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Improving Nursing Care Protocols for Diabetic Patients Through a Systematic Review and Meta-Analysis of Recent Years

Improving nursing care in diabetes

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Abstract

BACKGROUND

Diabetes Mellitus has become one of the major pandemics of the 21st century. In this scenario, nursing interventions are essential for improving self-care and quality of life in T2DM patients, which is crucial for managing the disease and preventing complications.

AIM

To analyze nursing interventions in recent years through a systematic review and meta-analysis and propose improvements in care plans.

METHODS

This study has conducted a systematic review and meta-analysis of the impact of nursing interventions on quantitative glycemic variables, such as Glycated Hemoglobin and Fasting Plasma Glucose.

RESULTS

After confirming that the combined effect of all studies from the past five years positively impacts quantitative variables, a descriptive analysis of the studies with the most significant changes was conducted. Based on this, an improvement in diabetic patient care protocols has been proposed through follow-up plans tailored to the patient's technological skills.

CONCLUSION

The combined results obtained and the proposal for improvement developed in this manuscript could help to improve the quality of life of many people around the world.

Key Words: Diabetes mellitus; Nursing interventions; Systematic review; Meta-analysis; Protocol enhancement proposal

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Core Tip: Diabetes Mellitus is a major global health issue, and practical nursing interventions are vital for improving self-care and quality of life in T2DM patients. This study presents a systematic review and meta-analysis evaluating the impact of nursing interventions on glycemic control, specifically glycated hemoglobin and fasting plasma glucose. The findings confirm that these interventions significantly improve glycemic parameters. Based on these insights, the study proposes protocol enhancements, including personalized follow-up plans aligned with patients' technological abilities, to optimize care and improve outcomes for millions worldwide.

INTRODUCTION

Diabetes Mellitus (DM) has become one of the major public health emergencies of the 21st century, with a steadily increasing global prevalence. In 1980, approximately 108

million adults aged 20 to 79 were affected by this disease. Currently, the global prevalence has risen to 10.5% of the population, affecting 536 million people, and it is projected that by 2045, this figure will increase to 12.2%. DM is characterized by an alteration in the regulation of blood glucose levels, which can lead to severe complications if not managed properly. This disease can manifest in various forms, with Type 2 Diabetes Mellitus (T2DM) being the most prevalent, accounting for approximately 90% of cases.

T2DM is a chronic disease characterized by hyperglycemia due to alterations in insulin production or an ineffective use of this hormone, leading to an imbalance in glucose homeostasis and, consequently, a reduced glucose availability for the cells.

Various risk factors contribute to the development of T2DM. Some of them are non-modifiable; however, others are, such as overweight, sedentary lifestyle, hypertension, harmful habits (such as alcohol and tobacco consumption), diet, and cholesterol levels. Due to the long-term impact of T2DM on quality of life and its increasing prevalence, especially in an ageing population, it is crucial to implement preventive measures, early diagnosis, and proper management of the disease, thus addressing these modifiable factors.

In this context, nursing interventions are crucial to improving self-care and patients' quality of life with T2DM. Self-care in people with T2DM is essential for the control of this disease and the prevention of complications. Nursing interventions aimed at educating patients on managing their condition, promoting healthy lifestyle habits, and treatment adherence have proven effective in improving glycemic control and other risk factors associated with T2DM. Additionally, the personalized care nurses provide, which includes regular monitoring of blood glucose levels, adjusting medication as necessary, and providing emotional support, plays a crucial role in managing T2DM. Interventions that focus on patient empowerment, such as glucose self-monitoring and developing health-related decision-making skills, are essential for effective self-care .

Given the increasing prevalence of T2DM and the evidence supporting the effectiveness of nursing interventions, it is necessary to conduct a systematic review of

the various interventions implemented to date. This review aims to unify existing knowledge and provide a practical guide to improve self-care and the quality of life of the adult population with T2DM. Moreover, it is hoped that this review will help identify gaps in current research and priority areas for future research. This systematic review will evaluate the effectiveness of nursing interventions in improving self-care and the quality of life of adult patients with T2DM, providing a comprehensive view of the most effective strategies and their implications for clinical practice. Subsequently, by performing a meta-analysis, the effect of nursing interventions will be studied in a combined manner and the studies with the greatest impact on the patient will be identified, with the aim of proposing improvements in the care plans.

MATERIALS AND METHODS

Study selection

The study used the PRISMA guidelines as the methodological basis. The main objective was to provide an update on the state of the art in relation to the different nursing interventions in health education focused on improving diabetes control. For this reason, all original studies that studied possible nursing interventions for glycemic control were selected.

Search strategies and criteria

The search for articles of interest was carried out in July 2024, using the academic reference search engines PubMed (PubMed.ncbi.ncbi.nlm.nih.gov, accessed 3 July 2024), Web of Science (webofscience.com/wos/alldb/basicsearch, accessed 3 July 2024) and Google Scholar (https: //scholar.google.com.mx/scholar, accessed 3 July 2024). A strategy focusing on generic terms was used to maximise results and make sure to include potential articles of interest. The terms ((((("Type 2 Diabetes Mellitus" OR T2DM OR "Type 2 Diabetes") AND (Nursing intervention)) AND ("Therapeutic Education" or "Health Promotion" or "Health Education")) AND (Hb1Ac OR fasting blood glucose OR glucose OR glycated hemoglobin) were used, including articles published in the last

five years. The search was carried out independently by three researchers (RMGT, MGA and MBG), and their decisions at each of the literature search and assessment steps were determined by consensus.

After removing duplicate articles using the bibliographic manager Mendeley (Mendeley Ltd., Elsevier, London, UK), articles were evaluated by title/abstract. All articles that were not original intervention studies (such as observational studies) or reviews, articles that did not study the pathology of interest, protocols, or conference abstracts, were excluded (Figure 1). Subsequently, the full text of the manuscripts was analysed and evaluated.

Selection of articles for qualitative and quantitative analysis

After the full-text analysis, a descriptive analysis of the selected articles was carried out. In addition, data were extracted for the qualitative and subsequent quantitative analysis. All studies that provided fasting plasma glucose (FPG) or glycated hemoglobin (HbA1c) values were included, both in interventions where the study group is compared with a control group (intergroup) and in those studies where pre- and post-intervention values were selected. Discrepancies between independent reviews were resolved by consensus.

"RMGT, MGA, MBG, SAH, and SCA, extracted data from all studies and were analysed jointly in the form of a meta-analysis. After obtaining the results, those manuscripts with the highest quantitative improvements in the patient's pathology were selected and included in Table 1. The variables collected from each article in Table 1 were authorship, year of publication, type of study, intervention groups, follow-up period, sample size, and the quantitative variables related to diabetes (fasting plasma glucose and/or glycated hemoglobin).

Meta-analysis

Review Manager software (RevMan 5.3, Cochrane, London, UK) was used to perform the mean difference method, using the variables arithmetic mean, standard deviation

and sample size. Four different meta-analyses were performed: At the intra-group level (control group vs. intervention group), fasting plasma glucose and glycated hemoglobin, and at the inter-group level (pre-intervention *vs* post-intervention), both quantitative glycemic parameters were also analysed.

Heterogeneity among studies was calculated by applying the Chi^2 and I^2 tests. The I^2 statistic was calculated as a percentage, and the results were interpreted as low, medium or high heterogeneity, reaching 25%, 50% and 75%, respectively. The fixed-effect model was used when no heterogeneity was detected among studies, while the random-effect model was preferred when variance existed. A $P < 0.05$ was considered statistically significant for all the analyses performed.

Risk of bias

To evaluate publication bias in the meta-analysis, funnel plots were used to identify symmetry or asymmetry in the distribution of results.

RESULTS

Selection of articles

The initial search identified 79 articles in PubMed, 54 in Web of Science and 22 in Google Scholar. After exporting the reference set to the Mendeley desktop application and removing duplicates, 141 articles were obtained. The first analysis based on the title and abstract eliminated 83 articles that did not meet the selection criteria, resulting in a total of 58 articles. Subsequently, a thorough full-text reading of the remaining articles was performed, leaving a total of 21 studies with interventions to be included in the review. In addition, a manual identification of studies was carried out outside the database search and a total of 9 articles were found, of which, after applying the selection criteria, it was decided to include six of them in the meta-analysis.

Finally, 27 manuscripts meeting the search criteria were selected for qualitative and quantitative analysis (Figure 1).

Meta-analysis

The results have been classified based on the study type and the quantitative variable of blood glucose analysis. Within the study type, they have been categorized as either intragroup (Baseline vs. Post-treatment) or intergroup (Control vs. Intervention). The quantitative variables for blood glucose analysis have been classified as HbA1c and FPG.

Intragroup Differences: As shown in Figures 2 and 3, the results exhibited high heterogeneity, with I^2 values exceeding 90%. In this case, the figures present striking results, with almost all data shifted to the right side, demonstrating a predominance in favour of post-intervention outcomes in both glycemic parameters. Accordingly, the results of the combined analysis showed a value of 1.03 [0.67, 1.39] ($P < 0.00001$) for HbA1c and 33.95 [22.70, 45.20] ($P < 0.00001$) for FPG.

Intergroup differences: As in the previous group, there has been high to moderate heterogeneity in health education studies from a nursing perspective over the last five years, with I^2 values of 90% for HbA1c and 50% for FPG.

Notably, the combined results reveal statistically significant data in favour of the intervention, supported by a mean difference of -0.27 [-0.49, -0.05] ($P < 0.02$) for HbA1c and -21.11 [-27.14, -15.07] ($P < 0.00001$) for FPG.

Publication bias

As can be seen in Figures 2-5, the studies included in all the meta-analyses do not have a high degree of dispersion, so despite the observed heterogeneity, symmetry is observed in the funnel plots.

Qualitative analysis of interventions with the higher changes in glycemic parameters

Intragroup differences HbA1c: Based on the meta-analysis conducted regarding the intragroup changes for the HbA1c variable, following a nursing intervention, it was identified that the three studies that provided the highest pre-post differences were Kim *et al*., 2019, Chen *et al*., 2019, and Alison and Anselm., 2020. The first randomised clinical

trial compared three groups. The first group was the control group, the second received an educational intervention for managing T2DM based on social networks and audiovisual material use, and the last one received an educational intervention based on telephone support without audiovisual aids. After 12 weeks of follow-up, the intervention group based on social network support and audiovisual material showed a 2.57-point decrease in HbA1c percentage, representing the most remarkable change among of the three groups. Similarly, Chen *et al*., in 2019, demonstrated that a nursing intervention based on interactive health education through the WeChat platform resulted in a significant intra-group change in HbA1c percentage of 2.23 points between pre and post . Finally, Alison & Anselm conducted a randomised clinical trial and concluded that health education combined with a pharmacology-based disease management program was of more significant benefit than only the educational program at 12-month follow-up.

Intragroup differences Fasting Plasma Glucose: Based on the meta-analysis conducted regarding the intra-group changes for the FPG variable following a nursing intervention, it was identified that the three studies that contributed the most remarkable pre-post differences were Moradi *et al*., 2019, Wu *et al*., 2019 y Elgerges *et al*., 2020. Moradi *et al*. conducted an educational intervention through text messages to each patient's phone. The text messages addressed topics primarily related to diabetic foot care and the recommendation of regular physician visits. After three months and after receiving 90 text messages the subjects who underwent the educational intervention not only improved their self-care and knowledge related to the diabetic foot, but also substantially improved their glycemic parameters. Wu *et al*. conducted a 6-month intervention study using Steno Balance Cards, a tool with which, through dialogue, participants can identify their own goals, problems, and solutions. In addition, they are used to encourage patients' proactivity in managing their disease. Similarly, the results showed significant improvements in HbA1c and FPG levels.

Elgerges *et al*. conducted a randomised clinical trial of 100 patients divided into a control group that received a standard treatment for disease control and an

experimental group that received an education programme under a multidisciplinary team and was provided with an educational kit and a pedometer for monitoring physical activity. This study showed statistically significant differences in this variable in both groups, but they were more prominent in the experimental group.

Intergroup differences HbA1c: Based on the meta-analysis conducted regarding the inter-group changes for the HbA1c variable following a nursing intervention, it was identified that the three studies contributing the greatest post-intervention differences compared to the other intervention groups were Lozano del Hoyo *et al*., 2022, Chen *et al*., 2019, and Moradi *et al*., 2019.

Lozano del Hoyo *et al*. worked with one of the largest analysed cohorts, showing the best data observed in the meta-analysis (Figure 4). The researchers conducted a randomised controlled trial for 18 months on 384 patients, of whom 192 subjects belonged to the intervention group. In it, monthly telephone interventions conducted by specially trained research nurses were based on an individualised psychoeducational monitoring protocol that incorporated motivational interviewing and collaborative care strategies. Chen *et al*. demonstrated that in addition to the notable intra-group changes mentioned earlier, the experimental group also showed statistically significant inter-group differences with a p-value of 0.004. Along similar lines, Moradi *et al*. with the use above of text messages, substantially improved the plasma HbA1c levels of the treated patients concerning the control group, with values of 7.39 (1.44) vs. 8.54 (1.81).

Intergroup differences Fasting Plasma Glucose: Based on the meta-analysis conducted regarding inter-group changes for the variable FPG following a nursing intervention, the three studies that showed the greatest differences at post-time compared to the other intervention groups were Moradi *et al*., 2019, Wu *et al*., 2019, and Subramanian *et al*., 2020.

The works of Moradi *et al*. and Wu *et al*. have shown the highest results at both intragroup and intergroup levels in the FPG analysis. In Moradi *et al*., the work with the most left-shifted results (Figure 5), it is interesting to note the presence of elevated basal

glycemic levels in all study subjects, which practically do not change in the control group after the intervention. In this case, at the intergroup level, the results of Intervention vs. Control showed the figures of 180 (74) vs. 216 (93) mg/dL in the analysis of 80 vs. 80 patients. However, in Wu *et al*., the results were 131.2 (32.3) vs. 165 (42.6) mg/dL. Subramanian *et al*. performed a nurse-led intervention featuring a 30-minute video-assisted teaching session that addressed the nature of the disease, including information on diet, medication, hand and leg exercises, and home care management. This session was followed by a demonstration of hand and leg exercises, with participants performing them themselves. In this case, the results were similar to Wu *et al*., 132.8 (42.87) vs. 161.57 (55.86).

DISCUSSION

The management of T2DM through health promotion is a comprehensive approach that has shown promising results, particularly in reducing HbA1c and FPG levels. In the present manuscript, several strategies related to educational intervention implemented by nurses have been evaluated and they have shown to be effective in controlling this disease, significantly improving glycemic parameters compared to patients treated with traditional approaches.

The novel approach of the present manuscript has two aspects: On the one hand, a meta-analysis has been performed updating the state of the art of recent years, demonstrating that educational interventions focused in a nursing context can significantly improve quantitative parameters such as HbA1c and FPG. On the other hand, thanks to the combined quantitative study, it has been possible to identify the studies with the most displaced results, allowing a narrative analysis of the type of intervention carried out on the patients. In this way, it has been possible to observe how nursing interventions that include follow-up, either face-to-face or telematic, have a significant beneficial effect on patient health compared to the traditional approach. Thus, studies such as that of Lozano del Hoyo *et al*. or Subramanian *et al*., to name a few, showed no variations in pre- and post-follow-up glycemic levels in their respective

control groups. However, the results of the control group by Kim & Utz, or Chen *et al*. are also striking. In their 12- or 3-month follow-ups, respectively, they observed decreases of about 1% in HbA1c or 1 mmol/L in FPG.

Of course, the baseline status of each subgroup is an essential factor to consider, and a limitation of the results of some of the groups studied; although most of them present homogeneity among the study groups, the manuscript by Subramanian *et al*. stands out negatively in this regard. As shown in Table 1, the baseline FPG values of the control group were 160.57 (58.7) mg/dL, while those of the intervention group were 146.7 (54.63) mg/dL.

Another factor to consider when comparing the effect of the different interventions is the follow-up time. Among the studies identified in the meta-analysis, the one by Lozano del Hoyo *et al*. stands out, with its 18-month intervention. Unsurprisingly, one of the best results was identified in the study with the longest follow-up time. Although only the quantitative value in real-time was used, the authors followed up over the semesters, obtaining HbA1c values in the intervention group of 8.72 (1.49), 7.90 (1.22), 7.11 (1.17) and 7.03 (1.09) at 0, 6, 12 and 18 months, respectively. As seen in Table 1, most of the studies identified performed follow-ups at 3-4 months, which constitutes an interesting element for future studies and nursing care plans.

Furthermore, not only the combined quantitative data from the meta-analysis itself should be highlighted but also the identification of the academic papers with the most substantial impact. Thus, the four intra-group and inter-group analyses performed in FPG and HbA1c, have significantly demonstrated that nursing interventions focused on health education exert a beneficial effect on the progression and evolution of diabetes. The results observed in FPG are particularly striking but should be taken with caution since HbA1c levels better reflect the patient's glycemic status because they provide an estimate of the patient's glycemic status over the past 3 months. Therefore, in the face of numerous studies that perform a 3-month (or less) follow-up, a drastic change in a parameter that requires longer-term follow-up would not be observed. In any case, as

can be seen in Figures 2-5, the p-value calculated for the combined analysis of all the results is always statistically significant, being, in most cases, less than 0.00001.

Another limitation of the study is the temporal restriction of the systematic review to the last five years to perform a paradigm update. Let us compare the results with those of previous work. We can find similarities in the systematic review by Chrvala *et al*., which revealed that T2DM education programs significantly reduce HbA1c levels, with an average decrease of about 0.6%. These educational interventions included informative sessions on diet, glucose monitoring, and the importance of physical exercise.

Another practical approach is individual and group consultations, where nurses can provide personalized support and ongoing follow-up. According to the review by Duke *et al*., regular consultations with T2DM nurses resulted in a significant decrease in blood glucose and HbA1c levels compared to standard care. These interventions allow for greater treatment adherence and better understanding of the disease by the patient. In this line, it is essential to highlight that active coping strategies, combined with health promotion activities from nursing, are crucial for effectively controlling T2DM. Therapeutic exercise, for example, has been identified as an effective intervention to reduce blood glucose levels and improve metabolic control. According to Colberg *et al*., regular exercise improves insulin sensitivity and reduces HbA1c levels in people with this disease. Thus, the combination of health education and therapeutic exercise may enhance the benefits of controlling T2DM. A study by Umpierre *et al*. showed that supervised exercise programs combined with diabetes education led to a more significant decrease in HbA1c levels compared to programs that only involves education. This evidence underscores the importance of a multifaceted strategy integrating different aspects of disease management.

Furthermore, also in line with our results and the need for our study, although pharmacological interventions are essential in managing T2DM, passive approaches, such as isolated medication administration, do not offer the same comprehensive benefits as active strategies. Passive interventions focus on symptomatic control rather

than addressing the behaviours and habits contributing to poor glycemic control. Additionally, passive interventions do not promote patient empowerment or significantly improve quality of life. In contrast, active strategies that involve the patient in self-management of their disease tend to produce better overall well-being and metabolic control outcomes. Powers *et al*. highlight that diabetes self-management programs, including education and ongoing support, substantially improve quality of life and reduce long-term complications.

Based on the exhaustive analysis of the literature and the evidence observed in the meta-analysis, it is proposed that nursing protocols for diabetes mellitus be improved by tailoring follow-ups to the patient's technological knowledge (Appendix I). Follow-up qualitatively and quantitatively improves patients' quality of life and their biochemical parameters. Consequently, a nursing intervention program is proposed in which patients are subcategorized into three groups (A, B, or C) according to their technological proficiency (Supplementary Figure 1). For patients with good technological skills (Group A), mobile apps and social networks are recommended, and they will receive notifications and reminders through these platforms. For those with moderate skills (Group B), information will be provided through a webpage with a Q&A forum, and follow-up will be conducted *via* email and SMS. Finally, for those with little or no technological capability, the focus will be on face-to-face interactions and daily SMS reminders. Detailed information can be found in Appendix I.

CONCLUSION

In conclusion, through the analysis of recent literature, this work has demonstrated that the implementation of active nursing care plans, which enhance patient follow-up, could improve the progression of diabetes mellitus by significantly reducing glycemic variables such as blood glucose and glycated hemoglobin. Moreover, the novel approach of this manuscript has allowed the identification of relevant studies through a meta-analysis, which has confirmed the positive combined effect of the interventions at both intra- and intergroup levels. Finally, based on all the evidence described, the

present manuscript proposes an improvement to the nursing care plan. We consider this plan essential to subclassify patients based on their technological skills to optimize the impact of the intervention plan, maximizing its effectiveness while minimizing effort. Ultimately, it could significantly enhance the quality of life for patients with diabetes mellitus.

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