

The Effectiveness of Diabetes Awareness Education Program Among 8–10 Years-Old Primary School Children

8-10 Yaş Grubu İlkokul Çocukları Arasında Diyabet Farkındalık Eğitim Programının Etkinliği

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ABSTRACT

The diabetes awareness education program, enriched with gamification techniques, offers an innovative approach to educating and raising awareness about diabetes among primary school students. This study aimed to evaluate the effectiveness of this program for children aged 8-10 years. Conducted at a primary school in Istanbul with 223 children, the study collected data using a Sociodemographic Information Form and a Child Diabetes Knowledge Form. The education was delivered weekly for five weeks by trained nursing students. Of the children, 51.1% were girls, 43.9% were aged 9, and 53.4% were in the 4th grade. Additionally, 25.6% had a family member with diabetes, 39.5% had a relative with diabetes, and 70.4% had heard of diabetes. Comparing pre-test and post-test scores, the program significantly increased scores related to diabetes awareness, symptoms, healthy nutrition, and prevention ($p < 0.001$).

Keywords: awareness, children, diabetes, education

ÖZ

Diyabet farkındalık eğitim programı, oyunlaştırma teknikleriyle ilkökul öğrencilerini diyabet konusunda eğitmek ve bilinçlendirmek için yenilikçi bir yaklaşım sunar. Bu çalışma, 8-10 yaş arası çocuklarda bu programın etkinliğini değerlendirmeyi amaçlamıştır. İstanbul'daki bir ilkökulda, 223 çocuk ile yapılan bu çalışmada veriler, Sosyodemografik Bilgi Formu ve Çocuk Diyabet Bilgi Formu ile toplanmıştır. Eğitim, haftalık olarak eğitilmiş hemşirelik öğrencileri tarafından beş hafta boyunca verilmiştir. Çocukların %51,1'i kız, %43,9'u 9 yaşında, %53,4'ü 4. sınıftadır. %25,6'sının diyabetli bir aile üyesi ve %39,5'inin diyabetli bir akrabası vardır, %70,4'ü diyabeti duymuştur. Ön test ve son test puanları karşılaştırıldığında, eğitim programının diyabet farkındalığı, belirtiler, sağlıklı beslenme ve diyabetin önlenmesi konularında çocukların puanlarını artırma-da etkili olduğu görülmüştür ($p < 0.001$).

Anahtar Kelimeler: farkındalık, çocuklar, diyabet, eğitim

INTRODUCTION

Diabetes is a major global health problem with an increasing prevalence over the years. The global prevalence of diabetes is predicted to increase to 10.9% by 2045, affecting approximately 700 million people (1). Diabetes is categorized into two main types: type 1 and type 2 diabetes. Type 1 diabetes, also known as insulin-dependent diabetes mellitus, is characterized by the

autoimmune destruction of insulin-producing beta cells in the pancreas. On the other hand, type 2 diabetes, also referred to as non-insulin-dependent diabetes mellitus, is primarily characterized by insulin resistance and impaired insulin secretion. This type of diabetes is often associated with lifestyle factors such as obesity, physical inactivity, and poor diet. Although many factors are related to the development of type 2 diabetes, unhealthy diet, sedentary lifestyle, and obesity are the primary causes (2).

Childhood is a crucial period of lifetime that involves gaining habits for the rest of one's life. Poor eating and sedentary lifestyle habits may start during this period and continue throughout their life. Studies have identified a sedentary lifestyle as an independent predictor of being overweight in children and emphasized its implication in the development of obesity (3). Furthermore, a sedentary lifestyle is a common risk factor for

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developing type 2 diabetes, especially when combined with other factors such as poor eating habits and obesity (4). Notably, long-term gains in overweight and obesity since childhood have been associated with an increased risk of type 2 diabetes in adulthood (5). Lifestyle modifications, such as weight loss and exercise, have been proposed as effective strategies to prevent diabetes and its associated complications in children (6). Early detection and prevention efforts are essential, as the risk of complications from diabetes increases with the duration of the disease, making preventive strategies particularly crucial for children (7). Therefore, providing information about diabetes, healthy nutrition, and physical activity during childhood is vital in raising awareness about risk factors and prevention for diabetes across the lifespan (8).

Research on diabetes awareness programs in schools has shown positive outcomes in preventing diabetic ketoacidosis and improved management practices (9). Studies have emphasized the importance of training school staff on diabetes, focusing on symptom recognition, blood glucose level management, and emergency response (10). The Kids and Diabetes in Schools (KiDS) project was launched in 2013 by the collaboration of the International Diabetes Federation (IDF), the International Society for Pediatric and Adolescent Diabetes (ISPAD), and Sanofi. The main objective of the KiDS program is to introduce diabetes education into school settings to combat the stigma associated with diabetes and encourage healthy behaviors to address the modifiable risk factors for type 2 diabetes. A key aspect of the KiDS initiative is its resources, which have been carefully developed with input from an international advisory committee comprising experts from various fields. These resources are tailored to local languages, cultures, and contexts to facilitate their adoption and implementation on a global scale (11). Furthermore, initiatives such as the “KiDS and Diabetes in Schools” project have provided evidence of the effectiveness of educational interventions between parents and school professionals in promoting diabetes awareness and creating safe school environments

for children with diabetes (12). A supported and inclusive environment can be developed for children by improving knowledge, attitudes, and practices related to diabetes care in schools (13). Therefore, raising awareness of a healthy lifestyle and taking preventive measures in primary school children is critical to preventing diabetes.

Various programs for school children with diabetes have been developed and implemented in Turkey. The “Diabetes in School Program” aims to raise awareness about Type 1 diabetes (T1D) through schools and teachers to ensure early diagnosis of T1D in school-age children and reduce diabetic ketoacidosis to strengthen school care for diabetes in school-age children and to raise awareness about healthy eating and obesity, is ongoing throughout Turkey (14). The “Diabetes Management Program at School,” which came into force in 2010 in Turkey, is to increase teachers’ awareness of the needs of children with diabetes and thus improve their support for school-age children (8).

There are gaps in the literature on addressing preventive and awareness interventions conducted with school-age children aimed at reducing potential type 2 diabetes in the future. This interventional study aimed to measure the effect of a ‘Diabetes awareness education program’ as an intervention on primary school children.

MATERIAL AND METHOD

Study Design

The type of the study is an interventional study/trial using a training/diabetes awareness education program as an intervention. The research was conducted using a pre-test and post-test design and between March 1st, 2024, and March 29th, 2024. In this study, a pre-test and post-test design was implemented. The guidelines of the ‘Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) Statement Checklist were followed when conducting the research (15).

Sample and Setting

The research sample was determined using a non-probabilistic sampling method. The study was conducted at Atatürk Primary School, situated

in the Zeytinburnu District of Istanbul. The participants were students from the third and fourth grades. The primary school has a total enrollment of 672 students, with 336 in the third and fourth grades. The students in their third and fourth years and their parents were invited to participate, and those who voluntarily wished to participate in the study were included. A total of 223 students and their parents were accepted to participate in the study.

Inclusion criteria were as follows; being between 8 and 10 years old, currently enrolled in primary school, having no visual, auditory, or mental impairments, proficient in reading and writing in Turkish, having parental consent for participation, and attending all training sessions.

Exclusion criteria were as follows; having any illness that would prevent participation in the training, lacking literacy skills, and not volunteering to participate.

Diabetes Awareness Education Program

The diabetes awareness education program was organized by five nurses specializing in public health nursing, child health nursing, psychiatric nursing, and nursing students. The diabetes awareness education program was designed to be conducted once a week, with each session lasting 30 minutes, over 5 weeks. There are a total of 4 main topics: awareness of living with diabetes, understanding diabetes symptoms, healthy nutrition for diabetes prevention, and physical activity for diabetes prevention. Primary school students were taught one topic per week, completing all topics in five weeks. The educational sessions and related details are provided in Table 1.

Procedures

The study process was conducted in three stages.

First stage: Children between 8 and 10 years old, accompanied by their parents, were informed about the research's purpose with the help of their teachers, who also distributed consent forms to families. The researcher explained to both parents and children that diabetes is commonly known as 'Şeker Hastalığı' in the community to ensure

understanding. Children who expressed interest and had a parental consent form completed the 'Child Information Form' and 'Child Diabetes Knowledge Form' facilitated by researchers through questionnaires in each classroom.

Second stage: To increase diabetes knowledge levels, researchers created diabetes education activities using the KIDS education package and literature. At the same time, these educations are gamified with a scenario or enriched with a video to enhance the effectiveness of the education sessions. As an example, more information about education session one is provided in Appendix 1. Before the games and education were implemented, expert opinions were obtained from six individuals knowledgeable about children's health for content validity, and the educational content was rearranged according to their suggestions. To ensure effective delivery of education in each class, third-year BSc nursing students underwent half-day training conducted by researchers, equipping them with the necessary skills to present each of the four topics to primary school children. Each educational session was conducted by undergraduate students under the supervision of researchers. These sessions were presented to third and fourth-grade students in primary school weekly.

Third stage: Following the completion of the educational sessions, children were requested to complete the 'Child Diabetes Knowledge Form' on the 5th week.

Data Collection Tools

This questionnaire comprises questions covering various aspects of diabetes, including general knowledge (5 questions), signs and symptoms (8 questions), management (8 questions), and prevention (7 questions). These questions were developed by researchers based on literature (16) and the content of the KiDS education package (11). Response options are structured as binary choices (yes=1 point or no=0 point). A score of 1 was assigned for each correct answer and 0 for each incorrect answer. The maximum possible scores were 5 points for the general knowledge subscale, 8 points for the signs and symptoms subscale, 8 points for the management subscale,

and 7 points for the prevention subscale. The maximum total score for the scale was 28 points, while the minimum score was obtainable across all subscales, and the total scale was 0. All items underwent expert review, and revisions were made based on feedback to ensure content validity. The Content Validity Index (CVI) indicates the degree to which the items in the instrument are relevant and representative of the measured construct. One method for calculating the CVI is the Davis method, which involves expert judgment to determine the relevance of items in the instrument (17). Each item in the instrument is presented to the panel of experts, who are asked to rate the relevance of each item on a scale. The typical scale ranges from 1 to 4: 1: Not relevant; 2: Somewhat relevant; 3: Quite relevant; 4: Highly relevant. We calculated the CVI for each item using the proportion of experts who rated the item as either “quite relevant” or “highly relevant.” We calculated the CVI for each item and averaged these scores to obtain the overall CVI for the entire questionnaire. This provides an overall indication of the instrument’s content validity. A higher CVI indicates more substantial content validity, suggesting that a larger proportion of experts rated the items as relevant. The CVI values above 0.80 indicate good content validity (18). The CVI value of this questionnaire was 0.99, which is an acceptable and appropriate value.

Data Analysis

SPSS (Statistical Package for the Social Sciences) for Windows IBM 28 package program was used for data analysis. Descriptive statistics such as mean, standard deviation, median, interquartile range, frequency, and percentage distributions were used to evaluate descriptive data. Comparison of children’s pre and post-education assessment scores were evaluated using the Wilcoxon test. The $p < 0.05$ was accepted as the significance level.

Ethical Issues

This study received approval from the Koç University Ethical Committee (IRB no: 2024. 021. IRB3. 004). The written informed consent form was obtained from parents for their children’s participation. Additionally, permission to conduct the study was granted by the district

National Education Directorate where the primary school is situated, and institutional permission was also gathered. Participants were assured that the data collected would be used solely for scientific purposes, kept confidential, and coded anonymously. The study adhered to the principles of the Declaration of Helsinki and ensured that ethical standards were adhered to throughout the research process.

Results

Socio-demographic characteristics of the students

A total of 223 students participated in the study, with 114 (51.1%) females and 109 (48.9%) males. Of the participants, 46.6% (104 students) were in the 3rd grade, while 53.4% (119 students) were in the 4th grade. Among all participants, 25.6% (57 students) had a family member with diabetes, whereas 74.4% (166 students) did not. Additionally, 70.4% (157 students) had previously heard of diabetes, while 29.6% (66 students) were unfamiliar with the disease. Other socio-demographic characteristics are presented in Table 2.

Effectiveness of Diabetes Awareness Education Program

The median value of pre-test general knowledge scores were 3 (IQR: 3-4), 5 (IQR: 3-6) for signs and symptoms, 4 (IQR: 3-5) for both management and prevention of diabetes, and 16 (IQR: 14-19) for total scores. The median value for post-test scores were 4 (IQR: 4-5) for general knowledge, 7 (IQR: 6-8) for signs and symptoms, 6 (IQR: 5-7) for management, 5 (IQR: 4-6) for prevention with the total score of 22 (IQR: 19-28).

The general knowledge subdomain score significantly differed between the pre-test and post-test scores ($Z: -9.120, p < 0.001$). Using the KiDS educational program combined with gamification techniques increased students’ general perception sub-domain scores, with a medium effect size ($d = 0.747, 95\% \text{ CI: } 0.598 \text{ to } 0.895$). The scores for the diabetes management subdomain were found to be significantly different ($Z: -10.965, p < 0.001$), with a large effect size ($d: 1.078, 95\% \text{ CI: } 0.886\text{--}1.213$).

The diabetes prevention subdomain scores also demonstrated a significant outcome (Z : -7.363, $p < 0.001$) with a medium effect (d : 0.538, 95% CI: 0.397–0.678). Consequently, the mean values of

the total scores indicated a statistically significant difference (Z : -12.004, $p < 0.001$) with a large effect size (d : 1.351, 95% CI: 1.168 to 1.532). Other findings related to questionnaire scores were demonstrated in Table 3.

Table 1: The Content of Educational Sessions Covered by Each Group, İstanbul-2024

Training Sessions	Main Theme	Content	Method/Material	Duration
Awareness of living with diabetes	What does it mean to live with Diabetes?	- What is diabetes? - Who can have diabetes? - Why do we develop diabetes? Types of diabetes disease. - A day with diabetes in school: Story - What happens in our body with diabetes? : Ali's who uses insulin, pays attention to his diet, and checks his blood sugar and his reaction during cell metabolism	- Direct explanation (ppt presentation) - Video demonstration - Role-play (how do our cells function when someone has diabetes?) - Question and answer session: What did we learn? - Summary	30 mins
Diabetes Symptoms	Recognizing symptoms of diabetes	- General symptoms - Symptoms of low blood sugar - Symptoms of high blood sugar - What to do if you have low blood sugar? - What to do if you have high blood sugar?	- Introduction with brain storm (Person with diabetes sorts the symptoms and asks if anyone know what is wrong with her) - Direct explanation (ppt presentation) - Game (Find the right and wrong about diabetes symptoms) - Role-play (comparison of a person with diabetes and non-diabetes) - Question and answer session: What did we learn? - Summary	30 mins
Healthy nutrition and prevention of diabetes	The significance of nutrition in preventing diabetes	- The importance of the relationship between healthy eating and diabetes - Food groups - Healthy plate - Video Demonstration (how much do we need to each from each food group?) - Cards Game (selection of healthy foods) consumption? - How can we increase vegetable and fruit co - Diabetes and Foods	- Brain storming (healthy plate) - Video demonstration - Direct explanation (ppt presentation) - Cards game (healthy and unhealthy foods) - Question and answer - Feedback	30 mins

Physical activity and prevention of diabetes	The significance of physical activity in preventing diabetes	-Exercise recommendations - How long should you exercise? - Use of technology and sedentary lifestyle - What does being sedentary lead to?	-Time to Increase Activity! -Warm-up exercise (let's stand up and warm up with music) -Direct explanation (ppt presentation) -Role-play (use of technology and sedentary lifestyle and its relationship with diabetes)	
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Table 2. Socio-demographic characteristics of the students, İstanbul-2024

	Number (n)	Percentages (%)
Gender		
Female	114	51.1
Male	109	48.9
Age		
8	42	18.8
9	98	43.9
10	83	37.2
Class		
3 th class	104	46.6
4 th class	119	53.4
Number of people in the family		
1-3 people	17	7.5
4-5 people	132	59.2
6 or more	74	33.2
Having a family member with diabetes		
Yes	57	25.6
No	166	74.4
Having a relative with diabetes		
Yes	88	39.5
No	135	60.5
Having heard of diabetes before		
Yes	157	70.4
No	66	29.6

Table 3. Pre-test and Post-test Comparison for Sub-dimensions of Diabetes Awareness Education Program, İstanbul-2024

Subdimensions	Pre-test			Post-test			Z	p- value	Cohen's d	%95 CI	
	Mean±SD	Median (Q3)	Median (Q1-Q3)	Mean±SD	Median (Q1-Q3)	Median (Q1-Q3)				Lower	Upper
General knowledge	3.34±0.9	3 (3-4)		4.2±0.8	4 (4-5)		-9.120	<0.001	0.747	0.598	0.895
Signs and symptoms	4.56±1.8	5 (3-6)		6.71±1.7	7 (6-8)		-10.965	<0.001	1.050	0.886	1.213
Diabetes management	3.91±1.6	4 (3-5)		5.91±1.6	6 (5-7)		-11.038	<0.001	1.078	0.912	1.243
Diabetes prevention	4.26±1.7	4 (3-5)		5.25±1.5	5.2 (4-6)		-7.363	<0.001	0.538	0.397	0.678
Total score	16.09±4.08	16 (14-19)		22.08±4.41	22 (19-26)		-12.004	<0.001	1.351	1.168	1.532

SD: Standard deviation, Z: Wilcoxon signed-ranked test, CI: Confidence Interval

DISCUSSION

This study evaluated the effectiveness of a diabetes awareness education program given to primary school students based on the KiDS education program with gamified teaching techniques. Diabetes awareness education programs are essential for improving knowledge and understanding of the condition and preventing the disease among children. In this study, diabetes awareness education programs demonstrated positive results in enhancing children's knowledge about diabetes. A study by Theng et al. (2015) emphasized integrating game-based approaches like gamification in diabetes initiatives for self-management and education (19). Chinnici et al. (2019) evaluated the KiDS project and reported that the program effectively raised diabetes awareness among children (20). Bechara et al. (2018) stated that the KiDS project is the first international initiative to create a safe and supportive school environment while raising awareness about diabetes (21). The literature emphasizes that awareness education programs have been shown to provide a better understanding of diabetes, promote better management of the disease, and positively influence lifestyle choices (22, 23). Furthermore, educational interventions have increased awareness of diabetic complications, leading to improved self-regulatory practices (24). Based on the literature and the results of this current study, it is revealed that a diabetes awareness education program has positive outcomes in increasing children's knowledge about diabetes, which aligns with existing literature, highlighting the importance of educational interventions in improving diabetes awareness. By employing gamification strategies, educators can develop engaging and effective learning experiences that facilitate knowledge retention and behavioral change in children.

Diabetes in children can present with a variety of signs and symptoms that are crucial for early detection and management. Common signs and symptoms of diabetes in children include polydipsia (increased thirst), polyuria (frequent urination), polyphagia (excessive hunger), unexpected weight loss, extreme fatigue,

blurred vision, and slow wound healing (25). Implementing awareness education in schools is an essential strategy for early detection and even prevention of diabetes, which is increasing disease among children. In this study, diabetes awareness education programs enable children to learn the signs and symptoms of diabetes. Children's baseline mean scores increased after the training. This study used many interactive and gaming methods to raise diabetes awareness and prevention among children. The education program integrated with all these applications enables children to learn the symptoms and signs, understanding disease and prevention which is focuses on nutrition and physical exercise (16, 26, 27). This research findings are parallel to the literature. The International Society for Paediatric and Adolescent Diabetes (ISPAD) states that education is the cornerstone of diabetes treatment (28). This guideline emphasizes that the signs and symptoms of diabetes in children should be taught with interactive and technological methods in education programs and that this education should be given to students, teachers, and parents (28). Mourão et al. (2023), the child-centered design of the KiDS education program increases comprehension and retention among children with its age-appropriate language and content (16). This aligns with combining special educational tools such as the KiDS education program with gamification, which engages children and ensures that the material is directly relevant to their learning needs. By incorporating gamification elements into pediatric health education, children are more likely to participate actively, leading to better recognition of the signs and symptoms of diabetes, which is crucial for early diagnosis and management of the condition.

The diabetes awareness education program increased children's awareness of diabetes management. This result highlights the effectiveness of educational interventions in increasing knowledge and potentially influencing future behaviors toward disease prevention. The results of this study are supported by previous research (29). Educational interventions for children and adolescents with diabetes have

strongly influenced psychosocial outcomes, highlighting the importance of specific educational programs for this population (20). Furthermore, childhood interventions have been highlighted as particularly effective for improving management behavior in children with diabetes (30). By providing children with this critical information at an early age, we can potentially influence healthier lifestyle decisions that may contribute to reducing the risk of developing diabetes later in life.

Diabetes awareness education programs have shown promising results in enhancing learning outcomes, particularly in the context of diabetes prevention. Studies like the "KiDS and Diabetes in Schools" project by Bechara et al. (2018) and "Improving the School Experience of Children with Diabetes: Evaluation of the KiDS Project" by Chinnici et al. (2019) have highlighted the positive impact of such interventions in creating a supportive environment for managing diabetes among children at school (12, 20). A study by Bani Salameh et al. (2017) examined the effectiveness of a school-based diabetes prevention program for adolescents as a randomized controlled trial. This study's results demonstrate the effectiveness of a school-based diabetes prevention program that includes education on healthy eating and physical activity for adolescents (31). Literature highlights the positive impact of comprehensive education programs on reducing diabetes risk factors in youth (25, 32). Prevention of diabetes in children through education programs can be effectively achieved by adopting a comprehensive approach. Educational programs should be implemented to teach children how to prevent diabetes through healthy eating and physical activity from an early age. By fostering a supportive and engaging learning environment, these initiatives improve health literacy, promote healthy behaviors, and empower children to take charge of their well-being.

The combination of the KiDS education program with gamification techniques has yielded promising results, enhancing children's motivation, engagement, and retention of health-related knowledge. These findings align

with existing literature (33-35). By integrating interactive elements such as rewards, progress badges, and digital challenges, the program can make learning about diabetes more relatable and accessible, promoting active engagement and self-care behaviors (19, 36). Gamified methods also support the recognition of diabetes symptoms and reinforce basic management skills by enabling students to apply their knowledge in practical ways (26). However, potential downsides to gamification include the risk of students focusing more on rewards than understanding content, as well as the need for digital resources that might be challenging to provide in certain educational settings (29, 37). Despite these limitations, the child-centered design and age-appropriate language of the KiDS program ensure that content remains relevant and easy to understand. This approach is particularly effective in fostering a supportive, engaging environment that strengthens diabetes awareness, and it is therefore recommended that gamification be further integrated into educational programs.

Limitations

This study has some limitations. Firstly, the study used a non-randomized trial with a non-probabilistic sampling method, which may limit the generalizability of the findings. Secondly, the intervention was conducted over a relatively short period of five weeks, with each session lasting only 30 minutes. This brief exposure might not be sufficient to create long-lasting knowledge retention or behavioral change in diabetes awareness among children. Lastly, conducted in a specific primary school setting, the findings might not apply to children in different educational, cultural, or geographic contexts. Future studies should be performed by repeating the post-test application after 6 months to show the true extent of the training effectiveness and permanence of the knowledge.

Conclusion

This study revealed the effectiveness of the KiDS education program in combination with gamification techniques in increasing the diabetes

knowledge of primary school students aged 8-10 years. Implementing these educational strategies significantly improved children's ability to understand and recognize the signs and symptoms of diabetes. By combining interactive learning methods and gamified elements, the diabetes awareness education program effectively captured children's attention and enabled them to learn critical information on diabetes management and prevention. Integrating the KiDS education program with gamification was an effective method to educate children about diabetes, improve their understanding, and empower them to participate actively in managing and preventing the condition. In this context, it is recommended that diabetes awareness education programs be spread to all schools as much as possible after more extensive research to raise awareness in children about diabetes and similar chronic diseases. To increase the effectiveness of the KiDS education program, it is recommended that gamification techniques such as points, rewards, and progress tracking be integrated to increase motivation and engagement among children. However, careful design is required to ensure that children focus on learning and not only on rewards.

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