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Effectiveness of Peer Education on Self-Care Behaviors and Glycemic Control in Adolescents with Type 1 Diabetes: Randomized Controlled Trial (RCT)

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Abstract

Background: Adolescents with type 1 diabetes (T1D) often struggle with maintaining optimal self-care and glycemic control. Peer education, leveraging support from individuals with similar experiences, is a promising strategy for improving health behaviors in chronic conditions.

Objectives: This study aimed to evaluate the effectiveness of a structured peer education program on self-care behaviors and glycated hemoglobin (HbA1c) levels in adolescents with T1D.

Methods: In a randomized controlled trial, 62 adolescents (aged 12-18 years) with T1D and baseline HbA1c >7.5% were recruited from a single center (Ali Asghar Hospital, Zahedan, Iran) in 2024-2025. Participants were randomized into an intervention group (receiving a 12-week program of four 90-minute peer-led educational sessions) and a control group (receiving routine care). Outcomes were measured at baseline and 12 weeks using the validated Persian version of the Summary of Diabetes Self-Care Activities (SDSCA) questionnaire and HbA1c tests. Data were analyzed using IBM SPSS Statistics (version 26) and included paired and independent t-tests. This research was supported by Zahedan University of Medical Sciences, Zahedan, Iran.

Results: All participants completed the study. The intervention group showed a significant improvement in self-care scores (from 65.7 ± 9.9 to 79.2 ± 11.0, $p < 0.001$) and a significant reduction in HbA1c levels (from 9.4 ± 1.3% to 8.1 ± 0.9%, $p < 0.001$). No significant changes were observed in the control group for either outcome.

Conclusions: A structured peer education program significantly improved self-care behaviors and glycemic control in adolescents with T1D within this trial context, suggesting it may be a valuable adjunct to conventional care. However, the findings should be interpreted considering the study's limitations, including its single-center design, relatively small sample size, reliance on self-reported measures of self-care, and lack of long-term follow-up.

Key Words: Adolescents, Glycemic Control, HbA1c, Peer Education, Self-Care, Type 1 Diabetes.

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1- INTRODUCTION

Type 1 diabetes (T1D) is a chronic autoimmune condition characterized by the destruction of insulin-producing beta cells in the pancreas, typically diagnosed in children and adolescents. Effective management requires lifelong insulin therapy and consistent self-care, including glucose monitoring, medication adherence, dietary control, and physical activity (1). Despite advances in diabetes care, many adolescents struggle with maintaining optimal glycemic control, partly due to psychosocial and developmental factors (2).

The World Health Organization estimates that over 1 million children and adolescents globally live with T1D, and the incidence is increasing by 3–4% annually, particularly in low- and middle-income countries (3). Poor self-management during adolescence can lead to early onset of complications such as retinopathy, nephropathy, and cardiovascular disease (4).

Traditional educational models, often delivered by healthcare professionals, may not sufficiently address the psychosocial challenges faced by youth with diabetes. Peer education has been shown to improve adherence, knowledge, and psychological well-being in other chronic conditions. However, few studies have rigorously examined its impact on objective clinical outcomes like HbA1c in T1D adolescents (5).

Peer education has been used in various health fields, for example, HIV, psychological health, and chronic health conditions. In relation to conventional teaching methods, peer education is a new educational model in which individuals from the same social group, who are not actually teachers or professionals, help each other learn and are themselves educated in the process; in other words, in this process, both the teacher and the learner are involved in the ongoing teaching experience and participate in the teaching process. Peer education is defined as two types: near peers and co-peers. Near peers are students who are academically at the same level (6).

Mechanisms of action of peer education include knowledge transfer, skill development, psychosocial support, and behavior reinforcement. The effects on self-care behaviors include blood sugar control, treatment adherence, lifestyle changes, and quality of life (7).

Therefore, considering the importance of blood sugar control in diabetic patients, especially type 1 diabetic patients who include a younger age range, and the occurrence of dangerous complications in these patients, we conducted a randomized controlled trial study to investigate peer education on self-care behaviors and glycosylated hemoglobin in adolescents with type 1 diabetes referred to Ali Asghar Hospital in Zahedan in 2024-2025.

2- METHODS

This randomized controlled trial with a pre-post design was conducted at Ali Asghar Hospital, Zahedan, Iran, in 2024-2025. A total of 62 adolescents aged 12–18 years with a diagnosis of T1D for at least one year and baseline HbA1c >7.5% were recruited via convenience sampling and randomized using permuted block stratification into intervention and control groups (31 per group). At the time of diagnosis of type 1 diabetes, both groups received identical training in the hospital from a pediatric endocrinologist.

Exclusion criteria included: 1) having psychological disorders that could interfere with learning, 2) a history of taking medications that impair the learning process, 3) a history of other chronic diseases, or 4) reluctance to participate in the study.

In the present study, 62 adolescents with type 1 diabetes were enrolled based on the inclusion and exclusion criteria and were divided into two intervention groups (Peer education) and a control group (Control education).

2-1. Sample Size Calculation and Sampling Method

The required sample size was calculated for the total study population using G*Power software (version 3.1) based on the primary outcome (change in HbA1c). With an effect size of 0.8 (derived from previous similar studies), an alpha error of 0.05, and a power of 80%, a minimum of 28 participants per group was estimated. Accounting for a potential 10% dropout rate, we aimed to recruit 31 participants per group (total N=62).

Participants were recruited via convenience sampling from the pediatric endocrinology clinic of Ali Asghar Hospital. Eligible individuals who met the inclusion criteria were then randomly allocated to either the intervention or control group (31 per group) using permuted block randomization, as detailed in the following section.

2-2. Randomization

Random allocation of patients to two groups was performed using the permuted block stratified randomization method. To ensure balanced representation of both sexes across groups, the stratification was specifically performed based on sex. In this way, first, eligible referring patients are classified according to age and gender in the order of arrival. Then, they were assigned to the desired group based on blocks of 4 (consisting of two groups A and B and two replications for each) that were randomly selected from all possible permutations. These blocks were created using the statistical software R version 4.0.2.

The two groups were matched in terms of age and sex using the stratified randomization method of permutation block frequency matching. Blinding of participants and educators was not feasible because of the nature of the educational intervention. The statistical consultant was blinded to group allocation during the statistical analysis.

The recruitment, randomization, follow-up, and analysis of participants are summarized in the CONSORT flow diagram (Figure 1).

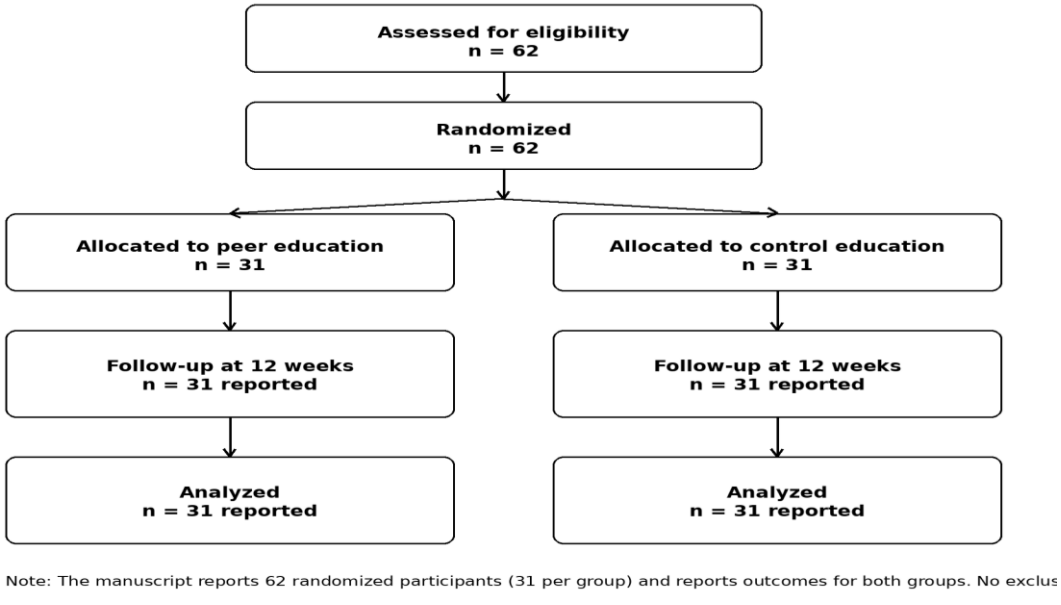

Figure-1: CONSORT flow diagram of participant recruitment, randomization, follow-up, and analysis.

Table-1. Educational content in four sessions.

Session	Content
1	An overview of the program and introduction of trainers and members to each other, discussion of the definition and importance of peer education, explanation of the identity and cause of diabetes, answering patient questions
2	Review of previous sessions, types of diabetes, symptoms of diabetes, risk factors for diabetes, complications of diabetes, answering patient questions
3	Review of previous sessions, explaining the importance of self-care skills, nutrition in diabetes, exercise in diabetes, blood sugar control in diabetes, answering patient questions
4	Review of previous sessions, diabetes treatment, diabetes medication, diabetes control, answering patient questions

2-3. Intervention

In the intervention group, a pediatric specialist assistant who had been trained by a pediatric endocrinologist delivered the peer education program. The sessions were conducted every three weeks, with each session lasting approximately 90 minutes. The intervention consisted of four structured educational sessions. The sessions addressed diabetes physiology and causes, types and symptoms of diabetes, complications, self-care skills, nutrition, physical activity, blood glucose monitoring, diabetes treatment, medications, and diabetes control. Previous session content was reviewed at the beginning of subsequent sessions, and participants were given opportunities to ask questions and discuss issues related to diabetes management. The detailed content of the four sessions is presented in Table 1.

2-4. Data Collection

Self-care behaviors were assessed using the Summary of Diabetes Self-Care Activities (SDSCA) questionnaire, validated in Persian (8). This scale is a 15-item self-report questionnaire that assesses patients' self-care measures over the past seven days and covers various aspects of the diabetes treatment regimen, including general diet and diabetes-specific diet (5 questions: questions 1–5), exercise (2 questions: questions 6 and 7), blood sugar testing (2 questions: questions 8 and 9), insulin injection or antidiabetic pills (1 question: question 10), foot care (4 questions: questions 11–14), and smoking (1 question: question 15). In this scale, each behavior was given a score from 0 to 7, with the exception of smoking behavior, which is scored from 0 to 1, and an overall adherence score was obtained by summing the scores for each question. The total score of the scale ranges from 0 to 99. In the current sample, the SDSCA demonstrated excellent internal consistency, with a Cronbach's alpha coefficient of 0.85. HbA1c levels were measured using standardized laboratory methods at baseline and after 12 weeks.

2-5. Statistical Analysis

Data were analyzed using SPSS v26. Normality was assessed with the Shapiro-Wilk test. Data were analyzed using SPSS version 26. Normality was assessed using the Shapiro–Wilk test. Analysis of covariance (ANCOVA) was performed to compare post-intervention HbA1c and self-care scores between the intervention and control groups, with the corresponding baseline measurements included as covariates. The treatment group was entered as the independent variable. Statistical significance was set at $p < 0.05$. Effect sizes and corresponding 95% confidence intervals were calculated for the primary outcomes to quantify the magnitude and precision of the intervention effects. A two-sided p-value

<0.05 was considered statistically significant.

2-6. Ethics

This study was approved by the Ethics Committee of Zahedan University of Medical Sciences under the ethical code IR.ZAUMS.REC.1403.436. This research was supported by Zahedan University of Medical Sciences, Zahedan, Iran.

2-7. Trial Registration

This randomized controlled trial was not prospectively registered in a public clinical trial registry.

3- RESULTS

The mean age of participants was 15.2 ± 1.9 years, and gender distribution was similar between groups. At baseline, there were no significant differences in HbA1c or self-care scores. After 12 weeks, the intervention group demonstrated a significant reduction in HbA1c (mean change: -1.36%, p<0.001), while the control group showed no significant change. Self-care scores improved significantly in the intervention group (mean increase: +13.5 points, p<0.001), with no notable improvement in the control group. Figure 1 shows HbA1c at the first study and after 3 months in the control and case groups.

Between-group comparisons revealed statistically significant differences in both HbA1c and self-care outcomes (p<0.001). No adverse effects related to the intervention were reported.

Based on the results, there was no significant difference in the mean percentage of HbA1C levels in the routine education group before the intervention and three months later (p=0.266). Based on the results, the mean percentage of HbA1C levels in the peer education group at the beginning of the study and three months later was significantly different (p<0.001). Three months after the start of the study, HbA1C levels were significantly lower (mean difference = 1.36).

Table-2. Demographic characteristics in case and control groups.

Demographic profile	**CONTROL (MIN±SD)**	**CASE (MIN±SD)**	**P-value**
Age (yr)	15.1 ±35.8	15.2± 6.11	0.564
	Frequency(%)	**Frequency (%)**	
Sex Male **Female**	**(**45.2% **)** 14 **(**54.8% **)**17	**(**45.2 % **%**)14 **(**54.8%**)**17	1.00
Father's level of education Illiterate Less than a diploma Diploma University education	 (16.1%)5 (29%)16 **(**35.5%)11 (19.4)9	 (19.4%)6 (41.9)13 (22.6%)7 (16.1)5	0.615
Mother's level of education Illiterate Less than a diploma Diploma University education	 (9.7%)3 (51.6%)16 (35.5%)11 (3.2%)1	 (22.6%)7 (25.8%)8 (38.7%)12 (12.9%)4	0.106
Economic situation Expenses less than income Cost equal to income Expenses more than income	 (12.9%)4 (35.5%)11 (51.6%)16	 (6.5%)2 (48.4%)15 (45.2%)14	0.493

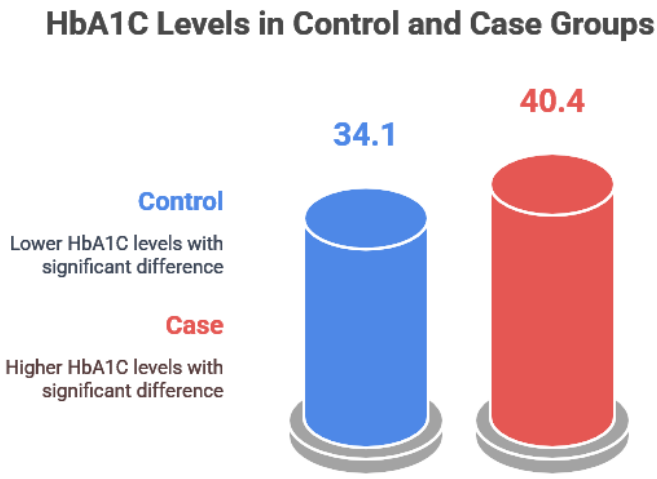

Figure-2: HbA1c in the first study and after 3 months in the control and case group.

Changes in HbA1C were significantly different in the two study groups (p=0.001), with greater changes in HbA1C in the intervention group (mean difference = -1.08).

Based on the results, the average diabetes self-care score in the routine education group did not differ significantly before the intervention and three months later (p=0.133). Based on the results, the average self-care score in the peer education group before the intervention and at three months later was significantly different (p<0.001); the self-care score three months after the start of the study was significantly higher than at the beginning. Based on the results, the mean self-care score at the beginning of the study was not significantly different between the routine education and peer education groups (p=0.577). However, three months after the start of the study, the mean self-care score of the group of children with type 1 diabetes was significantly higher (p<0.001). Table 3 shows self-care in the first study and after 3 months in the control and case groups.

4- DISCUSSIONS

The present randomized controlled trial evaluated whether a structured peer education program could improve self-care behaviors and glycemic control among adolescents with T1D. The intervention was associated with significant improvements in both outcomes. In the peer education group, mean HbA1c decreased from 9.4% at baseline to 8.1% after three months, while the mean self-care score increased from 65.7 to 79.2(9). In contrast, no significant within-group changes were observed in the routine education group. The between-group difference in HbA1c change was also statistically significant, suggesting that the observed improvement was greater among participants who received peer education. These findings support the potential value of peer-based education as an adjunct to conventional diabetes education, although the relatively short follow-up period warrants caution in interpreting the sustainability of these effects (10).

Table-3. Self-care in the first study and after 3 months in the control and case groups.

Variable	time	Control Min ±SD	Case Min ±SD	P-value
Self-care number	First study 3 months after study	64.9± 58.38 67.7±70.56	65.9±70.87 79.10±22.95	0.557 <0.001

Several mechanisms may plausibly explain the observed improvements. Adolescence is a developmental period in which peer relationships and social acceptance become particularly important. Consequently, educational messages delivered by individuals with shared experiences may be perceived as more relatable and relevant than information provided exclusively through conventional clinician-led education (11). Peer educators may provide practical examples of diabetes self-management and demonstrate how diabetes-related recommendations can be incorporated into everyday life. This type of experiential learning may facilitate understanding and reinforcement of self-care behaviors. These mechanisms are consistent with the principles of social learning theory, in which behavioral change can occur through observation, modeling, and reinforcement within a social environment (12).

Another potential pathway is the development of self-efficacy. Adolescents who interact with peers successfully managing T1D may perceive diabetes self-management as more achievable and may gain confidence in performing behaviors such as glucose monitoring, dietary management, physical activity, and treatment adherence. Increased confidence may, in turn, facilitate more consistent engagement in daily self-care (13). The improvement in self-care scores observed in the present study is compatible with this interpretation. However, because self-efficacy and the specific psychosocial processes underlying behavioral change were not directly measured, these mechanisms should be regarded as plausible explanations rather than demonstrated mediators of the intervention effect (14).

The improvement in HbA1c is particularly relevant because glycemic control reflects the cumulative effects of multiple diabetes-management behaviors over time. The simultaneous improvement in self-care and reduction in HbA1c observed in the intervention group raises the possibility that better self-management contributed to improved glycemic control (15). Nevertheless, HbA1c is influenced by several factors beyond the behaviors addressed during the educational intervention. Dietary intake, physical activity, treatment adherence, insulin management, and other clinical and developmental characteristics may all contribute to glycemic outcomes. Therefore, the relationship between the improvement in self-care and the reduction in HbA1c should not be interpreted as proof of a direct causal pathway (16).

Our findings are broadly consistent with previous literature indicating that peer support and peer-led approaches may improve self-management and psychosocial outcomes among individuals living with chronic diseases. Previous studies have emphasized the potential importance of shared experience, social support, and peer modeling in facilitating behavioral change among adolescents with diabetes (17). However, the existing evidence should be interpreted cautiously because peer interventions differ considerably in their content, duration, delivery format, intensity, and characteristics of the peer educators. Such heterogeneity may explain why the magnitude and consistency of reported benefits have varied across studies. In addition, improvements in self-care behaviors do not necessarily translate into sustained improvements in glycemic control, particularly when follow-up is limited (18).

The present study contributes to this literature by examining a structured, four-session peer education program and evaluating both a behavioral outcome (self-care) and an objective clinical outcome (HbA1c). The concurrent

improvement in these two outcomes provides a more comprehensive assessment of the potential value of peer education than an evaluation based solely on knowledge or self-reported behavioral outcomes (19). The randomized allocation of participants also provides a stronger basis for evaluating the intervention effect than studies based exclusively on observational or uncontrolled designs. Nevertheless, the findings should be interpreted within the context of the study's single-center setting, relatively small sample, and short follow-up period (20).

The potential role of peer education may be particularly relevant in settings where healthcare resources are limited. A structured peer-based approach may complement conventional diabetes education by extending support beyond routine interactions with healthcare professionals and by providing adolescents with opportunities to learn from individuals with comparable experiences. However, implementation should not be viewed as a replacement for professional diabetes care. Rather, peer education may be most appropriately considered an adjunctive component of a comprehensive diabetes-management program (21).

Nutrition is another important consideration when interpreting these findings. Similar nutritional recommendations were provided to both groups; however, dietary behaviors can substantially influence glycemic control and may be particularly important during adolescence. Because detailed dietary intake was not systematically assessed, the extent to which changes in dietary behavior contributed to the observed HbA1c improvement cannot be determined. This issue reinforces the need for future trials to measure potential behavioral and clinical mediators of glycemic change more systematically (22).

Overall, the findings suggest that peer education may be a useful complementary strategy for improving self-care and glycemic control among adolescents with T1D. The results are encouraging but should not be interpreted as definitive evidence of a sustained clinical benefit. Larger, multicenter randomized trials with longer follow-up and standardized assessment of behavioral, psychosocial, and clinical mediators are needed to determine whether the observed improvements are maintained and to clarify which components of peer education are most important for achieving clinically meaningful changes in diabetes management.

4-1. Limitations

This study has several limitations that warrant consideration. First, the single-center design and relatively small sample size may limit the generalizability of the findings to other populations or healthcare settings. Second, the primary reliance on the self-reported SDSCA questionnaire, although validated in Persian, is susceptible to social desirability and recall bias. Third, the lack of long-term follow-up prevents assessment of the sustainability of the observed improvements in self-care and glycemic control beyond the 12-week intervention period. Fourth, logistical constraints due to the geographical vastness of the study area necessitated that follow-up education be delivered via telephone, which may have influenced the depth of interaction compared to in-person sessions. Fifth, important potential confounders such as participants' physical activity levels, detailed dietary intake, and pubertal stage (Tanner staging) were not systematically measured or adjusted for in the analysis, which could influence the outcomes. Sixth, the primary outcome (HbA1c) is a surrogate marker; the study was not designed to assess the impact of the intervention on hard clinical endpoints

such as diabetes-related complications or cardiovascular events. Finally, the use of anthropometric cut-off values derived from non-Iranian reference populations for indices such as waist-to-height ratio may introduce classification bias, highlighting the need for nationally validated pediatric standards.

Additionally, detailed documentation of the peer educator selection criteria, formal competency assessment, and intervention fidelity procedures was not available, which may limit the reproducibility of the intervention.

The absence of prospective registration in a public clinical trial registry is an additional limitation and may reduce the transparency of the study protocol and outcome reporting.

Detailed baseline clinical characteristics, including insulin regimen, BMI, frequency of glucose monitoring, and history of diabetes-related complications, were not systematically collected or reported. Therefore, the potential influence of these factors on glycemic outcomes could not be fully evaluated.

4-2. Strengths

The use of the validated Persian version of the SDSCA questionnaire strengthens the reliability of the self-care behavior assessment. The significant improvement in self-care scores across multiple dimensions (diet, exercise, monitoring) suggests peer education effectively targets core aspects of diabetes management critical for glycemic control.

4-3. Future Directions

Future research should explore the scalability and integration of peer education into standard diabetes care. Hybrid models combining peer support with digital health tools (e.g., glucose tracking apps) could enhance engagement. Studies should also determine the optimal frequency and duration of peer-led sessions and employ longer follow-up periods to assess sustainability. Qualitative research is needed to elucidate the mechanisms of change, such as the role of emotional support and shared problem-solving. Furthermore, investigating the potential of tailored peer education programs to address health disparities in underserved communities, where adolescents face barriers like limited healthcare access, is a crucial area for future work to promote health equity.

5- CONCLUSION

In conclusion, the results of this trial suggest that a structured peer education program can be a promising and effective strategy for improving self-care behaviors and glycemic control in adolescents with T1D in our setting. By leveraging peer influence and social support, such programs have the potential to complement traditional healthcare provider-led education and address specific psychosocial challenges in this population. While these preliminary findings are encouraging, they highlight the potential of peer education as a scalable and cost-effective intervention model, particularly in resource-constrained settings. Future research should focus on long-term outcomes, scalability across diverse populations, and the integration of peer education into comprehensive diabetes care models to strengthen the evidence base for its widespread implementation.

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