EduDiab-Online: Uses Peer support to Improve Health Literacy in Type 2 Diabetes Patients

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ABSTRACT

Background: *Type 2 Diabetes Mellitus (T2DM) remains a leading contributor to premature mortality and long-term complications, particularly in Indonesia, where health literacy levels are alarmingly low. This study aims to evaluate the effectiveness of EduDiab-Online, a web-based diabetes education model integrated with a peer-support approach, in improving health literacy and clinical outcomes among patients with type 2 diabetes mellitus (T2DM) in community settings.*
Method: *A quasi-experimental pretest-posttest design with a control group was employed by involving 120 T2DM patients from two primary healthcare centers in Pekanbaru, Indonesia, divided equally into intervention and control groups. The intervention consisted of six weekly online educational modules combined with peer-support forums facilitated by trained peer mentors. Data were collected over four months using validated instruments assessing health literacy, self-efficacy, HbA1c, body mass index (BMI), and blood pressure. Statistical analyses, including paired and independent t-tests, were performed using SPSS version 25.*
Result: *Compared with the control group, the intervention group demonstrated significantly greater improvements in health literacy (N-Gain = 0.61 vs. 0.08, $p < 0.001$), accompanied by a significantly greater increase in self-efficacy and greater reductions in HbA1c, BMI, and blood pressure (all $p < 0.05$). Furthermore, 88% of participants actively engaged in peer-support activities, indicating high adherence to the program. These findings suggest that EduDiab-Online is an effective and scalable community-based diabetes education model that integrates digital learning with peer support to improve both behavioral and clinical outcomes. Further studies are recommended to evaluate its long-term effectiveness and applicability to other chronic disease management programs.*

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INTRODUCTION

Type 2 diabetes mellitus (T2DM), one of the leading causes of premature death, contributes to the largest economic burden in the health sector.(1)(2) Researchers predict more than 1.3 billion people will live with diabetes by 2050.(3) In Southeast Asia, including Indonesia, the prevalence rate of diabetes has jumped sharply from 7.1% in 2019 to 10.5% by 2023, with more than 19 million diagnosed cases in Indonesia.(4) Ironically, more than 50% of people with diabetes in Indonesia are unaware of their disease status until serious complications such as nephropathy, neuropathy, and cardiovascular disease appear.(5)

The main problem faced today is not only the high incidence rate, but also the lack of public health literacy regarding diabetes management.(6)(7) According to the Indonesian Basic Health Research, only 27.8% of diabetes patients understood the importance of regular HbA1c monitoring, while fewer than 35% participated in formal education on diet, exercise, and medication adherence.(8) The low number of participating patients resulted in 4 out of 5 patients experiencing long-term blood sugar control failure.

Health education is a key strategy in reducing complications and health costs.(9) As technology evolves, conventional educational approaches are shifting to digital platforms.(10) A randomized controlled trial (RCT) conducted in China involving 480 patients with T2DM demonstrated that a web-based education program reduced HbA1c levels by an average of 0.82% over six months and

increased treatment adherence from 51% to 73%.(11) Similar findings were reported in South Korea, where an online education program improved health literacy scores by 38% compared with conventional education methods.(12)

However, the main obstacle in online education programs is low patient engagement.(13) A meta-analysis study showed active participation in digital education was only 48% without a social approach,(14) where peer support becomes very important. Peer support has been shown to increase motivation, self-efficacy, and reduce depression in patients with chronic diseases, including diabetes.(15)(16) A randomized controlled trial (RCT) conducted in Malaysia involving 240 participants demonstrated that integrating peer support into diabetes education programs reduced dropout rates from 41% to 13% and increased self-efficacy scores by 1.2 points on a five-point scale.(17)(18)

Intervention studies in Indonesia are still limited to individualized education approaches, without taking into account the social dynamics of the community.(19) Previous studies have demonstrated that web-based diabetes education and peer-support interventions are effective in improving diabetes self-management and clinical outcomes among patients with T2DM. However, most studies have independently evaluated these approaches. Evidence regarding the integration of web-based diabetes education with structured peer support, particularly within primary healthcare settings in Indonesia, remains limited. This gap highlights the need to develop and evaluate an integrated educational model that is both contextually relevant and feasible for implementation in Indonesian primary healthcare centers.(15)(20) In fact, the collectivist culture and social values in Indonesian society provide a great opportunity for a more robust and socially relevant peer-support-based digital community approach.(21)

To address this gap, this study developed and evaluated the EduDiab-Online model, which integrates web-based diabetes education with a structured peer-support approach to improve health literacy, self-efficacy, and clinical outcomes, including HbA1c, body mass index (BMI), and blood pressure among patients with T2DM. Specifically, the study aims to evaluate the effectiveness of the EduDiab-Online model in improving health literacy, assess its impact on patients' self-efficacy, examine its effects on clinical outcomes, including HbA1c, body mass index (BMI), and blood pressure, and determine participant engagement in peer-support activities. It was hypothesized that participants receiving the EduDiab-Online intervention would demonstrate significantly greater improvements in these outcomes than those receiving conventional diabetes education.

In addition to introducing a combination of technology-based educational approaches and social support, the EduDiab-Online model also offers an adaptive educational program structure, where materials, duration, and interaction methods are tailored to participants' literacy needs, education level, and digital skills. Such a model has not been widely adopted in digital education about chronic diseases. With a community-based bottom-up approach and peer-mentoring, this model also allows patients to become agents of change in their own neighborhoods, thus extending the impact of education from the individual to the community level in a sustainable manner. To facilitate the understanding of the intervention mechanism designed in this study, Figure 1 presents the conceptual framework of the EduDiab-Online Model:

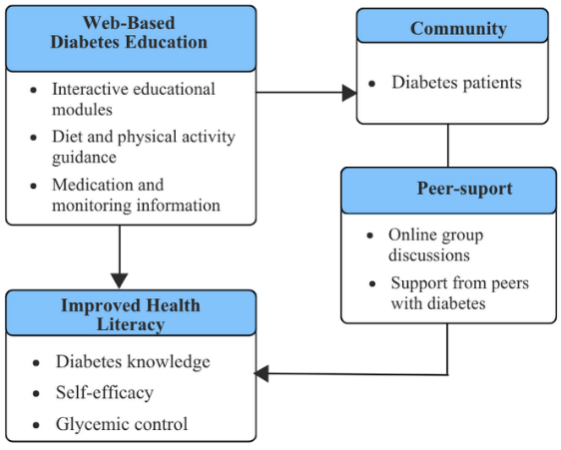

Figure 1. EduDiab-Online model

This model describes the integration of web-based diabetes education with a community peer-support approach, aiming to improve health literacy, self-efficacy, and clinical control of T2DM patients. In this model, online education serves as the primary source of health knowledge, while peer-support interactions support the motivational and emotional aspects of participants. The combination of the two is expected to result in changes in health behaviors and significant improvements in clinical parameters. The model is designed to improve health literacy, self-efficacy, and glycemic control through an adaptive, community-based digital intervention.

This study aims to achieve the Sustainable Development Goals (SDGs), specifically SDG 3 (Healthy Lives and Well-Being) and SDG 10 (Reducing Inequalities). By increasing access to digital health education, EduDiab-Online is reachable by vulnerable communities in areas that have limited access to conventional health services. This approach also strengthens inclusiveness in health services, encourages active community participation, and accelerates the achievement of national targets in controlling non-communicable diseases in the era of digital transformation.

METHOD

Research design

This study employed a quantitative approach utilizing a quasi-experimental pretest-posttest design with a control group. This design was selected to evaluate the effectiveness of the EduDiab-Online model in improving health literacy, self-efficacy, and clinical outcomes among patients with T2DM.

Study setting

The research was conducted over a six-month period from January to June 2024. It took place at two primary healthcare centers located in Pekanbaru City, Riau Province, Indonesia. These specific locations were selected with purpose because they registered the highest number of T2DM patients according to the local health authority database.

Sampling methods

The study population comprised 120 patients T2DM. Participants were recruited using a purposive sampling technique from two selected primary healthcare centers in Pekanbaru. To minimize treatment contamination between participants, a non-random group allocation was employed based on the participants' registered health center. Patients recruited from the first primary healthcare center were assigned to the intervention group (n = 60), whereas those recruited from the second primary healthcare center were assigned to the control group (n = 60). Based on the inclusion criteria, the participants were aged 25–65 years, diagnosed with T2DM for at least six months, capable of using a smartphone or internet-enabled digital device, and willing to participate throughout the study by signing an informed consent form. Patients showing severe diabetic complications, cognitive impairments, or other medical conditions that would prevent participation in online education were excluded. Ethical principles were strictly maintained. All participants voluntarily agreed to partake after being informed of the study's objectives, and participant confidentiality and anonymity were preserved throughout the research process.

The minimum required sample size was calculated using GPower version 3.1 for comparing two independent means with a significance level (α) of 0.05, statistical power of 80%, and a medium effect size (d = 0.50). The calculation indicated that at least 51 participants were required in each group. To compensate for potential participant dropout during follow-up, the sample size was increased to 60 participants per group, resulting in a total sample of 120 participants.

Research variables

The dependent variables included health literacy, self-efficacy, and clinical parameters comprising glycated hemoglobin (HbA1c), body mass index (BMI), and systolic and diastolic blood pressure. Health literacy and self-efficacy were assessed using validated structured questionnaires, while the clinical parameters were measured using standardized clinical procedures. HbA1c levels were determined from venous blood samples analyzed at a certified clinical laboratory using a standardized assay. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m^2) using calibrated anthropometric equipment. Systolic and diastolic blood pressure were measured using a validated blood pressure monitor after participants had rested in a seated position for at least five minutes. Detailed measurement procedures are described in the Data Collection Procedures section.

Data collection procedures

During the intervention, the experimental group was given full access to the EduDiab-Online platform, while the control group only received conventional education via leaflets and brief oral instructions. The EduDiab-Online model consisted of interactive educational modules (thematic videos, infographics, web-based quizzes) and a digital peer-support forum facilitated by

trained health workers and experienced peer mentors. Participants in the intervention group were required to complete six learning sessions over six weeks, with interactions taking place via WhatsApp Groups and a twice-weekly web education forum. Self-efficacy was assessed using a validated 10-item Diabetes Self-Efficacy Scale administered before and after the intervention.

Data measurements were recorded at two distinct time points: before the intervention (pretest) and after the intervention (posttest). Data validity was ensured through instrument triangulation and participatory observation during the educational forum sessions. All variables in this study were measured using previously validated instruments, as summarized in Table 1.

Data were statistically analyzed utilizing IBM SPSS Statistics version 25. Descriptive statistics were employed to summarize the demographic characteristics of the respondents. Prior to testing hypotheses, data normality was verified using the Shapiro–Wilk test, and the homogeneity of variance was evaluated using Levene's test. Prior to hypothesis testing, the normality of each outcome variable in both the intervention and control groups was assessed using the Shapiro–Wilk test, while the homogeneity of variances between groups was evaluated using Levene's test. All variables satisfied the assumptions of normality ($p > 0.05$) and homogeneity of variance ($p > 0.05$), indicating that parametric statistical analyses were appropriate. Accordingly, paired-sample t-tests were used to compare pretest and posttest scores within each group, while independent-sample t-tests were performed to compare the outcomes between the intervention and control groups. The mathematical formulas for the applied t-tests are presented below:

For the paired t-test:

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

Where:
$\bar{d}$ = average difference between pretest and posttest,
s_d = standard deviation of the difference,
n = number of respondents.

For a two-sample (unpaired) t-test:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Where:
$\overline{X_1}, \overline{X_2}$ = the average score of groups 1 and 2
s_1^2, s_2^2 = the variance of each group
n_1, n_2 = the number of respondents per group
Normalized Gain (N-Gain) score was calculated to proportionally measure the improvement in health literacy between the pretest and posttest. Statistical significance for all tests was determined at a 95% confidence level ($p < 0.05$).

EduDiab-Online intervention

The EduDiab-Online intervention was delivered over six consecutive weeks through a structured web-based educational platform integrated with peer-support activities. The educational program consisted of six sequential learning modules covering basic understanding of T2DM, healthy dietary management, physical activity and exercise, medication adherence and blood glucose monitoring, prevention of diabetes-related complications, and long-term self-management strategies. Each module included a 15–20-minute educational video, illustrated infographics, short reading materials, and an online quiz to reinforce key learning objectives.

Table 1. EduDiab-Online research instrument

Instrument	Measurement Objective	Scale / Unit
Health literacy questionnaire	Assessing participants' knowledge and understanding of diabetes and its management Likert 1–5 (20 items)	Likert 1–5 (20 items)
Self-efficacy scale of management	Measuring patients' self-confidence in managing diabetes independently	Likert 1–5 (10 items)
HbA1c examination	Assessing objective glycemic control	% (percentage of HbA1c)
Blood pressure measurement	Assessing the impact of interventions on cardiovascular health	mmHg
Body Mass Index (BMI) measurement	Assessing changes in patient nutritional status as a risk factor for diabetes	kg/m²
Self-assessment peer-support participation	Assessing the intensity of participant engagement in peer-support forums	Likert 1–4 (weekly frequency)
Pretest and posttest (N-Gain)	Measuring increased understanding after participating in an educational intervention	N-Gain Score (scale 0–1)

The educational materials were developed by a multidisciplinary team consisting of diabetes nurse educators, public health lecturers, and internal medicine physicians based on the Indonesian Society of Endocrinology guidelines and the American Diabetes Association Standards of Care. Prior to implementation, all materials underwent content validation by three independent experts specializing in diabetes education and public health, with revisions incorporated based on their recommendations.

The peer-support component was facilitated by trained peer mentors who were T2DM patients demonstrating good glycemic control, effective communication skills, and at least two years of self-management experience. Before the intervention, peer mentors completed an eight-hour training program conducted by the research team covering communication skills, motivational support, group facilitation techniques, ethical considerations, and the standardized delivery of intervention materials.

Peer-support activities were conducted twice weekly through moderated WhatsApp group discussions and scheduled online forums. During each session, mentors facilitated discussions, answered participants' questions, shared practical experiences, encouraged adherence to healthy behaviors, and promoted mutual support among participants. Research investigators supervised all mentoring sessions to ensure consistency in intervention delivery throughout the study period.

RESULTS AND DISCUSSION

This study involved 120 respondents diagnosed with T2DM and allocated into an intervention group (n = 60) and a control group (n = 60). Data were normally distributed according to the Shapiro–Wilk test ($p > 0.05$), and homogeneity of variance was confirmed using Levene's test ($p > 0.05$), indicating that parametric analyses were appropriate. Demographic characteristics showed equality between the two groups in terms of age, gender, and duration of diabetes. The mean age of the respondents was 52.4 years (SD±8.1), with 68.3% of them being female. Table 2 presents the baseline characteristics of the respondents involved in this study.

Table 2 shows that there are no significant differences between the two groups in the baseline characteristics of the respondents ($p > 0.05$). It indicates the division of the groups is fair and proportional, meaning that the results of the EduDiab-Online intervention has a pure effect of the treatment, not due to the influence of different external variables.

Furthermore, Table 3 shows the pre- and post-intervention health literacy scores in both groups. The large increase in scores in the intervention group reinforces the effectiveness of the EduDiab-Online program.

The N-Gain score of 0.61 in the intervention group showed a medium-high increase. This increase of 23.4 points shows that self-directed learning through a structured web platform is able to improve participants' understanding in a meaningful way. This result is also in line with the effectiveness of the online community-based social reinforcement method as participants not only receive information, but also discuss with peers, which improves understanding through peer experience. In contrast, the control group experienced minimal and insignificant improvement ($p > 0.05$), indicating that conventional education is not effective enough in shaping new in-depth knowledge in T2DM patients.

Table 4 displays the changes in important clinical parameters, including HbA1c, BMI, and blood pressure before and after treatment. These parameters provide objective evidence that the intervention impacted the respondents not only on cognitive aspects, but also on tangible health outcomes.

Table 2. Demographic characteristics of respondents

Variables	Intervention Group	Control Group	P-value
Age (mean ± SD)	52.1 ± 8.0	52.7 ± 8.3	0.682
Gender (P%)	67%	70%	0.711
Duration of T2DM (>5 years)	71.6%	73.3%	0.829

Table 3. Comparison of health literacy scores

Group	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Δ Change	N-Gain	P-value
Intervention	61.2 ± 7.9	84.6 ± 6.5	23.4	0.61	<0.001
Control	60.5 ± 8.1	63.1 ± 7.8	2.6	0.08	0.102

Table 4. Changes in clinical parameters

Parameter	Intervention Group			Control Group			Mean Difference	P-value*
	Pre	Post	Mean Change	Pre	Post	Mean Change		
HbA1c (%)	8.7	7.9	-0.8	8.6	8.5	-0.1	-0.7	< 0.001
BMI (kg/m²)	27.8	26.9	-0.9	27.5	27.3	-0.2	-0.7	0.041
Systolic BP (mmHg)	142.3	135.7	-6.6	141.9	140.8	-1.1	-5.5	0.027
Diastolic BP (mmHg)	87.1	82.5	-4.6	86.7	85.6	-1.1	-3.5	0.031

* P-value calculated based on independent sample t-test comparing the change scores (Δ) between groups

Table 5. Self-efficacy and peer-support participation scores

Parameter	Intervention Group			Control Group			Mean Difference	P-value*
	Pre	Post	Mean Change	Pre	Post	Mean Change		
Self-efficacy score	2.9	4.1	+1.2	2.8	3.0	+0.2	+1.0	< 0.001

As presented in Table 4, the intervention group demonstrates substantially greater improvements in all clinical parameters than the control group. The mean reduction in HbA1c is −0.8% in the intervention group compared with −0.1% in the control group, resulting in a significantly greater decrease in glycemic levels ($p < 0.001$). Similarly, the intervention group shows larger reductions in body mass index (−0.9 vs. −0.2 kg/m², $p = 0.041$), systolic blood pressure (−6.6 vs. −1.1 mmHg, $p = 0.027$), and diastolic blood pressure (−4.6 vs. −1.1 mmHg, $p = 0.031$) than the control group. These findings indicate that the EduDiab-Online intervention combined with peer support produced significantly greater improvements in metabolic control and cardiovascular risk indicators than conventional diabetes education. Table 5 presents the results of the self-efficacy measures and the level of participation in the peer-support forum.

Table 5 presents a significantly greater improvement in self-efficacy in the intervention group than the control group. The mean self-efficacy score increases from 2.9 to 4.1 in the intervention group, corresponding to a mean change of +1.2, while the control group shows only a modest increase from 2.8 to 3.0, with a mean change of +0.2. The between-group difference in mean change is +1.0, indicating that participants receiving the EduDiab-Online intervention experienced substantially greater gains in confidence to manage their diabetes than those receiving conventional education. This difference is statistically significant ($p < 0.001$), demonstrating that the integration of web-based diabetes education with a peer-support approach effectively enhanced participants' self-efficacy beyond the improvements observed in the control group.

The findings of this study provide strong evidence that a web-based diabetes education model combined with a peer-support approach, as designed in EduDiab-Online, had significant effectiveness in improving health literacy, self-efficacy, and clinical outcomes in T2DM patients. The statistically significant increase in health literacy scores ($p < 0.001$) in the intervention group reflected the interactive digital educational media is able to bridge knowledge gaps and support chronic disease management. This is in line with the previous findings,(22) which show that information technology-based educational interventions improve health literacy and patient independence in decision-making.

The intervention group demonstrated a mean reduction in HbA1c of 0.8 percentage points (from 8.7% to 7.9%; $\Delta = -0.8\%$), which was significantly greater than that observed in the control group ($\Delta = -0.1\%$, $p < 0.001$). Such reduction magnitude is generally regarded as clinically meaningful because decreases of approximately 0.5–1.0 percentage points have been associated with improved glycemic control and a lower risk of diabetes-related complications. These findings suggest that the EduDiab-Online model, which combines web-based diabetes education with peer-support activities, effectively improved patients' diabetes self-management. Consistent with previous randomized controlled trials, community-based online education integrated with peer support has been shown to achieve HbA1c reductions ranging from 0.5 to 1.2 percentage points among patients with T2DM, supporting the clinical relevance of the present findings.

The measured reductions in blood pressure and BMI in this study also reinforce the hypothesis that an educational model that touches on the emotional and social aspects of patients provides broader clinical outcomes.

Within the framework of Social Cognitive Theory,(24) observational experiences and social interactions gained from peer groups were shown to increase self-efficacy and strengthen individuals' commitment to healthy lifestyle changes. This effect was reflected by a significant increase in self-efficacy scores in the intervention group (from 2.9 to 4.1; $p < 0.001$).

However, this study has limitations. The long-term effects of the intervention on metabolic control were not measured, and the influence of individual characteristics such as education and motivation on the success of the program was not explored. Therefore, further research is recommended to evaluate the long-term effectiveness and refine the adaptive components of this educational platform. Overall, the results of this study support the adoption of technology-based education models integrated with social approaches as a transformational strategy in diabetes management at the community level. This is in line with the global direction of achieving the Sustainable Development Goals (SDG 3) related to improving health and well-being, giving opportunities for creating similar models to educate patients about other chronic diseases in the future.

CONCLUSION

The findings of this study indicate that the EduDiab-Online intervention, which integrates web-based diabetes education with a peer-support approach, significantly improved both clinical and psychosocial outcomes among patients with T2DM compared with conventional education. Quantitative analyses showed greater improvements in the intervention group, including a mean reduction of 0.8 percentage points in HbA1c, reductions in blood pressure and body mass index, and a significant increase in self-efficacy ($\Delta = +1.2$) (all $p < 0.05$). These findings are consistent with the proposed mechanism, while structured digital education improves health literacy and diabetes self-management. In addition, peer-support enhances motivation, adherence, and confidence in disease management. The observed outcomes are also consistent with previous studies highlighting the complementary benefits of web-based education and peer-support interventions in chronic disease management. Overall, the EduDiab-Online model represents a promising and scalable educational approach for improving diabetes self-management and glycemic control among patients with T2DM.

Conflict of Interest

The authors declare no conflict of interest.

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