IMPROVING COGNITIVE SKILLS IN SCHOOL-AGE CHILDREN ABOUT PREVENTION OF DIABETES MELLITUS THROUGH DIABETAMON GAMES

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ABSTRACT

Diabetes is not solely an adult health issue—it has also become a growing concern among school-age children. The rise in childhood obesity has contributed to an increasing incidence of type 2 diabetes in children and adolescents, which now parallels and sometimes surpasses that of type 1 diabetes. Parents need to take proactive steps to prevent this disease by providing accurate information to their children. Children can also gain knowledge through educational approaches aimed at enhancing their cognitive abilities, including through games. This study aims to analyze the effectiveness of the Diabetamon game in improving cognitive skills related to diabetes mellitus prevention among school-age children. This research used a quasi-experimental design with a control group. A total sample of 99 school-age children was divided into an intervention group (47 students) and a control group (52 students), selected using proportional random sampling. The study was conducted over a one-month period, with the intervention delivered twice a week for 60 minutes over three weeks. Data collection instruments included a questionnaire and an observation checklist to assess children's snack habits. Statistical analysis was performed using paired t-tests to examine within-group changes and independent samples t-tests to compare between-group differences, with a significance level of $p<0.05$. The results showed that the cognitive abilities of the intervention group improved significantly compared to the control group. The Diabetamon game was proven effective in enhancing school-aged children's knowledge about the importance of consuming fruits and vegetables, in line with the pillars of balanced nutrition and physical activity.

ABSTRAK

Diabetes bukan hanya monopoli orang dewasa, namun juga menjadi perhatian yang berkembang di antara populasi anak usia sekolah. Meningkatnya obesitas pada anak telah menyebabkan meningkatnya insiden diabetes tipe 2 di kalangan anak-anak dan remaja, yang sekarang sejajar dan terkadang melebihi diabetes tipe 1. Orang tua perlu mengambil langkah-langkah untuk mencegah penyakit ini dengan memberikan informasi yang benar kepada anak-anak mereka. Anak-anak juga dapat memperoleh informasi melalui pendidikan untuk meningkatkan kemampuan kognitif mereka dengan menggunakan berbagai metode, termasuk permainan. Penelitian ini bertujuan untuk menganalisis efektivitas permainan DIABETAMON dalam meningkatkan keterampilan kognitif pada anak usia sekolah tentang pencegahan diabetes melitus. Jenis penelitian ini adalah quasi eksperimen dengan desain kelompok kontrol. Sampel anak usia sekolah dibagi menjadi kelompok intervensi sebanyak 47 orang dan kelompok kontrol sebanyak 52 siswa dengan menggunakan proporsional random sampling. Penelitian dilakukan selama 1 bulan dan pemberian intervensi dua kali seminggu selama 60 menit sebanyak tiga minggu. Instrumennya adalah kuesioner yang berisi pertanyaan dan mengamati kebiasaan ngemil anak. Analisis statistik menggunakan uji-t berpasangan untuk menganalisis perubahan dalam kelompok dan uji-t sampel independen untuk membandingkan perbedaan antar kelompok, dengan tingkat signifikansi p < 0,05. Hasil penelitian menunjukkan bahwa fungsi kognitif kelompok intervensi meningkat secara signifikan dibandingkan dengan kelompok kontrol. Permainan Diabetamon efektif mengubah pengetahuan anak usia sekolah mengenai pentingnya makan buah dan sayur sesuai dengan pilar gizi seimbang dan aktivitas fisik.

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INTRODUCTION

Diabetes mellitus in children and adolescents is a growing global health concern, with an increasing incidence of both type 1 and type 2 diabetes (Afkarian, 2017). The prevalence of diabetes, particularly in low- and middle-income countries, has nearly doubled since 1980 (Flood et al., 2022). This trend is often associated with changes in dietary habits, occupational patterns, and physical activity as countries undergo urbanization. However, even rural populations are not exempt from this rising threat. According to the Indonesian Pediatric Association (IDAI), diabetes cases in children have increased seventyfold in rural areas over the past decade, emphasizing the urgent need for a comprehensive approach to diabetes prevention across all communities (Flood et al., 2022). This increase is often linked to diets high in processed foods and sugary beverages, along with low consumption of fruits and vegetables—highlighting the urgent need for targeted nutritional education. Prevention should begin with health education from an early age. Children aged 6–12 years present unique challenges for healthcare providers due to the rapid physical, emotional, and social development occurring during this stage, all of which can influence disease prevention and management (Zappas & Granger, 2017).

One contributing factor to unhealthy eating habits is the easy availability of inexpensive, high-sugar, high-fat snacks in school canteens, which can undermine efforts to promote balanced nutrition. Effective prevention and management strategies are therefore essential to address the growing diabetes epidemic, particularly among vulnerable groups. School-aged children—considered the future of the nation—are between 6 and 12 years old (Sartika et al., 2023). A previous survey revealed that physical activities such as sports were only conducted during physical education classes. Moreover, 23.2% of students were classified as overweight, and 87.4% rarely consumed fruits and vegetables (Islam et al., 2019). Overweight children are at a higher risk of developing chronic conditions such as diabetes and hypertension. Inadequate fruit and vegetable intake can lead to vitamin and fiber deficiencies, affecting immune function and concentration in learning (Fradianto et al., 2023).

The growth and development of school-aged children are significantly influenced by their nutritional intake (Saavedra & Prentice, 2023). Adequate nutrition during this period is essential, as it supports cognitive development, academic achievement, and overall health (Roberts et al., 2022). Nutrient-rich diets help children maintain a healthy weight and meet their energy needs for physical activity and growth. Unfortunately, optimal nutrition is not always achieved due to the increasing prevalence of fast food and random snacking, which often provide poor-quality nutrients (Pinto, 2023). The school environment also plays a crucial role in shaping children's eating habits. For instance, children frequently buy food at school that is not nutritionally balanced or hygienically prepared (Devine et al., 2023).

Given the suboptimal dietary patterns among children, there is a critical need for health education initiatives aimed at promoting balanced nutrition and physical activity—particularly increasing fruit and vegetable intake (Hodder et al., 2020). Fruits and vegetables are rich sources of essential vitamins and minerals, such as vitamins A, C, and E, as well as calcium, all of which support cell growth and tissue development (Pem & Jeewon, 2017). Encouraging fruit and vegetable consumption from an early age can significantly enhance children's growth and health, although aversion to vegetables due to their taste, texture, or appearance is common (Halim et al., 2016). Other studies have found that health education programs are effective in increasing knowledge among elementary and high school students in China, especially regarding nutrition and food safety—indicating that such knowledge is essential to support comprehensive health promotion efforts (Zhou et al., 2016). Previous research has also recommended intervention strategies for diabetes mellitus prevention (Manuntung, 2018). In choosing nutritional intervention methods for children, a play-based approach is considered effective because it delivers health messages in a fun and engaging manner, making it easier for children to understand and adopt healthy habits in their daily lives (Islam et al., 2019).

Play is a natural and essential part of childhood, especially for school-aged children, who enjoy and learn best through play (Shree & Shukla, 2016). According to Lucas (2017), games form the foundation of early childhood education, serving as a bridge between home and school life. Through play, children gain numerous cognitive benefits, including enhanced logic, brain stimulation, and the development of imagination. Diabetes Monopoly (Diabetamon) is a game designed to educate children about diabetes and its prevention in an interactive, competitive, and engaging way. It includes elements

of reading, decision-making, and other active tasks that increase children's learning motivation and help them better retain information. This active participation ensures not only the reception of educational messages but also the internalization of healthy behaviors, thus making the learning process more effective and enjoyable (Andriyanto & Hidayati, 2018; Martos-Cabrera et al., 2020; Nørlev et al., 2022). Diabetamon is a modified version of the Monopoly game where players navigate a game board by making choices related to diet, lifestyle, and health scenarios. This study aims to analyze the effectiveness of the Diabetamon game in improving cognitive skills related to the prevention of diabetes mellitus among school-age children.

METHOD
Type of Research
This is a quasi-experimental study with a control group design.

Place and Time of Research
The research was conducted at SDN 1 Kepuhpandak and SDN 1 Watuumpak, located in Kutorejo District, Mojokerto Regency, from July to August 2024.

Population and Sample
The sample size was calculated using the average proportion of children's knowledge from a previous study on the effectiveness of health education, which reported 65% knowledge before the intervention and 94% after the intervention. The estimation used a 5% significance level and 80% statistical power. The parameters were as follows:

$Z_{I-\alpha}$ $= 1,96$
$Z_{I-\beta}$ $= 0,84$
P1 $= 0,65$
P2 $= 0,94$
P $= (0,65 + 0,94)/2 = 0,79$

The minimum sample size obtained is:

$$n = \frac{\left\{1,96\sqrt{2\ x\ 0,79\ (1 - 0,79)} + 0,84\ \sqrt{0,65\ (1 - 0,65) + 0,94\ (1 - 0,94)}\right\}^2}{(0,65 - 0,94)^2}$$

$n = 28,96$ rounded up 29

To account for potential design effects and sampling variability, the sample size was doubled. Therefore, 58 respondents were selected for both the intervention and control groups.

Data Collection
The intervention was conducted over one month, consisting of two 60-minute sessions per week for three weeks. The initial measurement was taken before the intervention using a structured questionnaire. The final measurement was conducted one week after the intervention's internalization phase. As a form of ethical consideration, the control group received one session of health consultation on healthy eating habits after the final measurement (Figure 1).
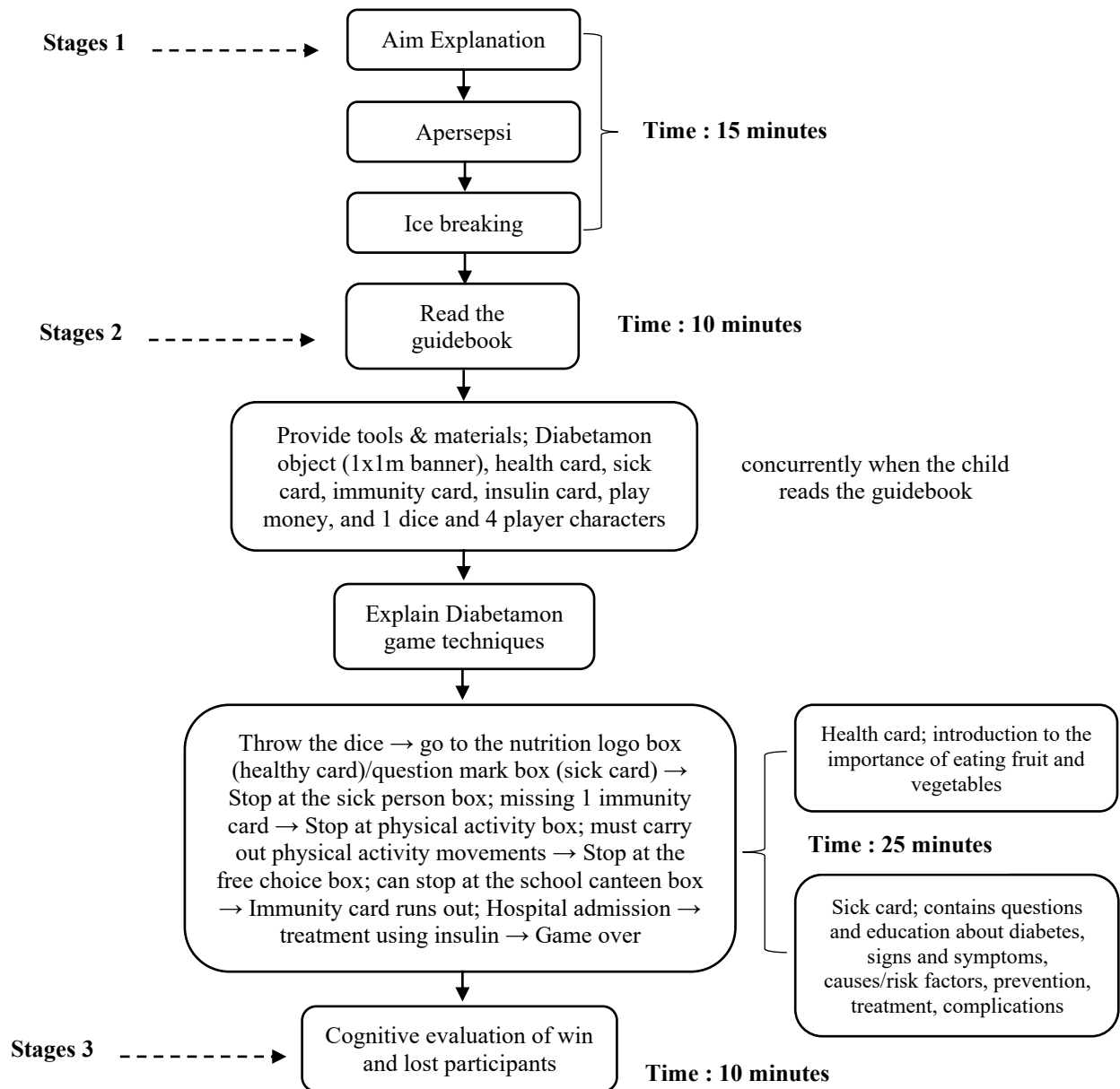
Figure 1. Stages of educational implementation with Diabetamon

Data Analysis and Processing

Bivariate analysis was conducted to assess the improvement in cognitive skills regarding diabetes mellitus prevention among school-age children through the use of the Diabetamon game. Data were analyzed using IBM SPSS version 21. The normality of the data distribution was tested using the Kolmogorov-Smirnov test ($p > 0.05$), which confirmed that the data were normally distributed. In the intervention group, the p-value was 0.334, and in the control group, it was 0.221, indicating normal distribution in both. Therefore, parametric tests were used. The paired t-test was used to analyze within-group differences (pre- and post-intervention), and the independent samples t-test (pooled t-test) was used to compare between-group differences (intervention vs. control).

RESULT

The study was conducted at SDN 1 Kepuhpandak and SDN 1 Watuumpak, located in Kutorejo District, Mojokerto Regency, between July and August 2024. The characteristics of the respondents were collected through a structured questionnaire and are presented in the form of frequency distribution tables. The characteristics assessed include age, gender, grade level, exercise habits, fruit and vegetable consumption habits, and mineral water intake.

Table 1. Distribution of Respondent Characteristics

Respondent Characteristics	Intervention (n=47)		Control (n=52)	
	f	**%**	**f**	**%**
Age				
8 years	20	42.6	15	28.8
9 years	16	34.0	17	32.7
10 years	11	23.4	20	38.5
Gender				
Man	20	42.6	24	46.2
Woman	27	57.4	28	53.8
Class				
Class 2	12	25.5	7	13.5
Class 3	18	38.3	20	38.5
Class 4	17	36.2	25	48.0
Exercise habits (30 minutes)				
Yes	13	27.7	18	34.6
No	34	72.3	34	65.4
Fruit & vegetable eating habits				
Yes	5	10.6	4	7.7
No	42	89.4	48	92.3
Mineral water drinking habits				
$\leq$ 5 glasses	41	87.2	48	92.3
> 5 glasses	6	12.8	4	7.7

Based on Table 1, most respondents in the intervention group were 8 years old, while in the control group, the majority were 10 years old. The proportion of female participants was 57.4% in the intervention group and 69.2% in the control group. The majority of students in the intervention group were from Grade 3, while those in the control group were from Grade 4. Both groups had a high percentage of students who reported not engaging in regular physical activity for at least 30 minutes per day. Likewise, the majority reported not having the habit of consuming fruits and vegetables and drinking fewer than 5 glasses of mineral water per day.

Table 1 also shows that 89.4% of students in the intervention group and 92.3% in the control group did not regularly consume fruits and vegetables. Additionally, both groups demonstrated low levels of physical activity. These findings highlight the urgent need for nutrition education interventions. The balanced nutrition intervention was implemented using the DIABETAMON educational game, designed to improve children's knowledge and healthy eating habits through a fun and interactive play-based approach.

Table 2. Cognitive abilities of school-age children before and after receiving education through the Diabetamon game

Group		Mean	Min-Max	SD	95% CI
Intervention	Before	48.227	24-76	15.11	19,73 – 24,18
(n=47)	After	81.054	56-96	9.60	37,12 – 41,09
Control	Before	48.993	24-76	15.15	19,47 – 23,27
(n=52)	After	50.183	24-76	15.30	19,46 – 23,23

As shown in Table 2, the mean cognitive score in the intervention group increased substantially from 48.227 to 81.054, whereas the control group showed only a slight increase from 48.993 to 50.183. This suggests a significant improvement in cognitive understanding among children who received the DIABETAMON intervention.

Table 3. Cognitive Differences in School-Age Children Before and After Being Given Education Through the Diabetamon Game

Group	Mean	SD	*p-value*
Intervention	32.826	13.51	0.001*
Control	1.190	4.88	0.085

*p signifikan ≤ 0,05

Table 3 shows that there was a statistically significant difference in the cognitive abilities of school-aged children in the intervention group before and after the educational intervention using the Diabetamon game (p-value = 0.001 < 0.05). In contrast, the control group did not show a statistically significant difference in cognitive abilities (p-value = 0.085 > 0.05). These results indicate that the educational game intervention had a meaningful impact on improving the knowledge of school-aged children regarding diabetes prevention, while the control condition—without interactive intervention—did not yield similar outcomes.

DISCUSSION

The results of this study demonstrated a significant improvement in cognitive scores (Table 2), supporting the conclusion that the Diabetamon game effectively increased knowledge about the importance of consuming fruits and vegetables. This aligns with previous research indicating that game-based interventions can enhance students' motivation and self-confidence (Hsu & Shih, 2018). Furthermore, the findings support the idea that integrating interactive digital environments into educational curricula can create rich opportunities for linguistic and cognitive development, leading to a deeper understanding across multiple content areas (Kirginas, 2023). Prior studies on the use of digital games for enhancing the cognitive abilities of school-aged children have similarly highlighted their positive influence, particularly in promoting healthy dietary habits and health-related behaviors (Goodman et al., 2018). However, while educational games show potential, the extent to which they facilitate the transfer of learned skills to academic performance remains a subject for further investigation, as current evidence in this area is mixed (Blumberg & Pagnotta, 2019). In addition, teacher and student-related factors should be examined to determine how these influence the successful implementation of educational games in school settings (Cheng & Milikich, 2023). The Diabetamon game conveys health messages through interactive components such as "health" and "illness" cards, strategically placed in boxes labeled with balanced nutrition and question marks. These elements help children actively learn the importance of eating fruits and vegetables. While the game shows promising outcomes, further research is needed to assess its generalizability across different subject areas and learner demographics (Nakao, 2019).

Previous research has shown that game-based education, such as using the Snakes and Ladders board game, significantly improved knowledge and attitudes among elementary school students (Fitrizah et al., 2020; Srinivasan, 2019). Similarly, in the context of primary school geography education, a Monopoly-style board game significantly influenced students' academic performance and interest (Vargianniti & Karpouzis, 2019). The Diabetamon game, inspired by Monopoly, provides a playful and engaging method for raising awareness about the importance of fruit and vegetable consumption, increasing physical activity, and teaching children to identify healthier snack options. In nursing education and health promotion, the use of board games has proven effective in enhancing knowledge and attitudes. For example, a study utilizing the format of the television game show *Family Feud* in infection control education showed that students who participated in the game scored significantly higher on knowledge tests compared to the control group (Nakao, 2019).

Health education through games is therefore highly recommended for nursing professionals conducting interventions with school-aged children. Games can serve as a powerful tool to stimulate engagement, enhance learning outcomes, and promote behavioral changes (Zahed et al., 2019). One of the primary strengths of game-based education lies in its ability to leverage developmental characteristics of children, making learning both meaningful and enjoyable. Rather than relying solely on video games as stand-alone solutions, it is important to analyze their components in relation to the developmental mechanisms of the target audience. In the context of diabetes prevention, games like Diabetamon can be instrumental in teaching children about nutrition and physical activity. Active video games have also been found to promote increased energy expenditure and physical movement among children (Goodman et al., 2018), while educational health games are shown to support changes in diet and diabetes-related behaviors.

The existing literature provides robust support for integrating game-based strategies in nursing and health education. Interactive game models have been demonstrated to encourage active learning and engage the digital-native generation of nursing students and educators (Popil & Dillard-Thompson, 2017). As nursing education continues to evolve, incorporating innovative teaching methods such as game-based learning has become increasingly essential (Aboul-Enein, 2017; Popil & Dillard-Thompson, 2017). A notable limitation of this study was the absence of parental involvement, which may have restricted the assessment of children's actual dietary behavior at home. Future research should consider including parent surveys or interviews to obtain a more comprehensive understanding of children's eating habits. Additionally, the study did not utilize student notebooks or journals, which could have provided insight into how the intervention influenced activities at home. Subsequent research could incorporate activity sheets or reflective journals as supporting tools (Santoso et al., 2019).

CONCLUSION

This study concludes that the Diabetamon game is an effective educational tool for enhancing school-aged children's knowledge regarding the prevention of diabetes mellitus. The significant improvement in cognitive scores among the intervention group highlights the potential of game-based learning in health education. These findings suggest that integrating interactive educational games into school health programs can serve as a valuable strategy to promote healthier eating habits and prevent nutrition-related health problems among children. These findings suggest future research should consider broader implementation across different regions and school settings, involve parental participation to assess home dietary behaviors, and explore the long-term impact of such interventions on children's lifestyle habits.

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