Original Article

# Interdependence Web-based Type 2 Diabetes Mellitus education for family intervention: An evaluation phase study

**Tengku Mohd Mizwar[1*], Annamma Kunjukunju[1], Nurul Fariza[1], Aini Ahmad[2]**

## ABSTRACT

**OBJECTIVE: To evaluate the Interdependence web-based type 2 diabetes mellitus education program for patients and informal caregivers. Specifically, the study first aims to determine the relationships among ease of use, perceived usefulness, attitude toward usage, and satisfaction in the formative phase. Next, to study the pre-post-test effects on reaction, learning, behavior, and results in the summative phase.**
**METHODOLOGY: Quantitative methods were used at formative and summative stages in hospitals and health clinics. 30 families participated in the formative pilot from 19 July 2024 to 8 August 2024, while 93 families were purposively sampled from 22 October 2024 to 28 February 2025 for the summative stage, for a total of 172 days. Participants aged 20 to 60 years were included.**
**RESULTS: Pearson correlation analysis was used in the formative stage, and Wilcoxon Signed-rank and Mann-Whitney tests were used in the summative stage. At the formative stage, results showed $p < .05$ overall, with r-values of 0.31 for T2DM patients and r- value of 0.61 for caregivers for attitude toward usage and satisfaction. Weak dyadic relationships present opportunities for more focused study. In the summative stage, results showed $p < .05$, indicating significant differences and changes in scores after web-based education was implemented.**
**CONCLUSION: Web-based interdependence education has improved the delivery of diabetes self-management education, supporting a more harmonious and healthy family system. The concept of interdependence in type 2 diabetes care still needs to be emphasized, particularly in the attitudes of patients' and caregivers towards the clinical care provided by health professionals.**

**KEYWORDS: Formative, Caregivers, Interdependence, Summative, Web-Based Education**

## INTRODUCTION

The development of technology-based education, often given a new lease of life, presents a golden opportunity for researchers in the design and development process of prototypes. For users, the aim is to derive benefits from the prototypes built to facilitate management, address questions, and elicit more effective responses. For web-based health education, it is necessary to include the management and care of type 2 diabetes mellitus (T2DM), which is a complex process to implement, especially when managing chronic diseases that require long-term care. This is because the purpose of the prototype is not only to provide knowledge and understanding, but also to be designed and implemented. However, the prototype can provide a positive force and use that knowledge to motivate and translate it into action. This is known as Diabetes Self-Management Education (DSME), which leads to the development of strategies to avoid complications and conflicts, ultimately fostering responsibility and long-term coping mechanisms[1,2].

*[1]School of Nursing, KPJ Healthcare University, Faculty of Nursing, Nilai, Negeri Sembilan, Malaysia*
*[2]Faculty of Health Science, Nursing, and Education, MAHSA University, Bandar Saujana Putra, 42610, Selangor, Malaysia*
*Correspondence: tengkumizwar@gmail.com*
*doi: 10.22442/jlumhs.2026.01544*

The concept of interdependent web-based education for T2DM is one of the more comprehensive approaches compared to the dependent and independent approaches introduced in this study[3,4]. The concept of interdependence in this study involves a dyadic process between T2DM patients and caregivers in the same family in performing their daily DSME. The involvement of T2DM patients and caregivers in this study has been demonstrated through empirical studies, which consistently show that both positive and negative forces are contributed by family members, ultimately leading to more optimal health control [5,6]. However, existing studies have not adequately examined the formative and summative evaluation of interdependent web-based education for T2DM. Surprisingly, the elements that influence the intention to use mobile learning remain unexplained, particularly in the context of T2DM patients and caregivers. This is not in line with the 2025 prediction, as approximately 71% of individuals have access to mobile internet[7]. Additionally, 53.6% of individuals download activity and 38.06% use mobile health applications only for frequent use in Malaysia[8].

This study aims to address existing research gaps by implementing both formative and summative evaluation analyses. The Technology Acceptance Model (TAM) and Kirkpatrick Evaluation Model (KEM) were adapted for use with T2DM patients and their caregivers. The formative evaluation, conducted as a pilot study, will utilize TAM constructs: Perceived Ease

*2026 © This is an Open Access article distributed under the terms of the Creative Commons Attribution – Non-Commercial 4.0 International License, which permits unrestricted use, distribution & reproduction in any medium provided that the original work is cited properly.*

of Use (PEU), Perceived Usefulness (PU), Attitude Toward Usage (ATU), Behavioral Intention to Use (BIU), and Satisfaction of Use (SU). The summative evaluation applied KEM elements, specifically reaction, learning, behavior, and result, to assess the overall impact of interdependent web-based education. Employing both models is expected to clarify the effectiveness of the interdependent approach in T2DM management and to strengthen the credibility and accuracy of the findings. The study objectives are: (i) to determine the relationship between T2DM patients and caregivers using Technology Acceptance Model constructs for formative evaluation, and (ii) to study a summative evaluation using Kirkpatrick Evaluation Model constructs among T2DM patients and caregivers. This evaluation study has not yet been conducted among T2DM patients, and caregivers have received limited literature on the concept of interdependent care.

*Conceptual Framework*

TAM[9] and KEM[10] are comprehensive theories that examine the acceptance and effectiveness of an assessment before and after an intervention. The combination of theories in this study has provided an interdependent process in which TAM explains the factors that influence the acceptance and use of technology. Meanwhile, KEM evaluates the effectiveness of training and development programs through four levels (reaction, learning, behaviour, and results). For this study, two theories have been integrated to evaluate the relationship and effectiveness of web-based education. The integration of this theory aims to evaluate acceptance in terms of reliability and usability using TAM in a formative manner. After that, implementation is carried out in the field study. At the summative level, effectiveness is assessed through KEM.

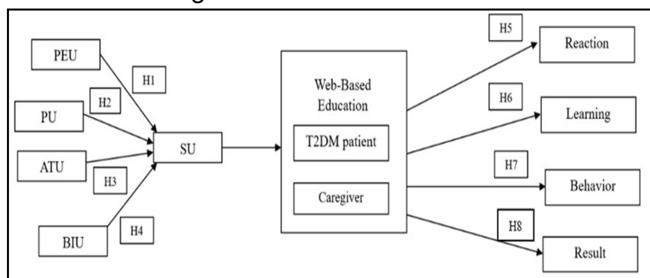


**Figure 1** briefly explains the relationship between conceptual study and hypothesis mapping.

Notes: Perceived Ease of Use (PEU), Perceived Usefulness (PU), Attitude Toward Usage (ATU), Behavioral Intention to Use (BIU), and Satisfaction of Use (SU).

## METHODOLOGY

*Study Design*

This study was part of a mixed-methods research study. Quantitative methods were used to examine the relationship and statistical effects of each study variable on web-based education. The formative assessment began with a pilot study conducted from19 July 2024 to 8 August 2024. Following this, the summative assessment employed a quasi-experimental one-group pre-posttest design, conducted from 22 October 2024 to 28 February 2025. The researchers used a cross-setting design: formative assessment was conducted in a tertiary healthcare setting, while summative assessment was conducted in primary care. Reflections from the tertiary stage were shared in the later stages. In direct terms, this method provides an advantage in spreading awareness about the dangers of T2DM complications. Therefore, the hypothesis of this study:

H1. There is no significant relationship between PEU and SU.

H2. There is no significant relationship between PU and SU.

H3. There is no significant relationship between ATU and SU.

H4. There is no significant relationship between BIU and SU.

H5. It has no significant effect on the level of reaction at the pre-test and post-test interventions.

H6. It has no significant effect on the level of learning at pre-test and post-test.

H7. It has no significant effects on the level of behaviour at pre-test and post-test.

H8. It has no significant effect on the level results at pre-test and post-test.

*Population and Sample*

Overall, this study involved patients with T2DM and their caregivers from the same family. Inclusion criteria for participants aged between 20 and 60 years old, had been involved in treating and managing T2DM for more than one year as caregivers, and had a biological relationship or partner.

In the formative assessment, a total of 30 families participated as part of a pilot study[11]. The selection of these 30 families consisted of T2DM patients who had received treatment in the hospital and were subsequently discharged. This is because the researchers wanted to observe how this web-based practice was implemented at home over 14 days.

Meanwhile, for the summative assessment, a total of 93 families were involved. This is based on the G*Power calculation[12], which was used to determine the minimum sample size required with an effect size parameter f = 0.15213, an error type of 0.05, and a power of 0.8. The minimum sample size required for the summative assessment is 72 families. The researchers also accounted for a 30% dropout rate, resulting of 94 families as participants.

However, the researchers successfully recruited 103 families at the initial stage; only 93 could be retained for the assessment stage of the study, which could be analyzed. The 93 families consisted of T2DM patients registered at four main health clinics in the Besut and Setiu districts of Terengganu, Malaysia. The difference for the summative stage is that it took 90 days.

The following (**Table I**) summarizes the number of families involved in the formative and summative phases.

**Table I: Sampling for the formative and summative phase**

| Phase | ELIGIBLE→ | ENROLLED→ | RETAINED and ANALYSIS |
|---|---|---|---|
| Formative | 30 families | 30 families | 30 families |
| Summative | 94 families | 103 families | 93 families |

*Instrument*

The researcher adapted the questionnaire from the elements in TAM, namely PEU, PU, ATU, BIU, and SU from Alharbi[14] and Bob et al.[15]. Meanwhile, the elements in KEM, including reaction, learning, behavior, and result, were adapted from Fazal et al.[16] and Heydari et al.[17]. All study instruments used a 5-point Likert scale. All items were validated through pilot testing during the formative phase involving 30 families (T2DM patients and caregivers). The pilot test results showed a Cronbach's alpha reading of 0.92. T2DM patients and caregivers answered the same questions, in which the word 'we' or 'us' was used for each question. Consecutive translation was done from English to Malay and then back to English, as most participants practiced communication in Malay. All questionnaires were administered online via Google Forms for logistical and convenience purposes and to ensure timely completion in this study.

*Data Analysis*

The data were analyzed using descriptive statistics, Pearson's correlation, and the Wilcoxon signed-rank test (within–group) and the Mann-Whitney test (Between-Group) using SPSS Software Version 25.

*Ethical Statement*

Ethical approval was obtained from the KPJ Research Ethics Committee, and written informed consent was acquired from all participants. The reference number is ERC letter No. KPJ Healthcare University, Malaysia. KPJUC/RMC/SON/EC/2023/468 and the Medical Research and Ethics Committee, Ministry of Health, Malaysia, letter No. NMRR ID-23-03333-CDI (IIR).

## RESULTS

*Characteristics of Participants*

Characteristics of participants (T2DM patients and caregivers) from the two formative and summative stages are briefly described in Table 1. The data suggest that individuals aged 36 to 50 years are more likely to play active roles in T2DM care, particularly when family involvement is present. Notably, over 50% have a strong family history of T2DM and HbA1c readings above 6.5%. For the formative and summative stages, participation rates are 70% and 83.8%, respectively.

Values are presented as the number of participants or the number (%).

At the formative stage, a total of 30 families have voluntarily participated and signed a consent form. For 14 days, this participant needs to see the acceptability and feasibility of the Web-based education. For this entire study, IBM SPSS Statistics version. 21.0 and the significance level (α) for statistical verification was set at $p<.05$.

To determine the appropriate analysis test for the study's objective, the Shapiro-Wilk normality test is more accurate because the sample size is less than

**Table II: Frequency distribution of participants based on the characteristics of the formative and summative phases**

| Characteristic | Formative | Summative |
|---|---|---|
| No. of participants | 30 families | 93 families |
| **A. T2DM patient** | | |
| Age | | |
| 25-30 | 0 | 0 |
| 31-35 | 3/10 | 4/4.3 |
| 36-40 | 12/40 | 18/19.3 |
| 41-45 | 8/26 | 5/5.3 |
| 46-50 | 7/23 | 8/8.6 |
| 51-55 | 0 | 5/5.3 |
| 56-60 | 0 | 53/56 |
| Single | 5/16.6 | 5/5.3 |
| Married | 18/60 | 81/87 |
| Divorced/Widowed | 7/23.3 | 7/7.5 |
| Family History | | |
| Yes | 28/93.3 | 72/77 |
| No | 2/6.6 | 21/22.5 |
| Duration of T2DM (years) | | |
| 1-5 | 8/26.6 | 15/16.1 |
| 6-10 | 14/46.6 | 30/32.2 |
| 11 and above | 8/26.6 | 15/16.1 |
| HbA1c | | |
| < 5.7% (Normal) | 3/10 | 8/8.6 |
| 5.8% - 6.5% (Pre Diabetes) | 6/20 | 7/7.5 |
| > 6.5 % (Diabetes) | 21/70 | 78/83.8 |
| **B. Caregiver** | | |
| Age | | |
| 25-30 | 5/16.6 | 20/21.5 |
| 31-35 | 6/20 | 12/12.9 |
| 36-40 | 2/6.6 | 3/3.2 |
| 41-45 | 3/10 | 14/15 |
| 46-50 | 8/26.6 | 19/20.4 |
| 50-55 | 1/3.3 | 7/7.5 |
| 56-60 | 5/16.6 | 11/11.8 |
| Family relationship | | |
| Spouse | 14/46.6 | 52/55.9 |
| Son and daughter | 7/23.3 | 23/24.7 |
| Sibling | 2/6.6 | 0/0 |
| Father /mother | 6/20 | 17/18.2 |
| Grandfather /mother | 1/3.3 | 1/1 |
| Received diabetic education before | | |
| YES | 18/60 | 82/88.1 |
| NO | 12/40 | 11/11.8 |
| Having enough time to be patient | | |
| YES | 19/63.3 | 72/77.4 |
| NO | 11/36.6 | 21/22.5 |

50 participants. The results of the analysis show $p > .05$, indicating that the parameter analysis of person correlation is more accurate. The following table (**Table III-IV**) presents the results of the analysis conducted on T2DM patients and their caregivers.

**Table III: Summary of Hypotheses Testing Results for T2DM patient**

| Hypotheses | Relationship *r* | Sig. (2-tailed) *p* | Interpretation |
|---|---|---|---|
| H1 PEU and SU | .55 | .00 | Moderate / Significant |
| H2 PU and SU | .57 | .01 | Moderate / Significant |
| H3 ATU and SU | .31 | .00 | Weak / Significant |
| H4 BIU and SU | .50 | .00 | Moderate / Significant |

**Table IV: Summary of Hypotheses Testing Results for the caregiver**

| Hypotheses | Relationship *r* | Sig. (2-tailed) *p* | Interpretation |
|---|---|---|---|
| H1 PEU and SU | .75 | .01 | Strong / Significant |
| H2 PU and SU | .64 | .01 | Moderate / Significant |
| H3 ATU and SU | .61 | .01 | Moderate / Significant |
| H4 BIU and SU | .60 | .00 | Moderate / Significant |

At the summative stage, a total of 93 families successfully participated in this study for 90 days and provided an assessment. The data obtained went through a data purification process involving (1) data analysis, (2) definition of transformation workflow and mapping rule, (3) verification, (4) transformation and (5) backflow of cleaned data, ensuring that the data met the most important criteria, namely that the questionnaire had to be answered by T2DM patients and caregivers[18]. This is crucial for obtaining accurate and high-quality study results. After that, to determine the appropriate analysis test for the study objective, the Kolmogorov-Smirnov normality test was performed, and the result showed $p < .05$. This indicates that the data is not normally distributed and suggests that non-parametric analysis is more appropriate. The Wilcoxon Signed-rank test (within-group) was conducted to analyze changes in scores in the T2DM patient and caregiver groups from pre-test to post-test.

Meanwhile, followed by the Mann-Whitney test (Between-group) to compare the difference in variance between the T2DM patient and caregiver groups. The choice of this analysis method is aimed at obtaining more accurate statistical analysis results[19,20]. The following is a summary of the analysis findings for the summative stage, as described in **Table V**.

**Table V: Summary of Hypotheses of Wilcoxon signed-rank test (within–group) and Mann-Whitney test (Between-Group) for the pre-test and post-test**

| | Wilcoxon signed-rank test (within–group) | | | | | Mann-Whitney test (Between-Group) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hypotheses | Group | Mean Rank | Sum of Ranks | z | p | Pre/Post test | Mean Rank | Sum of Ranks | u (pre/post) | p (pre/post) | Interpretation |
| H5 | T2DM Patient | 32.5 | 456 | | .00 | Pre | 97.5 | 9069 | 3951/3562.5 | .00/.00 | p < .05 |
| | | 39.2 | 2394 | 5.1 | | Post | 101.6 | 9457.5 | | | |
| | Caregiver | 21.5 | 322.5 | | .00 | Pre | 89.4 | 8322 | | | |
| | | 39.8 | 2233.5 | 5.5 | | Post | 85.3 | 7933.5 | | | |
| H6 | T2DM Patient | 7.2 | 14.5 | | .00 | Pre | 90.3 | 8397.5 | 4026.5/3844 | .00/.00 | p < .05 |
| | | 47.8 | 47.8 | 8.3 | | Post | 88.33 | 8215 | | | |
| | Caregiver | .00 | .00 | | .00 | Pre | 96.7 | 8993.50 | | | |
| | | 45.5 | 4095.0 | 8.2 | | Post | 98.6 | 9176 | | | |
| H7 | T2DM Patient | .00 | 14.5 | | .00 | Pre | 96.4 | 8965 | 4055/4215.5 | 0.00/.00 | p < .05 |
| | | 7.5 | 4356.5 | 3.3 | | Post | 94.6 | 8804.5 | | | |
| | Caregiver | .00 | .00 | | .00 | Pre | 90.6 | 8426 | | | |
| | | 5.50 | 55.0 | 2.8 | | Post | 92.3 | 8586.5 | | | |
| H8 | T2DM Patient | .00 | .00 | | .00 | Pre | 91.2 | 8488.5 | 4117.5/3863 | 0.02/0.01 | p < .05 |
| | | 47.0 | 4371.0 | 8.3 | | Post | 95.7 | 9157 | | | |
| | Caregiver | .00 | .00 | | .00 | Pre | 98.4 | 8902.5 | | | |
| | | 47.0 | 4371.0 | 8.3 | | Post | 88.5 | 8234 | | | |

## DISCUSSION

The study's results have statistically proven a positive relationship and significant impact between T2DM patients and their caregivers. This was due to the effectiveness of interdependent Web-based

education, which was successfully delivered through formative and summative evaluation analysis. This evaluation has explored the viability and feasibility of interdependent Web-based education, as no such education is currently being conducted.

Based on the results of the correlation test analysis, a positive relationship was found between T2DM patients and their caregivers. Where the r-value for each variable is moderate, and p < .05, the surprising result of the H3 ATU and SU analysis between T2DM patients and caregivers indicates a significant difference in the r-value of the relationship. The r-value is .31 (weak) for T2DM patients and .61 (moderate) for caregivers. Previous studies have highlighted a gap, showing that the incompetence of T2DM patients requires support in implementing more effective and safe daily management modifications. In the studies by Ingul et al.[21] and Peter et al.[22], the importance of attitude in safe modifications is emphasized. Addressing this important gap, interdependent Web-Based education is one of the strategies for safer T2DM daily management modifications in this study. The formative assessment has given researchers an advantage in identifying what needs to be emphasized, enabling subsequent assessments to be improved. This indicates that the TAM Model is well-suited for testing, particularly when combined with web-based education, to ensure the training program has a positive impact on productivity and performance among T2DM patients and caregivers.

Meanwhile, for the summative level, Wilcoxon signed-rank test (within–group) and Mann-Whitney test (Between-Group) for the pre-test and post-test were performed and found that the analysis results were significant at p <.05. Through the Wilcoxon signed-rank test (within–group) it showed a significant difference and the Mann-Whitney test (Between-Group) also showed a significant result on the change in score. This indicates that the intervention had a significant impact on reaction, learning, behaviour, and outcome scores, with a notable increase following the intervention. This situation can be demonstrated by the differences in action practices between T2DM patients and caregivers after the intervention was implemented. This has shown a significant increase compared to before. One possible explanation for this result is that moderator support[23], behaviour change interventions[24], and factor empowerment[21] represent gaps previously identified as suggesting a strong association that still needs improvement. This study has improved by identifying issues that can be addressed in the intervention, and the intervention has been successfully implemented. This also demonstrates that the KEM Model is highly suitable for summative assessment that covers the entire study.

Overall, this study has provided a preliminary assessment of the formative and summative effectiveness of the strength of the influence of using interdependent Web-based education in T2DM interventions among patients and caregivers. Caregivers have played a crucial role in helping patients manage T2DM more effectively through mutually agreed-upon modifications. This emphasis is crucial for the community's future health. This method also helps caregivers become more experienced with their families. Therefore, it is appropriate to expand this interdependent method on a larger scale by involving interested sectors more committed to community health, rather than focusing solely on business factors.

## LIMITATIONS

This study reveals limitations in the control group of the summative phase, which are more pronounced compared to the formative phase. This is because the researchers identified patients and caregivers who, after leaving treatment, still require ongoing health guidance, whereas those who have not yet experienced health complications do not. In addition, the relationship between patients and caregivers still needs to be emphasized, particularly in terms of attitude and dyadic responsibility. This can be used as a suggestion for future studies.

## CONCLUSION

In addition, the formative and summative stages are an assessment process that is very helpful in designing and implementing the program more effectively to deliver diabetes self-management education, thereby supporting a more harmonious and healthy family system.

The concept of interdependence in T2DM care should be further developed and applied in clinical practice. Therefore, it is appropriate that this web-based education method be supported by stakeholders and widely adopted across the government and private sectors, making it easier to share clinical data. Additionally, this step facilitates the development of web-based education and evidence-based practice in health education. This also contributes to a positive impact on the production of more informative health education resources. The framework in this study has great potential to contribute to the general question of what assessment framework can be used in this process. It should be analyzed more precisely to explore more effective implementation through formative assessment, followed by summative assessment.

Based on the findings of this study, attitudes among patients and caregivers regarding the management of T2DM still need to be strengthened, along with information on the complications of this disease. Health interventions are crucial because they enable multidisciplinary involvement, a strategy for creating healthy families and communities.

### Acknowledgment

KPJ Healthcare University supported the research reported in this publication: KPJUC/RMC/SON/

EC/2023/468 and the Medical Research and Ethics Committee, Ministry of Health, Malaysia, letter No. NMRR ID-23-03333-CDI (IIR).

**Ethical permission:** Ethical approval was obtained from the KPJ Research Ethics Committee, and written informed consent was acquired from all participants. The reference number is ERC letter No. KPJ Healthcare University, Malaysia. KPJUC/RMC/SON/ EC/2023/468 and the Medical Research and Ethics Committee, Ministry of Health, Malaysia, letter No. NMRR ID-23-03333-CDI (IIR).

**Conflict of interest**: Authors declare no competing interests in the study.

**Financial Disclosure / Grant Approval:** This study had no external funding.

**Data Sharing Statement:** The corresponding author can provide the data proving the findings of this study on request. Privacy or ethical restrictions bound us from sharing the data publicly.

## AUTHOR CONTRIBUTION

Each author contributed to this manuscript's design, data collection, analysis, and writing.

## REFERENCES

1. Kumah E, Afriyie EK, Abuosi AA, Ankomah SE, Fusheini A, Otchere G. Influence of the Model of Care on the Outcomes of Diabetes Self-Management Education Program: A Scoping Review. J Diabet Res. 2021; 2021(1): 2969243. https://doi.org/10.1155/2021/2969243.
2. Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM. Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. Diabetes Care. 2002 Jul 1; 25 (7): 1159-71. https://doi.org/10.2337/diacare.25.7.1159.
3. Ajibade B. Assessing the patient's needs and planning effective care. Br J Nursing. 2021 Nov 11; 30(20): 1166-71. https://doi.org/10.12968/bjon.2021.30.20.1166.
4. Largent EA, Clapp J, Blumenthal-Barby JS, Grady C, McGuire AL, Karlawish J et al. Deciding with others: interdependent Decision-Making. Hastings Center Report. 2022 Nov; 52(6): 23-32. doi: 10.1002/hast.1444.
5. Martire LM, Helgeson VS. Close relationships and the management of chronic illness: Assoc Interven. Am Psychol. 2017 Sep; 72(6): 601. doi: 10.1037/amp0000066.
6. Roddy MK, Nelson LA, Spieker AJ, Greevy Jr RA, Mayberry LS. Family involvement and diabetes distress across dyads for adults with type 2 diabetes. Patient Educ Counsel. 2023 Jul 1; 112: 107719. https:// doi.org/ 10.1016/j.pec.2023.107 719.
7. Noor AM, Mahmood NH, Zakaria WN. The impact of mobile learning application through intention to use on employees skill usage. Int J Acad Res Business Soc Sci. 2021; 11(11): 342-61. http:// dx.doi.org/10.6007/IJARBSS/v11-i11/11216.
8. Kc B, Alrasheedy AA, Hing Goh B, Blebil A, Bangash NS, Mohamed Ibrahim MI et al. The types and pattern of use of mobile health applications among the general population: a cross-sectional study from Selangor, Malaysia. Patient Pref Adheren. 2021 Aug 12: 1755-62. doi: 10.2147/PPA.S325851.
9. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly. 1989 Sep 1: 319-40. https://doi.org/10.2307/249008
10. Kirkpatrick D, Kirkpatrick J. Evaluating training programs: The four levels. Berrett-Koehler Publishers; 2006.
11. Sallam M, Salim NA, Barakat M, Al-Mahzoum K, Al-Tammemi AA, Malaeb D et al. Assessing health students' attitudes and usage of ChatGPT in Jordan: validation study. JMIR Med Educ. 2023 Sep 5; 9(1): e48254. doi: 10.2196/48254.
12. Kang H. Sample size determination and power analysis using the G* Power software. Journal of educational evaluation for health professions. 2021 Jul 30; 18. https://doi.org/10.3352/jeehp.2021.18.17.
13. Ramadas A, Chan CK, Oldenburg B, Hussein Z, Quek KF. Randomized-controlled trial of a web-based dietary intervention for patients with type 2 diabetes: changes in health cognitions and glycemic control. BMC Public Health. 2018 Jun 8; 18(1): 716. https://doi.org/10.1186/s12889-018-5640-1.
14. Alharbi S. Using the technology acceptance model in understanding academics' behavioural intention to use learning management systems. Int J Adv Comp Sci Applications. 2014 Jan 1. doi: 10.14569/IJACSA.2014.050120.
15. Bob L, Lehr D, Reis D, Vis C, Riper H, Berking M et al. Reliability and validity of assessing user satisfaction with web-based health interventions. J Med Internet Res. 2016 Aug 31; 18(8): e234. doi: 10.2196/jmir.5952.
16. Fazal A, Nasir F, Mujtaba A, Tanvir S, Fatima N, Nabeel S. Evaluation of Level 2 of Kirkpatrick's Model "Learning" Among the Masters of Health Professional Education Candidates of Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad. Ann PIMS SZABMU. 2023; 19(4): 457-61. doi. 10.48036/apims.v19i4.901.
17. Heydari MR, Taghva F, Amini M, Delavari S. Using Kirkpatrick's model to measure the effect of a new teaching and learning methods workshop for health care staff. BMC Res Notes. 2019 Jul 10; 12(1): 388. https://doi.org/10.1186/s13104-019-4421-y.
18. Ridzuan F, Zainon WM. A review on data cleansing methods for big data. Procedia Comp Sci. 2019 Jan 1; 161: 731-8. https://doi.org/10.1016/j.procs.2019.11.177.

19. Nahm FS. Nonparametric statistical tests for the continuous data: the basic concept and the practical use. Korean J Anesthesiol. 2016 Feb 1; 69(1): 8-14. https://doi.org/10.4097/kjae.2016.69.1.8.
20. Park Y. Optimal two-stage group sequential designs based on Mann-Whitney-Wilcoxon test. PloS One. 2025 Feb 20; 20(2): e0318211. https://doi.org/10.1371/journal.pone.0318211.
21. Ingul CB, Hollekim-Strand SM, Sandbakk MM, Grønseth TI, Rånes TI, Dyrendahl LT et al. Empowerment in Type 2 diabetes: A patient-centred approach for lifestyle change. Diabet Res Clin Pract. 2025 Feb 1; 220: 111998. https://doi.org/10.1016/j.diabres.2025.111998.
22. Peter PI, Steinberg WJ, van Rooyen C, Botes J. Type 2 diabetes mellitus patients' knowledge, attitude and practice of lifestyle modifications. Health SA Gesondheid. 2022 Oct 21; 27: 1921. doi: 10.4102/hsag.v27i0.1921.
23. Gupta L, Khandelwal D, Lal PR, Gupta Y, Kalra S, Dutta D. Factors determining the success of therapeutic lifestyle interventions in diabetes–role of partner and family support. Eur Endocrinol. 2019 Apr 12; 15(1): 18. doi: 10.17925/EE.2019.15.1.18.
24. Batalha AP, Ponciano IC, Chaves G, Felício DC, Britto RR, da Silva LP. Behavior change interventions in patients with type 2 diabetes: a systematic review of the effects on self-management and A1c. J Diabet Metabol Disord. 2021 Dec; 20(2): 1815-36. doi: 10.1007/s40200-021-00846-8.