Effectiveness of Peduli Family Module to Engage Diet, Exercise, and Medication Adherence on Type 2 Diabetes

ABSTRACT

Background: For diabetes patients, adhering to lifelong self-care routines is a significant challenge. This study aimed to introduce the PEDULI family module, which can be used as an educational tool for the families of diabetes patients and as a training resource for diabetes educators

Methods: This study employed a quasi-experimental design with a pretest-posttest. A total of 82 diabetes patients were involved. PEDULI family module, designed to enhance diabetes management through family involvement. Diet, exercise and medication adherence were measured.

Results: The intervention was highly effective in improving diet, exercise, and medication adherence, as well as overall health behavior. Exercise and medication adherence saw particularly strong improvements, influenced by demographic factors such as education, occupation, and family size.

Conclusion: These findings suggest that future interventions should consider tailoring strategies to individual characteristics to maximize their effectiveness.

Keywords: adherence, diet, exercise, engagement, family, medication

INTRODUCTION

The management of diabetes has yet to be optimized by patients, as evidenced by the high incidence of diabetes-related complications. Diabetes patients are required to implement their management plans in their daily lives, which often presents significant challenges (Rutten et al., 2018). Family members are a critical source of social support for individuals with diabetes, contributing to improved self-management and health outcomes (Mayberry & Osborn, 2012). In 2021, over 6.7 million people aged 20-79 worldwide died from diabetes-related causes. Indonesia ranked second in diabetes prevalence in the Western Pacific region, with 19.5 million individuals affected (International Diabetes Federation, 2021). In Bali, diabetes mellitus was among the top diagnoses for outpatient and inpatient care under the National Health Insurance program, indicating its substantial burden on the healthcare system (Dinas Kesehatan Provinsi Bali, 2019). Diabetes significantly reduces life expectancy and diminishes quality of life (Vanroy et al., 2017). Effective diabetes management requires patients to consistently perform self-management activities, including following dietary recommendations, self-monitoring, and adhering to

treatment regimens. However, many patients find these activities burdensome, and maintaining long-term adherence is challenging (Pyatak et al., 2018). When interventions focus solely on patients, they may feel overwhelmed, increasing the likelihood of non-compliance. Family involvement, therefore, plays a crucial role in enhancing medication adherence, self-management skills, and disease knowledge (Bongaerts et al., 2017). Research has shown that good glycemic control is often supported by family presence and engagement (Lee et al., 2018).

Patients frequently struggle to maintain progress without continuous follow-up and support(Piatt et al., 2018). The complexity of diabetes management requires lifelong commitment and significant lifestyle changes. Emotional and financial support from family members, alongside assistance with lifestyle adjustments, is essential. Barriers such as dietary challenges, medication adherence, limited health literacy, and physical activity constraints are common. These barriers are exacerbated by a lack of confidence, uncertainty about integrating physical activity into daily life, perceptions of difficulty, fear of injury, and insufficient social support from families (Wooldridge et al., 2019).

Adherence to lifelong self-care routines is particularly demanding for diabetes patients. Family eating habits and the broader social environment significantly influence these behaviors (Rutten et al., 2018). Feelings of boredom and fatigue can lead to lapses in self-care, especially without family involvement. A lack of family support may result in medication non-compliance, missed check-ups, poor dietary adherence, and the development of complications, ultimately imposing emotional and financial burdens on families and increasing healthcare costs for the government. Thus, involving families in diabetes care is critical to boosting patients' confidence in managing their condition (Luthfa & Ardian, 2019).

Previous studies by the author have highlighted the relationship between stress levels, family support, and blood sugar control in diabetes patients, demonstrating that family support positively impacts patients' ability to manage their condition (Trisnadewi et al., 2020). Another study revealed that both patients and their families often lack sufficient knowledge about diabetes management, underscoring the need for educational interventions (Trisnadewi et al., 2018). Providing families with proper education enables them to support patients more effectively and encourages the adoption of healthier lifestyle practices within the family unit.

To address these challenges, this study introduces the PEDULI family module, a comprehensive educational tool designed to enhance family involvement in diabetes management. The module

focuses on key areas, including monitoring blood sugar levels, providing emotional and spiritual support, ensuring proper dietary practices, promoting and supervising physical activity, supporting medication adherence, and fostering health literacy about diabetes. By addressing these aspects, the PEDULI module aims to improve medication adherence, diet, and physical exercise in type 2 diabetes patients.

Unlike other family education programs, the PEDULI module offers an integrated approach that combines practical guidelines, step-by-step implementation mechanisms, and ongoing training for diabetes educators. This approach ensures that all components of family support—emotional, instrumental, esteem, and informational—are effectively utilized. The module's innovative features include tailored education sessions, interactive tools for tracking patient progress, and strategies for overcoming common barriers to self-management. Preliminary pilot studies on the PEDULI module have shown promising results, with participants reporting improved adherence and better glycemic control.

This study aims to evaluate the effectiveness of the PEDULI family module in improving diabetes management outcomes. By incorporating family education and support, the module addresses the challenges faced by patients and ensures a more holistic approach to diabetes care. The findings of this study will provide valuable baseline data for developing technology-based interventions and enhancing diabetes care strategies. Ultimately, the PEDULI module represents a significant step forward in leveraging family support to improve the quality of life for diabetes patients.

METHODS

Study Design

This study employed a quasi-experimental design with a pretest-posttest approach to evaluate the effectiveness of the PEDULI family intervention module in improving medication adherence, dietary management, and physical exercise in patients with type 2 diabetes mellitus (T2DM). While a control group was not included, which limits causal inferences, the study aimed to explore preliminary impacts over an 8-week intervention period involving educational sessions for patients and their family members.

Study Setting and Participants

The study was conducted at Banjar Blangsinga Village Hall, Blahbatuh, Gianyar, in collaboration with Puskesmas Blahbatuh II Gianyar. Participants were recruited from the service area of

Puskesmas Blahbatuh II. Inclusion criteria were: 1) Patients diagnosed with T2DM who live with nuclear family members (spouse, children, in-laws, or grandchildren), 2) Patients and family members willing to participate, and 3) Patients without acute diabetes complications. Exclusion criteria included relocation during the study period or not residing in the Puskesmas Blahbatuh II service area.

Sample Size and Sampling Technique

A total of 82 participants were selected using purposive sampling, a non-probability technique. While this method allowed for the targeted recruitment of participants meeting the study's criteria, it may introduce selection bias, limiting the generalizability of the findings. The sample size was calculated based on a power analysis to ensure sufficient statistical power for detecting significant differences in outcomes.

Ethical Approval

Prior to the initiation of the study, ethical approval was obtained from the appropriate ethics review board. Informed consent was obtained from all participants, both patients and family members, ensuring voluntary participation and confidentiality.

Intervention

The intervention consisted of the PEDULI family module, a structured educational program emphasizing family involvement in diabetes management. The module addressed six key aspects: 1) Regular blood glucose monitoring, 2) Emotional and spiritual support, 3) Appropriate dietary practices, 4) Monitoring and encouraging physical activity, 5) Medication adherence, and 6) Seeking information and literacy about diabetes. Each session incorporated interactive discussions, practical demonstrations, and culturally adapted materials, including traditional Balinese Bondres dance performances, to engage participants and reinforce learning points.

The intervention was delivered once a week for eight consecutive weeks, with each session lasting 45 minutes. Participants' attendance was monitored, and compliance was recorded to evaluate engagement throughout the intervention.

Data Collection

Pretest

Baseline data were collected through validated questionnaires to measure medication adherence, dietary management, and physical exercise behaviors. Data collection was conducted by trained research assistants who were blinded to the study's objectives to minimize observer bias.

Posttest

At the end of the 8-week intervention, posttest assessments were conducted using the same validated tools to evaluate changes in the three main outcomes. Efforts were made to ensure consistency in data collection methods between pretest and posttest.

Outcomes Measured

The outcomes measured were:

1. Medication adherence was assessed using a validated self-reported questionnaire tailored to diabetes medication regimens.
2. Dietary management was evaluated based on adherence to diabetes-specific dietary recommendations.
3. Physical exercise was measured using self-reported engagement in recommended physical activities, supplemented by step count data from pedometers provided during the intervention.

Data Analysis

Pretest and posttest differences were analyzed using paired t-tests to identify changes in outcomes. Confounding variables such as age, gender, education, occupation, family member involvement, insurance, and years of diabetes were included in a multiple analysis of covariance (MANCOVA) to assess their potential influence on outcomes. Subgroup analyses were performed to explore variations in results based on demographic and clinical characteristics.

RESULTS

In this study, the majority of participants were male (57.3%), while 42.7% were female. Most had been living with diabetes for one year (41.5%), with smaller percentages reported for longer durations, including five years (20.7%) and other intervals. Regarding education, a significant portion had completed senior high school (32.9%), while 24.4% had only an elementary-level education, and 14.6% were uneducated. In terms of occupation, 30.5% were unemployed, with 24.4% engaged in business and smaller numbers in civil service (6.1%) or private sectors (4.9%). Family size varied, with 26.8% having six members and 23.2% with five members. Almost all participants (97.6%) had access to universal health coverage.

Table 1 Adherence characteristics

	Mean	Median	Mode	Std. Dev	Minimum	Maximum

Medical adherence	11.67	11	11	2.667	8	23
Exercise adherence	25.7	27	26[a]	4.46	15	33
Diet adherence	24.18	25	26	4.046	15	31
Pretest total	61.549	63	62.00a	8.409	41	76
Medical adherence	33	33	33	1.892	28	37
Exercise adherence	21.29	21	22	2.208	17	32
Diet adherence	29	29	29	1.388	25	32
Posttest total	83.293	83	85	3.949	75	100

The participants had an average age of 60.35 (±10.19) years, with a median and mode of 60, ranging from 40 to 90 years. Medical adherence scores averaged 11.67 (±2.67), with a median of 11, and scores ranging from 8 to 23. Exercise adherence had a mean of 25.7 (±4.46) and ranged from 15 to 33, while diet adherence averaged 24.18 (±4.05), with a range of 15 to 31. The pretest total adherence score had a mean of 61.55 , with a standard deviation of 8.41, and ranged from 41 to 76. Posttest scores revealed improvements, with a mean of 83.29 (±3.95), a median of 83, and scores ranging from 75 to 100.

Table 2 ΔAdherence analysis before and after intervention

Variables	**Paired Differences**					**t**	**Sig. (2-tailed)**
	Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval**			
				Lower	**Upper**		
ΔDiet Adherence	-8.817	3.472	0.383	-9.58	-8.054	-22.998	0
ΔExercise Adherence	4.402	4.722	0.521	3.365	5.44	8.443	0
ΔMedication Adherence	-17.329	2.45	0.2733	-17.873	-16.785	-63.408	0
ΔPretest Postest	-21.744	7.405	0.818	-23.371	-20.117	-26.59	0

The paired differences analysis reveals significant changes in diet, exercise, and medication adherence, as well as overall pre- and post-test scores.

The diet adherence scores decreased significantly from pre- to post-test, with a mean difference of -8.817 (p = 0.000), indicating an improvement in diet adherence after the intervention. The confidence interval for this difference is between -9.58 and -8.05, confirming a significant shift toward better dietary habits.

Exercise adherence showed a positive mean difference of 4.402 (p = 0.000), suggesting a significant increase in exercise adherence after the intervention. The confidence interval for this difference is between 3.37 and 5.44, further supporting the conclusion that participants improved their exercise routines.

Medication adherence demonstrated the most substantial change, with a mean difference of -17.33 (p = 0.000), reflecting a significant improvement in adherence to prescribed medications post-intervention. The confidence interval for this difference ranges from -17.87 to -16.79, indicating a robust and consistent improvement.

Lastly, the overall pre- to post-test comparison showed a significant mean difference of -21.74 (p = 0.000), confirming a general improvement in all measured behaviors after the intervention. The confidence interval for this difference is between -23.37 and -20.12, suggesting that the intervention had a broad and significant positive impact on participants' health-related behaviors.

Table 3 MANCOVA analysis of cofounding variables

Variables		**df**	**Mean Square**	**F**	**Sig.**
Sex	Pos-Pre	1	1.139	.139	.717
	Diet Pos-Pre	1	3.233	.588	.461
	Exercise Pos-Pre	1	8.192	5.120	.047
	Medication Pos-Pre	1	9.430	.000	.998
Years of diabetes	Pos-Pre	5	8.771	1.070	.432
	Diet Pos-Pre	5	2.768	.503	.768
	Exercise Pos-Pre	5	1.389	.868	.535
	Medication Pos-Pre	5	4.450	3.708	.037
Education	Pos-Pre	4	103.612	12.636	.001

	Diet Pos-Pre	4	17.717	3.221	.061
	Exercise Pos-Pre	4	35.553	22.221	.000
	Medication Pos-Pre	4	.749	.625	.656
Occupation	Pos-Pre	3	73.194	8.926	.004
	Diet Pos-Pre	3	6.448	1.172	.368
	Exercise Pos-Pre	3	50.797	31.748	.000
	Medication Pos-Pre	3	9.600	8.000	.005
Number of family	Pos-Pre	6	57.460	7.007	.004
members	Diet Pos-Pre	6	23.529	4.278	.021
	Exercise Pos-Pre	6	15.431	9.644	.001
	Medication Pos-Pre	6	9.309	7.757	.003

The statistical results provide important details about the factors influencing changes in adherence to diet, exercise, and medication between pre- and post-tests. The overall model shows a significant effect ($F = 7.488$, $p = .001$), with an R-squared value of .982 (adjusted R-squared = .850), indicating that the model explains 85% of the variation in post-pre adherence changes.

For diet adherence, the change was not statistically significant ($F = 2.359$, $p = .070$). However, family size had a significant impact ($F = 4.278$, $p = .021$), suggesting that individuals with more family members experienced more pronounced changes in diet adherence.

In contrast, exercise adherence showed a highly significant improvement ($F = 15.755$, $p = .000$). Sex significantly influenced exercise adherence ($F = 5.120$, $p = .047$), along with education ($F = 22.221$, $p = .000$), occupation ($F = 31.748$, $p = .000$), and family size ($F = 9.644$, $p = .001$). These factors indicate that demographic characteristics played a significant role in exercise behavior changes.

Medication adherence also showed a significant improvement ($F = 5.682$, $p = .003$). Years of diabetes ($F = 3.708$, $p = .037$), occupation ($F = 8.000$, $p = .005$), and family size ($F = 7.757$, $p = .003$) were significant factors influencing medication adherence, meaning these factors had a notable effect on how well participants adhered to their medication regimen.

The intercept was highly significant across all adherence measures ($p < .001$), indicating a general improvement from pre- to post-test in diet, exercise, and medication adherence. However, sex had a significant effect only on exercise adherence, while years of diabetes primarily influenced

medication adherence. Education played a key role in exercise adherence but had a marginal effect on diet adherence ($p = .061$), and occupation significantly influenced both exercise and medication adherence. Family size consistently emerged as a significant factor across all three adherence measures, highlighting its importance in health behavior improvements.

DISCUSSION

The findings of this study underscore the significant impact of an intervention aimed at improving adherence to health-related behaviors, such as diet, exercise, and medication, among participants. The statistical results suggest improvements across these areas, but the influence of demographic factors adds a layer of complexity that requires deeper analysis. In light of previous research and behavioral health theories, the results both confirm known patterns and provide new insights into the factors shaping adherence behaviors.

Diet Adherence

The improvement in diet adherence, with a significant mean difference of -8.817 ($p = 0.000$), indicates that the intervention was successful in promoting healthier eating habits. However, this change was not strongly influenced by most demographic factors, with family size being the only significant predictor. This aligns with previous research that emphasizes the role of family support in dietary changes. Studies have shown that families can act as both facilitators and barriers to dietary adherence, particularly in chronic disease management (Pender et al., 2011). The social cognitive theory of self-efficacy, which highlights the influence of social environments on behavior, supports this finding. Families that foster positive attitudes toward healthful eating may encourage better adherence.

Nevertheless, the lack of significant impact from education, sex, or occupation suggests that the intervention might not have been sufficiently tailored to different population groups. Previous studies, such as those by Wang et al. (2018), found that education level often correlates with greater adherence to dietary recommendations, likely because more educated individuals are better able to understand the health implications of their choices. The absence of a strong demographic effect here could indicate a need for future interventions to provide more personalized education and support, especially targeting lower-educated individuals who may benefit from additional dietary guidance.

Exercise Adherence

Exercise adherence showed a significant improvement, with a mean difference of 4.402 ($p = 0.000$). This finding is consistent with existing literature, which emphasizes the challenges of maintaining regular physical activity, especially in populations with chronic conditions like diabetes (Marcus & Forsyth, 2003). In this study, demographic factors such as sex, education, occupation, and family size significantly influenced exercise adherence. This highlights the need for interventions to consider these individual characteristics when promoting physical activity.

The positive influence of education on exercise adherence is supported by social cognitive theory, which suggests that individuals with higher education levels have better self-efficacy and knowledge about the benefits of exercise, making them more likely to engage in physical activity (Bandura, 1997). Moreover, sex differences in exercise adherence, with men typically being more physically active than women, are well-documented in previous research. The current study's finding that sex influenced exercise adherence aligns with this trend, emphasizing the need for gender-sensitive approaches to health promotion.

Occupation and family size also played important roles. Individuals in more structured or physically demanding occupations may find it easier to incorporate exercise into their routines, while larger families may provide social support for maintaining physical activity. These findings are consistent with Bronfenbrenner's ecological systems theory, which posits that individuals are influenced by the multiple systems they interact with, including family and work environments (Bronfenbrenner, 1979). Interventions targeting exercise adherence may benefit from focusing on creating supportive environments both at home and in the workplace.

Medication Adherence

The largest improvement was seen in medication adherence, with a mean difference of -17.33 ($p = 0.000$). This result mirrors previous studies, such as the work by Odegard and Capoccia (2007), which identified medication adherence as one of the most modifiable behaviors in managing chronic diseases like diabetes. The significant influence of years of diabetes, occupation, and family size on medication adherence in this study highlights the need for interventions that account for these personal factors.

The longer someone has lived with diabetes, the more familiar they may become with the importance of medication adherence, as supported by the health belief model (Rosenstock, 1974). This model suggests that individuals who perceive a greater risk of negative health outcomes due to non-adherence are more likely to follow their prescribed medication regimen. Occupation also

played a key role, possibly because certain jobs offer more flexibility or resources for managing medications. For example, individuals in sedentary or administrative roles may find it easier to adhere to medication schedules compared to those in more physically demanding or irregular work environments.

Family size again emerged as a significant factor, reinforcing the role of social support in medication adherence. Larger families may provide more opportunities for reminders and accountability, which are critical in managing complex medication regimens. This finding aligns with the literature on family-centered health interventions, which suggests that involving family members in care routines improves adherence (Baig et al., 2015).

Overall Pre- and Post-Test Improvements

The overall improvement in health behaviors, as indicated by the significant pre- and post-test differences (mean difference of -21.74, $p = 0.000$), suggests that the intervention was broadly effective. This finding aligns with behavioral theories such as the transtheoretical model (Prochaska & DiClemente, 1983), which emphasizes the importance of structured interventions in moving individuals through the stages of behavior change, from contemplation to maintenance.

The intervention's success across multiple adherence measures suggests that it provided participants with the tools they needed to make meaningful changes. However, the broad nature of these improvements also highlights the importance of maintaining these gains over time. Previous studies have shown that adherence to health behaviors often diminishes once structured support is removed (Vermeire et al., 2001). Long-term follow-up and continuous support will be essential to ensure the sustainability of these improvements.

LIMITATIONS

Despite the positive outcomes, several limitations of this analysis must be acknowledged. First, the reliance on self-reported data for diet, exercise, and medication adherence introduces the possibility of response bias. Participants may have overestimated their adherence levels due to social desirability or recall inaccuracies, which could skew the results.

Second, the intervention's short-term nature limits our understanding of its long-term effectiveness. While significant improvements were observed immediately following the intervention, it is unclear whether these changes will be sustained over time. A follow-up study

with a longer duration would be needed to assess the lasting impact of the intervention on participants' health behaviors.

Third, while the analysis identified significant demographic factors influencing adherence, the generalizability of these findings may be limited. The sample may not fully represent broader populations, particularly those with different socioeconomic, cultural, or geographic backgrounds. For instance, factors like access to healthcare, regional dietary norms, or exercise opportunities could vary widely in other contexts, making it difficult to apply these results universally.

Additionally, while family size was identified as a significant factor influencing adherence, the analysis did not delve into the specific dynamics within these families. Factors such as the quality of family relationships, support mechanisms, or the role of caregivers were not explored, which could provide deeper insights into how family structure influences health behaviors.

Finally, while education, occupation, and years of diabetes were shown to affect adherence, the analysis did not account for potential interactions between these variables. For example, the effect of education on adherence could vary depending on occupation or the number of years a person has lived with diabetes. Exploring these interactions could provide a more nuanced understanding of the factors driving adherence changes.

IMPLICATIONS

These results underscore the effectiveness of the intervention in promoting healthier behaviors. However, they also suggest that more personalized approaches may be needed to address the unique challenges faced by different demographic groups. For instance, interventions targeting exercise adherence could benefit from focusing on educational programs, while those aiming to improve medication adherence might prioritize practical support mechanisms, such as reminders or family involvement.

The significant impact of family size on adherence also suggests that involving family members in future interventions could further enhance outcomes. This may be particularly effective for individuals struggling with complex medication regimens or those needing encouragement to maintain exercise routines.

CONCLUSION

In conclusion, the intervention was highly effective in improving diet, exercise, and medication adherence, as well as overall health behavior. Exercise and medication adherence saw particularly strong improvements, influenced by demographic factors such as education, occupation, and family size. These findings suggest that future interventions should consider tailoring strategies to individual characteristics to maximize their effectiveness. By addressing specific needs related to occupation, education, and family structure, health professionals can further improve adherence rates and promote long-term health benefits in diverse populations.

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