in increasing the effectiveness of the education (8).

It is emphasized that providing education in this way is more effective when it comes to young adults, children and adolescents who frequently use mobile devices and applications. Also it is possible to comply with nutrition education and treatment quickly and have the opportunity to follow up (9). Gamification for children is also an important issue for nutrition education. Attracting children's attention to nutrition education through gamification is an effective method for gaining healthy eating behavior. Gamification in mobile applications and the badges, medals, coins, and points kids earn through these games significantly promote education. Gamification elements like competition, achievement, self-expression, and leaderboards that users can see are critical in boosting teaching effectiveness in childhood, where peer modeling is helpful (10).

For example, the Umbul card game was developed to create a fun learning environment for students. These cards contain the following seven items: eat enough fruits and vegetables; eat high-protein side dishes; desire to consume a variety of basic meals; eat less sugary, salty, and high-fat foods; consume enough water that is safe to drink; use soap and water to wash your hands; and playing a sport. It was found that this card game provided a primary school kid with an instructional learning environment (11).

Due to its impact on adulthood, childhood obesity is a critical concern that must be highlighted. To prevent obesity, it is advised to utilize creative methods to form dietary habits that concentrate on behavioral changes in young children. Putting healthy messages in

the game content and working with companies and legal regulators on this issue will be useful (12).

The various characteristics of smart devices make them good candidates for behavioral interventions. First, portable devices highly valued by individuals are available throughout the day to open up and be with individuals. Therefore, they enable behavioral interventions, influence people's decisions about their health, and provide an opportunity to bring real-life connections by removing barriers to behavior change (13). Second, smartphone apps can offer unique interventions that are less expensive, more practical, or need less time. Third, smartphone internet access makes it easier to share behavioral and health data easier with peers or healthcare experts. Due to the location, movement, mood, and social involvement capabilities of cell phones, it also enables contextual and timely treatments. Although there is a strong desire to provide interventions via smartphone applications, there needs to be more academic study on creating and assessing such programs. Currently, formative research is required in addition to studies of certain individual practices to assist us in better understanding the interest of various groups of people in engaging in such activities and the factors that may affect acceptance and participation (14).

### **3. Web-Based Technologies**

Interventions involving web-based technologies in nutrition education mimic conventional nutritional counseling. In these treatments, people are given information about their specific health behaviors, motivations, attitudes, and perceived barriers, among other personal factors, making the material individually selected and applicable. Since these technologies move diagnostic, instructional expertise and methodologies to a computer system, they need more direct social support of human therapy. In contrast to direct therapy, web-based technologies offer the chance to reach considerably more people at much cheaper prices. Web-based technology applications are a promising approach that merits more investigation due to their potential to reach bigger populations of individuals than human counseling (15).

Utilizing customized messaging to affect various health-related behaviors, using different information sources, and communicating through various channels are benefits of web-based technology (16). There are many difficulties in obtaining information on healthy eating behaviors from suitable sources by many individuals in society. Additionally, individuals require various kinds of incentives to establish healthy eating habits. Online nutrition education can play a significant role in assisting this circumstance. Presenting correctly prepared information based on scientific resources and web-based

technologies will significantly contribute to supporting healthy eating behavior in individuals. Although web-based technologies are utilized in nutrition education, they must be supported by a dietitian. However, it can be an effective complementary strategy because the information is generated using scientific data and has an engaging user interface (17).

One of the critical issues in nutrition education is to use the data from individuals' food consumption records to evaluate nutritional status, make decisions and set goals for improving healthy eating habits. Conventional dietary assessment tools are either of good scientific quality but involve high implementation costs (24-hour recall) and substantial commitment from the participants (dietary records) or are easily implemented but need more accuracy and precision (food frequency questionnaires). Digital measurement devices can help overcome the limitations of conventional dietary assessment tools, provide a cost-effective way to valuable real-time food intake data, and have the potential to eliminate participant burden linked to portion size estimation. However, since the use of these technologies needs the ability of computer skills, there are difficulties in applying them to all groups in society. In addition, there are concerns about its use in all types of research as it involves high costs (18).

Web-based interventions are being developed to improve nutritional behavior in children. The goal of an innovative web-based school nutrition intervention created by Chamberland et al. is to promote middle school students' consumption of dairy, fruits, and vegetables. This study, observed students' progress in fruit-vegetable and dairy-milk product consumption using a web-based platform for six weeks. The daily consumption of fruits, vegetables, milk, and dairy products increased significantly by three servings and 1.8 servings, respectively. According to some sources, adopting online or technology tools can assist children in developing healthy eating habits that will benefit them as adults (19).

Evidence supports the use of e-mails and SMS as action cues to reinforce behavior change and improve involvement with web-based therapies, which can increase their effectiveness. In a study by Rangelov et al. in Switzerland, the changes in students' eating habits were examined through a web-based program supported by e-mail and SMS during an 8-week intervention. According to the study data, groups supported only by web-based, SMS and e-mail had an increase in fruit consumption and a drop in daily sweet consumption. It is claimed that a carefully planned web-based intervention can enhance kids' intake of fruit, water, soft drinks, and sweets (20).

#### **4. Personal Digital Assistive Technologies**

Personal digital assistive technologies are technologies that allow individuals to monitor themselves and save data such as food consumption records and nutritional behaviors on the computer. Records can be digitally monitored by both the individual and the researcher, facilitating information transfer and tracking. It is stated that digital assistive technologies are effective in terms of feedback and support in the effect of nutritional behavior while reducing the time spent in preparing individual reports for individuals and dietitians. Supporting nutrition education with personal digital assistive technologies has increased individuals' orientation towards healthy eating behaviors (21). Personal digital assistive technologies are used in many areas such as diabetes, pain, asthma, and physical activity. There are also studies on nutrition education and treatment. With digital assistive technologies, visuals and documents where they can see portion sizes, nutritional habits and food consumption records are recorded more quickly. It increases the preference rate due to the benefits it provides for users (22).

Some personal digital assistive technologies combine data such as fat consumption, fruit and vegetable consumption amount and added sugar consumption of the individual with the software they contain and present them in graphic form. By examining these graphs, individuals can evaluate and regulate their food consumption in the following days and weeks according to these data. These data support individuals' self-management under the supervision of the dietician consulted and after nutrition education (23).

#### **5. Interactive Computer-Based Technologies**

Interactive computer-based technologies provide individuals with individually tailored feedback on current health behaviors, behavioral determinants, and recommendations to change behaviors through a personally tailored automated system. At the beginning of such specific interventions, computer technology is built around providing feedback based on individuals' responses to written questionnaires. Especially with internet connectivity, such interactive systems can provide individualized behavior change information to many people at low cost and thus potentially have wide application in health promotion (24).

Self-regulation skills such as planning and monitoring are known to affect dietary behavior. Setting goals and giving feedback on performance are two self-regulation-promoting intervention strategies linked to more significant changes in nutritional outcomes. It is claimed that actions such as rapid goal formation, rapid goal specificity, feedback on performance and rapid evaluation of behavioral objectives, which combine self-regulation behavior

change strategies and self-regulation behaviors, and help to enhance eating habits. It is stated that feedback can be received quickly and effectively owing to interactive computer-based technologies (25). Environmental influences are crucial for behavior change, in addition to factors at the human level. Interactive computer-based technologies make it possible to provide more complex feedback on environmental-level factors, such as the objectively evaluated availability of healthy products in the local food environment. Including such feedback could potentially increase the effectiveness of nutrition education interventions adapted to interactive computer-based technologies, as an essential category of determinants is addressed (26).

#### **6. Photography and Video-Based Technologies**

Photography and video-based technologies are based on taking food measurements and quantities in food consumption records using photos and videos. In nutrition education, accurate recording and evaluation of individuals' dietary consumption are important. Traditional methods for recording food consumption generally have disadvantages in expressing the correct portion sizes. A straightforward approach for measuring the precise portion size is to set a sample object, like a pen, next to the meal that is being photographed. This tool can then be used before and after the food is consumed to measure food waste. One of the advantages of taking photographs and video recordings is a way to realize the points that need to be changed in individuals' eating habits, and the researcher or dietitian can accurately see the portions and food types. It is mentioned that both nutrition education and diet therapy can be more effective via photographic recordings and videos (27).

Photographic tools can also capture and define images and determine the types of portion sizes. Trained dietitians and an automated system are required to convert captured images to nutritional content and portion size and assess the nutritional values. Although sophisticated automated systems have been developed to recognize foods and predict portion size and nutrient content automatically, the reliability of these automated systems is debated due to the complexity of foods and meals (28).

In a study in which photos of foods were taken before and after the meal and shared with researchers through a program, it was determined that meal timing, place, harmony in parent-child meals, level of preparation and food quality helped obtain information (29). According to a study that reviewed the validity and reliability of the remote meal photographing method for measuring food intake in adults and children, it allows for the wireless transmission of images of food selection and leftovers to a server in almost real-time for

analysis. It demonstrates how digital imaging reliably predicts food intake in a various settings, which has many benefits over earlier techniques like reducing participant load and doing away with the need to estimate participants' portion sizes. Additionally, it is said that it provides youngsters with nutrient recording that is more engaging and interactive as well as more accurate data (28).

## **7. Wearable Technologies**

The widespread adoption of wearable technologies presents new opportunities for researchers to provide medical care and information in a portable and cost-effective way. For healthcare professionals, having this information allows them to monitor the individual at any time accurately. The ability of this technology to continuously, silently, and unobtrusively monitor people without interfering with their regular everyday activities is one of its most crucial qualities (30). These devices often use complex mechanisms such as artificial intelligence to organize and extract meaningful information from the collected data. Essential machine learning functions include pattern detection, prediction, classification, language processing and image recognition functions which can similarly be transferred to applications in nutrition (31). Recognition of food images and learning with artificial intelligence are essential in accurately taking food consumption records and supporting nutrition therapy and nutrition education to be given to individuals (32). By processing data such as individuals' nutritional habits, physical activity status, and anthropometric measurements, it can provide faster assessment and feedback to nutritionists with individual recommendations. Artificial intelligence technology as an auxiliary element in nutrition education helps support individuals and nutritionists (33).

By far, smartwatches are the most widely used wearable health monitoring devices. These devices often use a combination of technologies such as an accelerometer, pedometer, heart rate monitor, proximity sensor, microphone, camera, and/or long-term communication. Combining these technologies with nutrition education makes it easier for nutritionists to obtain the correct information and support the individual (34). Wearable devices for image-based nutrient intake using cameras to classify foods and estimate portion sizes, having an algorithm to detect food ingredients and portion size based on environmental cues like plates and eating utensils, and determining energy and nutrient intake via a linked diet database are all examples (31).

In a study, the food consumption of 36 children aged 11 years was observed for three days through wearable cameras to determine their meal times, eating patterns and eating status. Images were analyzed

to assess the participants' food consumption. Data such as which foods and how often they consume, whether they are healthy or unhealthy, and whether they consume food standing or sitting were recorded. By analyzing the data, the specifics of the children's eating habits were appropriately identified after this study. Additionally, it was found that youngsters were becoming more mindful of their food intake. It is claimed that the usage of wearable technology in children can help shape their eating behaviors, which is crucial for nutrition education (35).

## **8. Distance Education Technology**

Unlike in-person instruction, distance education approaches provide better accessibility, cost efficiency, and schedule flexibility. Additionally, distance learning programs can promote coordinated forms of communication between teachers and students or between various student groups. Further studies are needed to develop new distance education methods, determine effective methods and evaluate intervention times (36).

Changes in knowledge, attitudes, and behaviors around breakfast were assessed in a study examining the efficacy of in-person and online nutrition education for kids. The evaluations conducted two and four months after the training revealed a decline in skipping breakfast. It has been stated that online nutrition education is as effective in behavior change as face-to-face education (37). An online education program evaluated children's knowledge, attitudes and behaviors about salt, self-efficacy and dietary salt intake. A 5-week behavior-based training program delivered through weekly online interactive training sessions resulted in improved salt-related knowledge, self-efficacy, and behavior (38).

## **9. Augmented Reality Technologies**

Individuals need help to participate in traditional nutrition education programs for reasons such as time, transportation and family responsibilities. This situation becomes more challenging especially in rural or low-income areas with limited access to accurate information and experts. Most nutrition-based education programs only give content sparsely (i.e., once a week or less) and offer insufficient interventions to people who are not actively participating. These factors contribute to poor participation motivation, which can be overcome by having a successful program experience. The COVID-19 epidemic has also illustrated the necessity of remote behavior modification initiatives and virtual approaches to nutrition education (39).

More work has to be done to improve the options for students with low levels of education and resources to learn about nutrition online.

Innovative computer software technologies, such as extended reality, encompassing augmented, and virtual and mixed reality subcategories may offer solutions (40). While offering technological features that may be appealing to families, children, and youth, extended reality technology offers the flexibility required in a platform to address the broad objectives of nutrition education and obesity prevention programs. A computer-generated interactive experience that takes place in a created environment is known as virtual reality technology. Virtual reality environment mainly contains audio and visual information. This immersive setting can be unique or just like the real world, producing an experience that is not attainable in everyday physical reality (41). Like virtual reality, augmented reality technologies give users a unified vision by superimposing a computer-generated image over their view of the world. Similar to augmented reality, mixed reality uses responsive digital information that is spatially aware to make virtual objects appear to be a part of the natural environment. The user's sensation of feel and presence may be diminished compared to more expensive headsets by cheaper and more accessible technologies, such as PC experiences and mobile phone apps. More user activity can boost the implemented efficiency (42).

Due to their capacity to dynamically enhance access to information and experiences that many people may not have, these technologies have the potential to significantly affect approaches to nutrition education and behavior modification. Other potential elements include options for social networking, tailored education methods, and empowerment through incentives. Access to traditional face-to-face nutrition education and behavior change programming can be significantly hampered by constrained environmental and contextual factors, as was observed during the COVID-19 epidemic (43).

Studies on augmented reality in children have generally focused on children with autism. It is stated that problems such as distraction and inability to focus that come with this disease can be overcome with augmented reality technology. At the same time, it is claimed that augmented reality technology can reduce distractions during classes in healthy children. It is recommended to use these technologies to effectively give the information during nutrition education and to be memorable (43,44).

#### 10. Artificial Intelligence Technologies

The use of computers to independently or partially independently carry out tasks that resemble human intelligence is known as artificial intelligence. Pattern recognition, prediction, classification, language processing, and picture recognition are fundamental machine learning tasks. Similar transfers can be made to applications

in nutrition (31). Artificial intelligence can be used to identify foods and estimate their quantities, allowing for the recording of food consumption in a healthy manner. At the same time, it can record the habits of the individual and provide some ideas to the nutritionist to regulate his prior conduct. By processing data such as individuals' nutritional habits, physical activity status, and anthropometric measurements, it can provide faster assessment and feedback to nutritionists with individual recommendations. Artificial intelligence technology as an auxiliary element in nutrition education helps to support individuals and nutritionists (33).

Recognition of food images and learning with artificial intelligence are essential in accurately taking food consumption records and supporting nutrition therapy and nutrition education to be given to individuals. There are various difficulties at this stage such as correct recognition of nutrients and processing of packaged products into the system (32).

#### 11. Conclusion

In recent years, web-based and mobile technology use in nutrition education has grown. Mobile and web-based training offers several benefits such as accessibility, flexibility, and time savings. Mobile applications enrich education through gamification and make it fun especially for children closely involved with technology. The fact that mobile applications include gamification and children get badges, medals, coins and points through these games is essential in education. At the same time, in childhood, when peer modeling is effective, gamification tools such as competition, success, self-expression and leaderboards that users can see are essential in increasing the effectiveness of education.

Despite some advantages of these technologies, the difficulties of individuals at every socio-economic level in accessing these opportunities and risks such as screen addiction must be considered. Mobile and web-based technologies facilitate the implementation of adequate and balanced nutrition only if used under dietitians' guidance and control. In order to shield people from the potential detrimental impacts of using new technologies, it is crucial that specialists properly inform them. More research is required to establish the effectiveness and sustainability of nutrition education enabled by new technology.

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