

Nurse-Led Interventions for Diabetes Education: A Literature Review

Rif'atunnailah Mat Isa^{1,2}, Chong Mei Chan^{1*}, Lee Wan Ling¹, Tajunisah Begam Mohamed Iqbal³, Thandar Soe @ Sumaiyah Jamaludin², & Mohd Iman Saiful Suhardi⁴

¹Department of Nursing Science, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia.

²Department of Medical Surgical Nursing, Kulliyah of Nursing, International Islamic University Malaysia, Pahang, Malaysia.

³Department of Ophthalmology, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia.

⁴Department of Emergency Medicine, Kulliyah of Medicine, International Islamic University Malaysia, Pahang, Malaysia.

ABSTRACT

Background: The incidence of blindness is escalating to 439 billion patients by 2030. This study aims to review studies of health education related to diabetic retinopathy that have been implemented to inform nurse-led intervention to patients with type 2 diabetes mellitus (T2DM).

Methods: A comprehensive search of the database was performed from October 2021 until March 2022. The databases include CINAHL, EMERALD insight, SAGE, Scopus, Web of Science and Science Direct. The Medical Subject Headings database was used to derive the following keywords: 'T2DM' OR 'Diabetes Mellitus type 2', 'Diabetic Retinopathy' OR 'Diabetic eye' OR 'retinopathies') AND 'education', 'self-care', 'visual quality of life', 'mHealth'. All studies in English pertaining to the type of teaching and the effects of education on the visual quality of life among T2DM patients were included. Type 1 diabetes mellitus studies were excluded. Analysis of the themes arising from the results was performed.

Results: The search yielded 868 articles, of which 27 met our criteria. The studies ranged from cross-sectional, controlled studies, quasi-experimental studies, and qualitative studies. Overall, there was three types of health education interventions: personalised, group-based, and technology-based.

Conclusion: There is paucity in nurse-led health education about diabetic retinopathy in East Asia. It appears that conventional health education helpful, but the mobile application might be an option to provide better health education, with an emphasis on diabetic retinopathy components.

Keywords: Nurse led interventions; Diabetes mellitus; Diabetes retinopathy

*Corresponding author

Dr. Chong Mei Chan,
Department of Nursing Science,
Faculty of Medicine,
University of Malaya,
50603 Kuala Lumpur, Malaysia.
Email: mcchong@um.edu.my

Article History:

Submitted: 14 June 2023
Revised: 27 July 2023
Accepted: 18 August 2023
Published: 30 November 2023

DOI: 10.31436/ijcs.v6i3.307
ISSN: 2600-898X

INTRODUCTION

The Global Burden of Disease (2017) stated that type 2 diabetes mellitus (DM) has emerged as one of the leading causes of disability around the world, ranking it fourth among the diseases that have caused the loss of years of healthy life due to disability (YLD). This increased burden was observed across all countries, irrespective of their level of development. Age-standardised YLDs increased for both females and males across all socio-demographic index quintiles between 1990 and 2017 (1).

439 million patients with diabetes mellitus will require specialized and intensive care by 2030. In addition, 28 eyes per second per year will require evaluation for diabetic retinopathy (DR), treatment, and careful follow-up (2). A higher prevalence of diabetic retinopathy was found in people of South Asian, African, and Latin American descent, compared to those in the West (3). It has been estimated that globally, approximately 93 million individuals may have some form of diabetic retinopathy, with 28 million suffering from the sight-threatening end-point of the disease.

Diabetic retinopathy (DR) is the most common microvascular complication. There are many risk factors for diabetic retinopathy including a longer duration of DM, pre-existing comorbidities such as hypertension, chronic kidney disease, cardiac vascular accident, cardiac vascular disease, hyperlipidaemia, anaemia, poor control of DM, obesity or inactive lifestyle, smoking and pregnancy in diabetics (6). With a general understanding that retinal disease is one of the major global causes of severe vision loss and blindness, retinal disease is given intense and broad attention. An estimated 285 million individuals worldwide have diabetes, and one third of them have Diabetic Retinopathy that might endanger their vision (4). The East and Southeast Asian population is predicted to be more susceptible to vision loss due to DR caused by comorbidities compared to Western nations (5).

The National Eye Survey in Malaysia (NESII) (2014) found that the most typical causes of blindness were untreated cataracts, diabetic retinopathy, other posterior segment diseases and glaucoma. Overall, 86.3% of the causes of blindness were avoidable and 58.6% of the

causes of blindness were treatable. Avoidable causes of moderate and severe visual impairment combined represented 96.3% of the study population and treatable causes of low vision, 82.4% (7).

Although health care personnel provided health education to patients with T2DM, the number of vision loss cases due to diabetic retinopathy continued to rise at an astounding level. As a result, it indicated that providing health education and empowerment through knowledge to patients with type 2 diabetes mellitus, as delivered by nurses, is important. Thus, in this review, we asked: What is the current state of health education in diabetic retinopathy? What factors influence the development of health education, and how can self-care management contribute to health education? The project's goal is to examine studies of diabetic retinopathy health education materials that have been used to inform a nurse-led intervention for patients with type 2 diabetes mellitus (T2DM). The methods of this study will be discussed further in the following section.

METHODS

Search Strategy

The review process started with a search for the relevant literature in electronic databases, which are subscribed to by the University of Malaya databases in its digital library services. The significant databases used for this review were CINAHL, EMERALD insight, SAGE, Scopus, Web of Science and Science Direct. The search was conducted by the author with assistance from a librarian using the following search terms: Type 2 diabetes mellitus (T2DM), diabetic retinopathy, patient education, self-care, visual quality of life and mHealth.

The search terms were combined with the Boolean operators 'AND' and 'OR' to narrow the search. The search strategies used were TITLE-ABS-KEY (['T2DM' OR 'Diabetes Mellitus type 2'] AND 'Diabetic Retinopathy' OR 'Diabetic eye' OR 'retinopathies') AND 'education' OR 'health education' OR 'family education') AND ('self-care') AND ('visual quality of life') AND ('mHealth'). Titles of items searched and screened from the database were viewed in the full-text articles. Relevant full-

text articles found were downloaded, saved, and stored to facilitate the retrieval process. We selected studies based on the PICO framework. This helps to structure clinical questions because it captures each key element required for a focused question (7). The PICO framework improves the search process by highlighting the main ideas for an efficient search strategy. **Table 1** describes the detail for the search area in this study.

Table 1: PICO framework strategy

Population	Type 2 diabetes mellitus and related healthcare professionals.
Intervention	Health education, webpage application, mobile application.
Comparison	Control and intervention group.
Outcome	Knowledge or self-care or visual-related quality of life.

Inclusion and exclusion criteria

The main criteria for articles included for review in this study were those in the English language and those that focused on health education given to patients. Additional key terms were used for the study selection focusing on the type of teaching and the effects of education on the visual quality of life among T2DM patients. The citations from the electronic database search were uploaded into the reference manager software EndNote, which facilitated the easy removal of duplicate articles. The remaining studies were reviewed for the inclusion criteria and screened for relevance. Two authors independently screened all titles and abstracts identified from the search to determine which criteria were met.

The inclusion criteria for the scoping review of the eye care education programme were the articles with full text that described the knowledge, self-care, and visual-related quality of life. The articles were written in English and published from 2012 to 2022. Patients of the study had to be adults aged 18-64 years. These criteria were chosen to ensure that the selected articles could provide in-depth understanding of the issue. Meanwhile, the exclusion criteria were the articles that referenced type 1 diabetes

mellitus and other diabetes complications. The inclusion and exclusion criteria used for the selection of the articles are summarised in **Table 2**.

Table 2: Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Literature type	Indexed journals, research articles.	Non-index journals, chapter in a book, conference proceeding.
Language	English.	Non-English.
Timeline	From 2012 to 2022.	< 2011.
Study design	Quantitative study, qualitative study, mixed methods.	Lab-based studies.
Keyword	Diabetes mellitus, diabetic retinopathy, patient education, self-care, visual quality of life, Type 2 diabetes mellitus.	Type 1 diabetes mellitus.

Data extraction

Data on objectives, study design, settings, participants, interventions and their theories, measured outcomes and main findings were extracted from selected studies and recorded in a data extraction table.

Data analysis

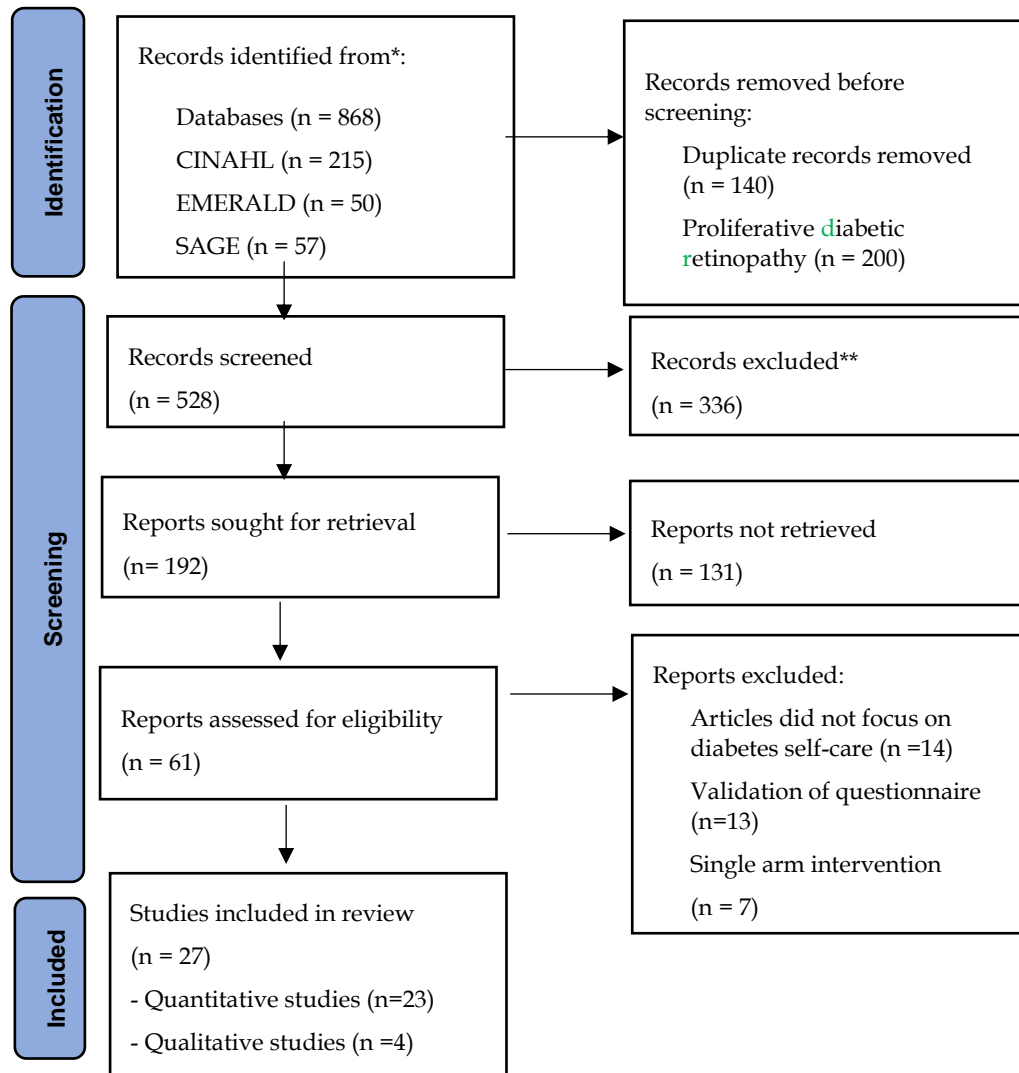
The Joanne Briggs Institute model is referenced widely in the literature and has been applied in evidence-based practices within complex healthcare settings. The relevant articles were appraised using a respective checklist. Thus, a checklist for each type of study from the Joanne Briggs Institute was applied accordingly in this study: for quasi-experimental studies for reports of meta-analyses of randomized controlled trials which were appraised using the QUOROM statement checklist, a qualitative checklist, and cross-sectional studies which were appraised using STROBE Statement checklist (9 & 10). All these articles were appraised accordingly and yielded in the following result section.

RESULTS

The systematic electronic database search yielded 868 potential articles, from which 27 articles were selected (Figure 2). The most common settings were at a diabetes clinic, an ophthalmology centre, or a general practice clinic. The nature of these studies is described

in detail in the summary of interventions section (Table 3.). The results were divided into three parts; type of health education provided, the basis of health education establishment, and finally the study design included for review.

Figure 2: PRISMA 2020 flow diagram for systematic search for reports to include in this study.



Types of Health Education Interventions

The types of interventions were classified into three main categories: personalized, group-based and technology-based.

Personalized interventions

Personalized intervention studies included in this review (11-13). For a personalized approach, a printed education message (PEM) related to diabetic retinopathy, prediction of A haemoglobin A1C (HbA1c) and risk of diabetic retinopathy were used. The ability of a PEM to prevent diabetes-related vision loss for the control group was conducted among 5,048 general practitioners with 179,833 patients with diabetes in Ontario, Canada, using a pragmatic cluster Randomized controlled trials (RCT) (13).

On a different note, Aiello et al.¹ determined that a point-of-care measurement of HbA1c related to a personalized diabetes complication risk assessment performed during a retinal ophthalmology visit improves glycaemic control. This study used the Problem Areas in Diabetes (PAID) questionnaire and the Self-Care Inventory (SCI-2) questionnaire. The addition of personalized education and risk assessment during ophthalmology visits did not result in any HbA1c improvement compared to usual care over a one-year period. Elsewhere, a study implemented self-care activities and functional health literacy in their study (11).

The intervention group received an educational intervention which occurred over three meetings, once a week, lasting 60 minutes, on average. The first meeting focused on expanding patients' knowledge of the disease, recognising its signs and symptoms, highlighting the importance of blood-glucose control, defining normal and altered values, and the prevention of acute and chronic complications. The second meeting was dedicated to a roundtable discussion which was conducted using educational posters that focused on important aspects of diabetes self-care practices. This approach was seen as an effective measure for adopting good habits. The last meeting focused on encouraging foot care, exploiting the practical experience of the participants and using posters with images.

Overall, difference aspect of care being delivered via personalised approach.

Group-based interventions

Peer-led self-management was discussed by previous studies (14 & 15). In a group-based intervention carried out in the Netherlands, an evaluation was made of a group-based self-management support programme for people diagnosed with type 2 diabetes (1–3 years post-diagnosis), based on its immediate effect as well as its effectiveness after six months (15). It appears that group-based self-management support does indeed result in favourable short-term behavioural changes and more persistent alterations in (perceived) empowerment in people living in the first years of type 2 diabetes.

A study applied a peer and community health workers' support programme, run for one year, for the therapeutic health education of 120 Africans (14). At the end of the programme, it resulted in an improved HbA1c level (p-value: 0.006), a decrease in body weight (0.0005) and a reduction in waist circumference (p-value: 0.0003). In addition, the involvement of peer support gave a positive contribution towards the attendance of the educational session, despite the low number of resources. Thus, targeted based outcome such as HbA1c is more efficient for group-based intervention.

Technology-based interventions

There are a few types of technology-based intervention. These include web-based health education, mobile application, WeChat, short message service (SMS) and WhatsApp. For mobile applications, SightBook™ is a free mobile app that tests visual acuity, Amsler grid and visual acuity at home in patients with diabetic retinopathy (5, 6, 8, & 16- 19). The Diabetes Carer App is divided into three parts: the diabetic component; self-management; and patient community (combined with or without self-monitoring of blood glucose [SMBG] on glycaemic control in patients with diabetes (18). Tele-health includes two technological interventions: baseline retinal imaging as a real-time patient education/engagement tool and a tele-health screening strategy. Participants' comments on goals and barriers or motivators to change are documented. An electronic

cardiovascular disease and diabetes decision-support tool based on current guidelines functioned as a medium for communication between healthcare providers and T2DM patients' and caregivers (20). A web-based diabetes training programme based on diabetes-related knowledge, attitudes and skills of health professionals was carried out in Turkey. A study conducted in China (18) used a mobile phone application (MPA) combined with or without self-monitoring of blood glucose (SMBG) on glycaemic control in patients with diabetes.

Mobile applications include a diabetes self-care application (5). A study also recognised that the number of mobile applications related to ophthalmology increased usage but the number of applications by sub-specialty did not correlate with the prevalence of a particular eye disorder (21). It has been accepted that social networking applications such as WhatsApp, WeChat, and Short Message Service (SMS) can serve as a medium for health education. The WhatsApp social networking application has been responsible for a significant increase in diabetes knowledge and self-efficacy levels (8). Meanwhile, another study used WeChat as instant messaging software to ensure the efficacy of diabetes self-management (16). Therefore, technology support may be useful for T2DM patients to learn remotely.

The Basis of Health Education

Previous studies have designed their interventions based on existing theories, models, concepts, or principles. The theories applied include the Health Belief Model theory, the Information-Motivation-Behavioural Skills Model of Diabetes Self-Care (IMB-DSC), self-efficacy, the Integrated Theory of Health Behaviour Change, the Common-Sense Model of Self-Regulation (CSM), the Social Cognitive Theory (SCT), social support theories and the Effective Teaching Instruction Model, which was implemented (5, 8, 16, 15, 17, 22). In contrast, two studies used ideas about prevention and self-management, nutrition, physical activity, health-seeking behaviour and counselling, a diabetic component, self-management and patient community and a patient's knowledge and medical management (7, 11, 18, 23).

The designs of the remaining studies were based on a review of published literature. They include: the verbal education and visual feedback of the patients' retinal images during consultation with the doctor, which helped increase awareness of diabetic retinopathy; mobile phone health prevention and disease control ; an assessment of patients' cognitive and social skills to determine their motivation and ability to access, process and understand information about basic health services necessary to make appropriate health decisions; and the concept of preservation and improvement of the patient's general well-being (11, 24, 25).

Study Design

Quantitative Studies

A total of 23 reports were included in this review of previous quantitative studies: ten randomized-controlled trials (RCT), two quasi-experimental studies, ten cross-sectional studies and a mixed-method study were identified and included.

Randomized-controlled trials.

Ten randomized controlled trials (RCT) were identified and included in this review. The most common outcome measured was diabetes-related self-care activities among participants. Two studies measured diabetes self-care and diabetes self-care, distress, and cognitions. Four studies measured glycemic control as assessed by HbA1c for four weeks, at baseline and six months, at baseline and 12 months and at baseline and one year. Two studies evaluated the importance of health education on diabetes complications to increase the frequency of retinal screening. Only one study evaluated the Web-Based Diabetes Training Programme (WB-DTP) on the diabetes-related knowledge, attitudes, and skills of health professionals.

Quasi-experimental studies

Two studies evaluated diabetes self-care factors. In the first, an evaluation of a diabetes self-care app was performed by measuring differences in diabetes self-care factors and the effect of an educational intervention on adherence to self-care activities. In the second study, functional health literacy and numeracy

in people with type 2 diabetes mellitus were conducted.

Cross-sectional studies

One study examined the self-management of diabetes in which it was found that health attitudes, treatment adherence and duration of diabetes were determinants of self-management behaviours. Another study examined diabetes-related self-care activities: controlling food, physical activities, medications, blood sugar monitoring and foot care were significantly correlated with subjective wellbeing. A study evaluated the impact of diabetic retinopathy (DR) on quality of life measures, whereas a study elucidates the contribution of both eyes to vision-related quality of life (VRQoL). In a large population sample, VRQoL differed when subjects were stratified just by the visual acuity of their better-seeing eye, as opposed to also taking the visual acuity of the other eye into account.

Furthermore, two research papers on knowledge, attitude and practice were discussed (KAP). A study investigated KAP and found variables with the KAP level, whereas another studied KAP and the current vision associated QoL with diabetic retinopathy (DR) in India. In contrast, higher HbA1c levels were independently linked with poorer knowledge of diabetes, whereas a higher level of education, speaking English at home, access to an ophthalmologist and a diabetes educator and National Diabetes Service Scheme (NDSS) membership were all independently associated with improved diabetes knowledge.

In addition, two studies addressed concerns pertaining to technological developments. A study discussed artificial intelligence (AI)-based diabetic retinopathy screening (26). New patient-focused mobile applications in the field of ophthalmology are becoming available on Google Play and the App Store. According to population-based studies, the most prevalent causes of blindness are glaucoma (6.6 %), diabetic retinopathy (10.4%), and untreated cataracts (58.6 %). Untreated cataracts account for 58.6 % of all cases of blindness (4). A mixed method study applied a five-day design sprint methodology developed by Google Ventures (Alphabet Inc, Mountain

View, CA) to create their initial dashboard prototype which was integrated into an electronic health record.

Qualitative Studies

Four qualitative studies were included in this review. These studies were conducted among patients with diabetes mellitus. However, two studies were conducted through a semi-structured interview while the other study was conducted via a focus group interview. The process of adaptation, development, and assessment of the acceptability of a health education intervention to improve referral uptake by people with diabetes was conducted in Sri Lanka (27). Four sessions of participatory workshops with patients with diabetes were conducted to develop material such as a video and a leaflet. The process of data collection involved a participatory approach using a focus group discussion. It also involved consultations with key stakeholders and 46 patients with diabetes mellitus who had any sign of diabetic retinopathy (DR). These results will be discussed in the next section.

DISCUSSION

The included studies presented a broad understanding of health education related to diabetic retinopathy that has been implemented in line with the objective of this review and may help identify recommendations for future nurse-led diabetic retinopathy intervention.

Health education and patients with T2DM

Health education that incorporates adequate information, appropriate strategies, and effective techniques may improve patients' self-care in the management of their diabetes. Diabetes education is a critical component of diabetes care (28) either it is delivered personally, group-based, or technology-based style. It depends on the acceptance of patients with T2DM and the availability of internet access as well.

While it has been challenging to demonstrate that formal diabetes education per se leads to improved metabolic control, it is clear that improvements in outcomes cannot occur without adequate instruction about the disease. Therefore, everyone suffering from diabetes

should be encouraged to attend a formal education programme conducted by a qualified diabetic educator nurse.

Besides, there are various types of health education programmes available for T2DM patients. If patients can apply their knowledge whenever and wherever they go, the provision of this health education material may benefit. In 2022, the overall performance of the Sustainable Development Goals (SDG) in Malaysia was scored at 72/163.

In 2019, in the SDG3 category of Good Health and Well-Being, the score of Malaysia fell short of the age-standardised death rate due to the prevalence of cardiovascular disease, cancer, diabetes and chronic respiratory disease in adults aged 30–70 years, which was 18.5%. This disappointing score indicated a stagnation, or at best, a slight increase of less than 50% of the required rate, which reflected the increase in the incidence of obesity in the country, with an average BMI > 30. Hence, a systematic review of updated articles could clarify the status of technology usage in the self-management education and support for diabetics in Malaysia, reflecting the ever-evolving healthcare system. This issue was discussed in the 6th edition of the Clinical Practice Guidelines (2020) for diabetes mellitus patients⁷ which emphasized the utilisation of an online platform to ensure continued care, despite challenges encountered in the community. Continuous evaluation of this online platform is needed to ensure the effectiveness of information sharing. Thus, the potential benefits of fully understanding the disease include a sense of empowerment and an improved quality of life (28-29).

Technology in health education provision

In addition, technology can support informed, motivated patients and prepared, proactive teams to produce positive outcomes, including a complete feedback loop. This feedback loop incorporates monitoring, interpretation of data, adjustment of treatment and communication of tailored devices, leading to a repetition of the cycle with the required elements. For example, diabetes self-management education and support incorporates patient-generated health data including structured glucose data, lifestyle data and a structured feedback loop. The

application of this feedback loop to chronic condition management is incorporated in the e-Health Enhanced Chronic Care model.

In this pandemic era which has restricted face-to-face interaction, we have witnessed a boom in computer technology in healthcare. Technology-enabled integration for self-management monitoring of diabetic patients provides a convenient solution to ensure continuous interaction yet it reduces exposure to harmful viruses between healthcare personnel and patients. For example, the MySejahtera application currently provides updated personal information, issues and personalized COVID-19 vaccination status for Malaysians and may well be employed in managing other chronic diseases soon.

Future implementation

Besides, in this millennium era, the emergence of AI based on deep learning (DL) is increasingly being adopted in ophthalmology. It includes screening tools (fundus photography, optical coherence tomography and visual fields), robust diagnosis of diabetic retinopathy and retinopathy of prematurity and disease intervention. Diagnostic performance has been developed and tested using the Singapore Integrated Diabetic Retinopathy programme in the past five years with ten external data sets recruited from six different countries, including Singapore, China, Hong Kong, Mexico, the USA and Australia. DL has shown it is capable of a clinically acceptable diagnostic performance in detecting many retinal diseases, particularly DR and retinal ocular prematurity (ROP) (30). With such technology, mobile integration in health education provides a new platform for healthcare professionals to interact with diabetes patients.

CONCLUSION

A significant positive effect is seen among diabetic patients who have received accurate information about retinopathy. It appears that conventional health education through personal interaction with healthcare providers is helpful in delivering the required information, but in the extraordinary situation of the Covid-19 pandemic, where regulations have restricted face-to-face interaction, the

medium of information sharing needs to be modified. Thus, a mobile application might be an option to provide better health education, with an emphasis on diabetic retinopathy components. However, the accessibility and usability issues among patients with diabetes, especially sight-threatening conditions and the elderly, need to be explored further.

LIMITATION

Only a few studies have been published about nurse-led health education about diabetic retinopathy in East Asia. Due to the diversity of cultures and languages in the region, interventions tested in one country may not be applicable to other countries. Aspects of health education have evolved remarkably in recent years and has benefitted from advances made in healthcare centres around the world. Engagement between healthcare providers and end-users (patients with diabetes) has become an essential component of the knowledge transfer process. Still, the effectiveness of face-to-face and online interaction must continue to be evaluated, especially during this time of the pandemic.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

FUNDINGS

The study did not receive any funds.

ACKNOWLEDGEMENT

We are grateful to the Ministry of Higher Education, Malaysia, and the International Islamic University of Malaysia for the financial contribution. We express our gratitude to the University of Malaya where the first author is currently pursuing a PhD.

AUTHOR CONTRIBUTIONS

RMI: Drafted the manuscript and contributed to the concept development and design of the article through data collection, analysis, and interpretation.

CMC: Provide with literature support.

LWL: Provide with literature support.

TBMI: assist in data analysis and interpretation of the data.

TSSJ: Provide with literature support, revised and finalised the manuscript.

MISS: Provide with literature support.

REFERENCES

1. Spencer LJ, Degu A, Kalkidan HA, Solomon MA, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*. 2018; 392(10159): 1789-1858. [https://doi.org/10.1016/S0140-6736\(18\)32279-7](https://doi.org/10.1016/S0140-6736(18)32279-7).
2. Schardt C, Adams MB, Owens T, Keitz S & Fontelo P. "Utilization of the PICO Framework to Improve Searching Pubmed for Clinical Questions.". *BMC medical informatics and decision making*. 2007; 17 (16) <https://doi.org/https://doi.org/10.1186/1472-6947-7-16>.
3. Skrzypecki J, Stańska K, & Grabska-Liberek I. Patient-oriented mobile applications in ophthalmology *Clinical & Experimental Optometry*. 2019;102(2):180. doi:10.1111/cxo.12830.
4. Fiona LM, ChewMAS, Zuraidah M, Mohd AH, Elias H, Tassha HA, Nor FN, Hans L, Pik-Pin G. Estimates of visual impairment and its causes from the National Eye Survey in Malaysia (NESII). 2018. <https://doi.org/10.1371/journal.pone.0198799>
5. Jeon E, Park HA. Experiences of patients with a diabetes self-care app developed based on the information-motivation-behavioural skills model: before-and-after study. *JMIR Diabetes*. 2019; 4(2):e11590. <https://doi.org/10.2196/11590>.
6. Threath J, Williamson JF, Huynh K, Davis RM, Hermayer K. Ocular disease, knowledge and technology applications in patients with diabetes. *Am J Med Sci*.

- 2013;345(4):266-270.
doi:10.1097/MAJ.0b013e31828aa6fb.
7. Chen-Wei P, Wang S, Wang P, Cai-Lian X, & Song E. Diabetic retinopathy and health-related quality of life among Chinese with known type 2 diabetes mellitus. *Quality of Life Research*. 2018; 27(8); 2087-2093.
doi:http://dx.doi.org/10.1007/s11136-018-1876-6.
8. Alanzi T, Bah S, Alzahrani S, Alshammari S, Almunsef F. Evaluation of a mobile social networking application for improving diabetes Type 2 knowledge: an intervention study using WhatsApp. *J Comp Eff Res*. 2018; 7(9):891-899.
https://doi.org/10.2217/cer-2018-0028.
9. Aromataris E, Munn Z (Editors). Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute, 2017. Available from
https://reviewersmanual.joannabriggs.org/
10. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies. *PLoS* 2007; 4(10): e296.
https://doi.org/10.1371/journal.pmed.0040296.
11. Moura NDS, Lopes BB, Teixeira JJD, Oriá MOB, Vieira NFC, Guedes MVC. Literacy in health and self-care in people with type 2 diabetes mellitus. *Rev Bras Enferm*. 2019;72(3):700-706..
doi:10.1590/0034-7167-2018-0291.
12. Aiello LP, Ayala AR, Antoszyk AN, et al. Assessing the effect of personalized diabetes risk assessments during ophthalmologic visits on glycemic control: a randomized clinical trial. *JAMA Ophthalmol*. 2015; 133(8): 888-896.
https://doi.org/10.1001/jamaophthol.2015.1312.
13. Zwarenstein M, Shiller SK, Croxford R. et al. Printed educational messages aimed at family practitioners fail to increase retinal screening among their patients with diabetes: a pragmatic cluster randomized controlled trial. *Implementation Sci*. 2014;(9):87.
https://doi.org/10.1186/1748-5908-9-87.
14. Debussche X, Besançon S, Balcou-Debussche M, et al. Structured peer-led diabetes self-management and support in a low-income country: The ST2EP randomised controlled trial in Mali. *PLoS One*. 2018;13(1):e0191262.
https://doi.org/10.1371/journal.pone.0191262.
15. van Puffelen AL, Rijken M, Heijmans MJWM, Nijpels G, Schellevis FG; Diacourse study group. Effectiveness of a self-management support program for type 2 diabetes patients in the first years of illness: Results from a randomized controlled trial. *PLoS One*. 2019;14(6):e0218242.
https://doi.org/10.1371/journal.pone.0218242.
16. Dong Y, Wang P, Dai Z, Liu K, Jin Y, Li A, Wang S, Zheng J. Increased self-care activities and glycemic control rate in relation to health education via Wechat among diabetes patients: A randomized clinical trial. *Medicine*. 2018; 97(50); e13632.DOI:
10.1097/MD.00000000000013632
17. Karahan OG & Ecevit AŞ. Effect of Web-based diabetes training program on diabetes-related knowledge, attitudes, and skills of health professionals: A randomized controlled trial. *Japan Journal of Nursing Science*. 2019; 16(2).
doi:http://10.1111/jjns.12228.
18. Yu Y, Yan Q, Li H, et al. Effects of mobile phone application combined with or without self-monitoring of blood glucose on glycemic control in patients with diabetes: A randomized controlled trial. *J Diabetes Investig*. 2019;10(5):1365-1371.
doi:10.1111/jdi.13031.

19. Tsui I, Drexler A, Stanton AL, Kageyama J, Ngo E & Straatsma BR. Pilot study using mobile health to coordinate the diabetic patient, diabetologist, and ophthalmologist. *J Diabetes Sci Technol*. 2014;8(4):845-849. doi:10.1177/1932296814529637.
20. Brazionis L, Jenkins A, Keech A, Ryan C, Bursell SE, & Group TES. An evaluation of the telehealth facilitation of diabetes and cardiovascular care in remote Australian Indigenous communities: - protocol for the telehealth eye and associated medical services network [TEAMSnet] project, a pre-post study design. *BMC Health Services Research*. 2017;5(17), 13. doi: 10.1186/s12913-016-1967-4.
21. Skrzypecki J, Stańska K, & Grabska-Liberek I. Patient-oriented mobile applications in ophthalmology. *Clinical & Experimental Optometry*. 2019;102(2):180. doi:10.1111/cxo.12830.
22. Yang L, Wu Q, Hao Y, et al. Self-management behavior among patients with diabetic retinopathy in the community: a structural equation model. *Qual Life Res*. 2017;26(2):359-366. doi:10.1007/s11136-016-1396-1.
23. Niroomand M, Ghasemi SN, Karimi-Sari H, Kazempour-Ardebili S, Amiri P & Khosravi MH. Diabetes knowledge, attitude and practice (KAP) study among Iranian in-patients with type-2 diabetes: A cross-sectional study. *Diabetes Metab Syndr*. 2016; **10**(1): 114-119. doi:10.1016/j.dsx.2015.10.00.
24. Fenwick EK, Xie J, Rees G, Finger RP, & Lamoureux EL. Factors Associated with Knowledge of Diabetes in Patients with Type 2 Diabetes Using the Diabetes Knowledge Test Validated with Rasch Analysis. *PLoS ONE*. 2018; 8(12). doi:http://dx.doi.org/10.1371/journal.pone.0080593.
25. Ligda, Ploubidis D, Foteli S, Kontou PI, Nikolaou C & Tentolouris N. Quality of life in subjects with type 2 diabetes mellitus with diabetic retinopathy: A case-control study. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 2019; 13(2). https://doi.org/10.1016/j.dsx.2018.12.012.
26. Xiaoting P, XY, Yingrui Y, Hongmei Z, Mengting X, Ranran H, Yuming W & Zhijie L. Efficacy of artificial intelligence-based screening for diabetic retinopathy in type 2 diabetes mellitus patients. *Diabetic Research and Clinical Practice*. 2022;184. https://doi.org/10.1016/j.diabres.2022.109190.
27. Piyasena MMPN, Murthy GVS, Yip JLY, Gilbert C, Peto T, Premarathna M, & Zuurmond M. A qualitative study on barriers and enablers to uptake of diabetic retinopathy screening by people with diabetes in the Western Province of Sri Lanka. *Tropical Medicine & Health*. 2019; 47(1).10.1186/s41182-019-0160-y.