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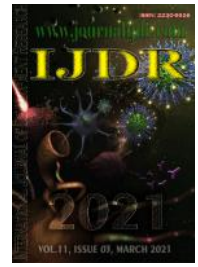
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RESEARCH ARTICLE

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## EFFECTS OF HEALTH EDUCATION ON THE PREVENTION OF DIABETIC FOOT: SYSTEMATIC REVIEW WITH META-ANALYSIS

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### ABSTRACT

The diabetic foot represents a clinical problem with repercussions on the quality of life but also an economic one. Self-care of the feet can prevent ulcers and consequently amputations in diabetic people. Aim: To evaluate the effects of health education actions in the foot care of people with diabetes. Methods: A systematic review with meta-analysis was performed. The descriptors used were "Nursing," "Self-care," "Disease Prevention," and "Diabetic Foot," associated with the Boolean operators AND and OR. The final data collection resulted in ten articles. The following methods of analysis were used: Forest plot and funnel chart, covariance ratio, Cook's distance, Baujat, GOSH analysis, and Egger's test. Results: The compiled analysis of the outcomes for behavior shows that the Standard Mean Difference (SMD) between groups increased from -1.56 (-4.0; 0.9) in the first evaluation to 14.1 (9.3; 18.9) in the final evaluation; for knowledge, it increased from -0.2 (-0.6; 0.2) in the first evaluation to 2.4 (1.2; 3.7) in the final evaluation; for self-efficacy, it increased from 0.6 (-1.1; 2.3) in the first evaluation to 9.6 (7.2; 12) in the final evaluation. Conclusion: The meta-analysis allowed us to conclude that there was effects for the knowledge, behavior and self-efficacy of health education actions in foot care in people with diabetes.

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## INTRODUCTION

Health education is a field of knowledge that aims to prevent diseases and reduce illnesses and complications through educational health promotion measures (Salci *et al.*, 2013). Health education should also be understood as a critical reflection that values the collective format and its ways of learning, relearning, and explaining knowledge on life in society and in family (Santos, 2006). The Brazilian Ministry of Health recommends that health education be advocated from the first consultation for people with diabetes mellitus (DM), continuously prioritizing blood glucose monitoring and control as well as activities that are fundamental to preventing DM complications and maintaining quality of life (Brazilian Ministry of Health, 2013). Data on DM are alarming. In 2019, it was estimated at 9.3% (463 million people) of the global population (International Diabetes Federation, 2019). It is noteworthy that this prevalence varies, being 10.8% in urban areas and 7.2% in rural areas, and 10.4% in high-income countries and 4.0% in low-income countries (Flor y Campos, 2017).

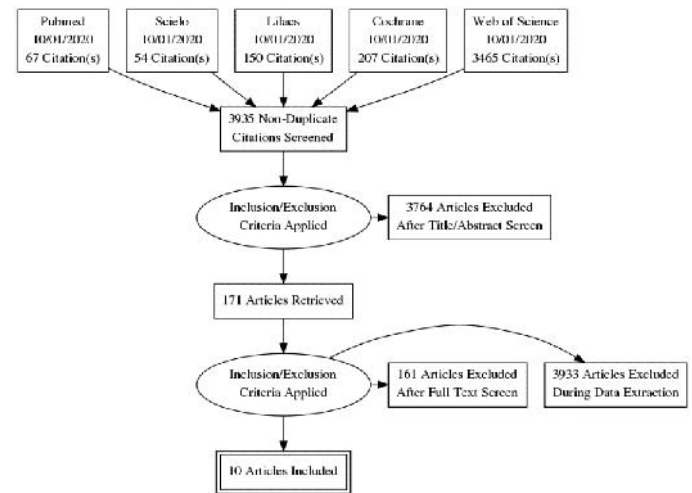
Of all complications related to the pathology, foot amputation is a complex aggravation that impairs quality of life and involves dietary changes, financial aspects, self-esteem, social integration, family support, and mental-spiritual health (Ribeiro *et al.*, 2010). The global diabetic foot ulcer prevalence was 6.3% (95%CI: 5.4-7.3%), which was higher in males (4.5%, 95%CI: 3.7-5.2%) than in females (3.5%, 95%CI: 2.8-4.2%), and higher in type 2 diabetic patients (6.4%, 95%CI: 4.6-8.1%) than in type 1 diabetics (5.5%, 95%CI: 3.2-7.7%). North America had the highest prevalence (13.0%, 95%CI: 10.0-15.9%), Oceania had the lowest (3.0%, 95% CI: 0.9-5.0%), and the prevalence in Asia, Europe, and Africa were 5.5% (95%CI: 4.6-6.4%), 5.1% (95%CI: 4.1-6.0%), and 7.2% (95%CI: 5.1-9.3%), respectively (Zhang *et al.*, 2017). The incidence of ulcers, amputations and all-cause hospitalisations is high in persons with diabetes and a history of foot ulceration or on dialysis treatment; however, those on dialysis treatment have disproportionately higher rates of foot-related hospitalisations (Lavery *et al.*, 2015). This can be minimized with health education (Salci, Meirelles y Silva, 2018) and there is also increasing evidence that the implementation of a multi-

disciplinary foot care team across not only secondary but also primary care might help reduce the rate of amputations in people with diabetes (Boulton, 2014). In Brazil, 70% of non-traumatic amputations studies have been reported in people with DM, and 85% of these amputations are due to foot injuries (Santos *et al.*, 2018). Taking care of the skin of the feet decreases the risk of injury because, essentially, all the affected people have, to some degree, skin impairment due to glucose deregulation, use of insulin, and lipid changes, which produce physical signs in the skin (Fajre *et al.*, 2009). In the United States (USA), it is estimated that 30% of people with DM aged over 40 years have severe skin impairments (Gregg *et al.*, 2004). These data show that foot evaluation and monitoring by a nurse are important to prevent injuries and future amputations. To provide high quality care, the care givers need proper working environments, education and training. Although the health team should ideally comprise of specialist physicians, wound care nurses and allied health professionals, nurse-led wound care has shown to improve patient outcomes (Harrison *et al.*, 2005). Although improvement of knowledge is expected with increasing nursing experience, surprisingly insufficient knowledge on pressure ulcer prevention (Gunningberg *et al.*, 2015) was reported in a study where the majority were experienced nurses. Since nurses' roles in wound management is vital, they need to have objective education on wound management and should be empowered in their role amongst the other team member (Corbett, 2012). A person with DM also needs to have adequate knowledge and behavior about foot care. For the patient with a foot ulcer in remission, there is a good chance of preventing a recurrent ulcer when state-of-the-art knowledge on prevention is put into practice (Armstrong *et al.*, 2017). The nurse should be attentive to the patient's feet and the shoes used during this process of adapting the care plan because these are risk factors for injuries and amputations. To detect neurological changes, some tests already validated to identify the risk of future injury should be conducted. Among the listed tests, these stands out: to assess vibratory, pain and protective sensitivity through examination with Semmes-Weinstein 10g monofilament, as indicative of populational risk screening, in addition to Achilles tendon reflex (Boulton *et al.*, 2018). Thus, the objective of this study was to evaluate the effects of health education actions to improve knowledge, behavior, and self-efficacy in care.

## METHODS

A systematic review with meta-analysis was performed. The research project was submitted to the International Prospective Register of Systematic Reviews (PROSPERO) under receipt number 198309. The research question was elaborated, and the PICO strategy was used for the eligibility criteria. The research question was as follows: How effect are health education actions aimed at preventing foot complications in people with DM (compared to conventional treatment) to improve knowledge, behavior, and self-efficacy in care? The inclusion and exclusion criteria were also established. The inclusion criteria were publications in any language and studies on adult and older patients of both sexes diagnosed with DM, without time limit. Randomized, almost experimental, controlled, and prospective, studies were considered, especially those that evaluated the use of health educational actions in foot care for people with DM. The exclusion criteria were articles that evaluated health education in hospitalized people and studies on children. The search was made in the following databases: PubMed, Scielo, Cochrane Central Register of Controlled Trials, Web of Science, and Lilacs. The following complete search strategy was used: [tw:((tw:(nursing )) OR (tw:(self-care)) OR (tw:(disease prevention))) AND (tw:(diabetic foot))]. The following descriptors were used: "Nursing," "Self-care," "Disease Prevention," and "Diabetic Foot," associated with the Boolean operators AND and OR. The date of the last data collection was January 10, 2020. The studies were selected in the process of data analysis to minimize errors and reduce the potential for bias. The search for articles was conducted independently by two researchers, and the studies were discussed among peers to standardize information. Differences were resolved in group discussion among the collaborators.

The selection was made by evaluating the study titles and abstracts that were potentially relevant for analysis. When title, keywords, or abstract had insufficient information to determine suitability for inclusion, the full article was analyzed. This process resulted in the selection of ten articles for review and meta-analysis, as shown in Figure 1.



Source: Elaborated by the authors.

**Figure 1. Selection of articles according to Prisma**

The risk of study bias was calculated using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system. Forest plot, Difference in Fits (DFFITS), funnel charts (Duval & Tweedie), covariance ratio, Cook's distance, Baujat, GOSH analysis, and Egger's test were performed.

## RESULTS

The selected studies including experimental, controlled, and prospective studies had different methodologies, with and without randomization. All studies had evaluations of face-to-face health education interventions using either pamphlets or booklets, or educational practices with discussion sessions, management of self-care activities, telephone calls, or text messages to the patient's cell phone. The educational actions aimed at foot care in people with DM. Biçer and Enç (2016) included 13.1% of people with type 1 DM, while the other studies included people with type 2 DM. It should be noted that not all selected studies present statistical data relevant to the execution of this conclusive meta-analysis. The articles collected for analysis are listed in Table 1. The variables were classified and separated into data groups based on, for example, demographic data of research participants, type of intervention and healthcare, and patients' knowledge, behavior, and self-efficacy regarding their feet during the studies.

This information was standardized in the respective groups, as shown in Table 1. The studies published by "Borges and Otswald, 2008" and "Seyyedrasooli et al., 2015" report three groups of participants who received health interventions during their treatments. Therefore, to facilitate classification and future statistical analyses, these groups were treated as separate studies, with "Borges & Otswald1, 2008" being the group receiving the intervention only through risk assessment and "Borges & Otswald2, 2008" being the group receiving the risk assessment intervention plus foot self-care. Another article was separated in a similar manner, as "Seyyedrasooli et al.1, 2015" as the group receiving the collective educational intervention and "Seyyedrasooli et al.2, 2015" as the group receiving the individual educational intervention. For both studies, their respective control groups were maintained for comparison. The following tables

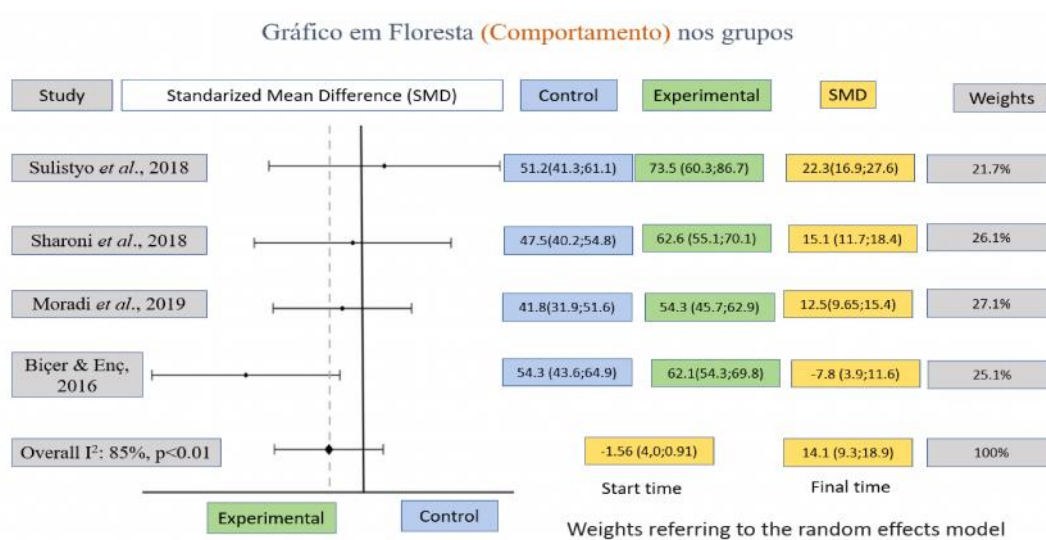
show data of the demographic characteristics of the patients in the articles.

outcomes analyzed in the meta-analysis were classified in the possible levels, and a "Moderate GRADE" evaluation was considered due to

**Table 1. Articles selected for the systematic review**

Authors	Journals	Title of the article
Biçer e Enç.	International Journal of Diabetes in Developing Countries, v.36, n. 3, p. 334-344, 2016	Evaluation of foot care and self-efficacy in patients with diabetes in Turkey: An interventional study
Borges e Otswald.	Western Journal of Nursing Research, v.30, n.2, p. 325-341.	Improving foot self-care behaviors with Pies Sanos.
Corbett	The Diabetes Educator Journal, v. 29, n.2, p. 273-282, 2003	A Randomized Pilot Study of Improving Foot Care in Home Health Patients with Diabetes
Moradi <i>et al.</i>	Diabetes & Metabolic Syndrome: Clinical Research & Reviews, v. 13, n.2, p. 1255-1260.	The Effect of Short Message Service (SMS) on Knowledge and Preventive Behaviors of Diabetic Foot Ulcer in Patients With Diabetes Type 2
Nguyen <i>et al.</i>	Diabetes research and clinical practice, v. 5, n.2, p. 29-38, 2019.	Effectiveness of a theory-based foot care education program (3STEPFUN) in improving foot self-care behaviours and foot risk factors for ulceration in people with type 2 diabetes.
Rodriguez <i>et al.</i>	Enfermería Global, v.1, n.29 p. 53-62, 2013.	Cuidado com os pés diabéticos antes e após intervenção educativa.
Seyyedrasooli <i>et al.</i>	International Journal of Community Based Nursing HYPERLINK "https://ijcbnm. sums.ac.ir/" & HYPERLINK "https://ijcbnm. sums.ac.ir/" Midwifery, v.3, n.2, p. 141-149, 2015.	Self-Efficacy in Foot-Care and Effect of Training: A Single-Blinded Randomized Controlled Clinical Trial.
Sharoni <i>et al.</i>	Plos One, v. 13, n. 3, p. e0192417, 2018.	The effects of self-efficacy enhancing program on foot self-care behaviour of older adults with diabetes: A randomised controlled trial in elderly care facility.
Sulistyo <i>et al.</i>	Journal of Research in Nursing, v. 23, n. 5, p. 416-425, 2018	The effect of a foot care camp on diabetic foot care knowledge and the behaviours of individuals with diabetes mellitus.
Elías-Viramontes e González-Juárez	Aquichan, v.18, n.3, p. 343-354, 2018.	Intervención educativa de enfermería para el autocuidado de los pies en personas que viven con diabetes tipo 2.

Source: Elaborated by the authors.



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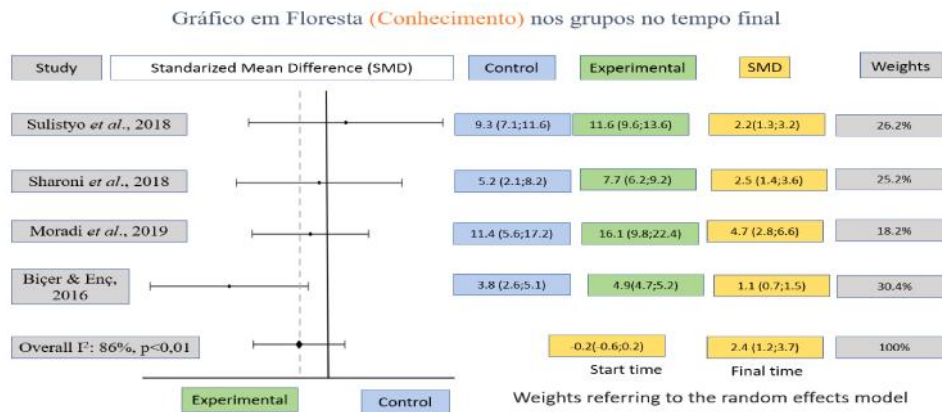
**Graphic 1. Forest plot (Behavior) in the experimental and control groups:**

All the studies included in the analyses used exclusion and inclusion criteria to select patients for participation in the treatments. Some of the articles present criteria as a type of DM, time since the first diagnosis of DM and age. The face-to-face class referred to patients receiving health education directly from the agents, personally. The pamphlet/booklet intervention class referred to patients who received pamphlets and/or booklets regarding knowledge and foot care. The intervention class through text message/telephone call referred to patients receiving the same type of information or follow-up, but through telephone call or text message. Finally, the standard care class referred to the standard foot care that diabetes patients normally receive in health centers. Using the GRADE methodology, the

inconsistency of the findings represented by the heterogeneity observed in the statistical analysis and the publication bias verified in the funnel charts. The analyses that were used as a reference for the three outcomes (indicators), considering mainly the variation in these parameters before (initial time) and after the intervention (final time) due to the possibility of comparing the information present in the selected articles. Graphic 1, 2 and 3, show the outcomes of behavior, knowledge, and foot care self-efficacy, respectively. The analyses were performed by constructing the Forest plot.

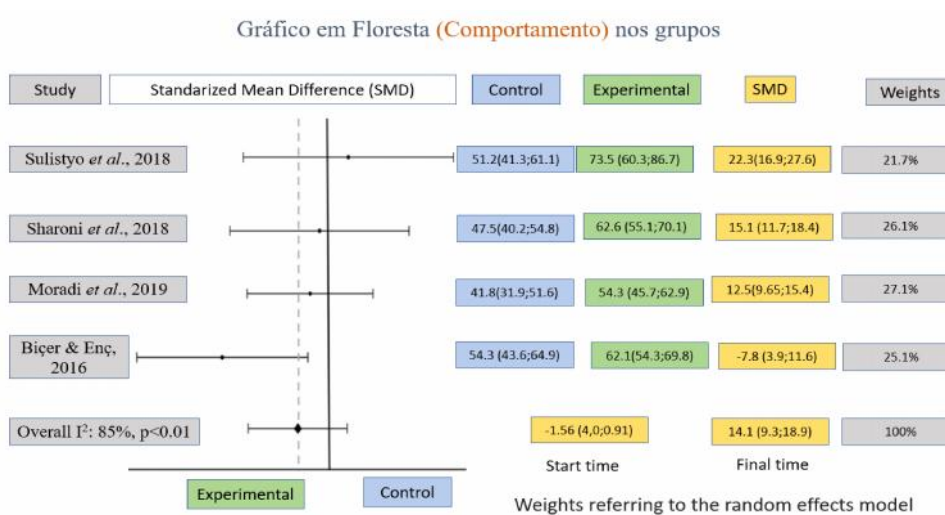
**General aspects:** This systematic review of ten selected articles included studies conducted in several regions of the world, including the USA, Mexico, Iran, Indonesia, Malaysia, Vietnam, and Turkey.

DM patients (Vázquez *et al.*, 2003). Considering the importance of self-care in the prevention of complications due to diabetic foot, an analysis of improved patient behavior is fundamental to evaluate the effects of health education programs.



Source: Elaborated by the authors.

Graphic 2. Forest plot (Knowledge) in the experimental and control groups



Source: Elaborated by the authors.

Graphic 3. Forest plot (Self-efficacy) in the experimental and control groups

All articles present nurses leading the implementation of health education measures and the development of these studies, demonstrating that, although diabetic foot is a global multifactorial pathology requiring treatment with a multidisciplinary team, nurses were protagonists in generating knowledge related to preventing foot ulcers and amputations.

**Epidemiological analysis:** As for patient distribution by sex, only Sharoni *et al.* (2018) reported a higher proportion of men. The higher percentage of females corroborates the literature because they predominate in most surveys involving samples of DM groups (Smanioto *et al.*, 2014). As for the educational level, the study population was composed mostly of people with access only to the first years of formal education. In the review of the ten articles selected, seven presented this information, reinforcing that less than 50% had access to secondary and higher education. Health professionals should also pay attention to the time of pathology because the longer the time since diagnosis, the higher the proportion of chronic complications and lower the prevalence of treatment adherence, thereby increasing the risk of complications and unsatisfactory metabolic control (Assunção *et al.*, 2017).

**Article analysis by behavior modification:** Behavior change in caring for one's health is revealed by learning about health, improving skills, and understanding health conditions according to lifestyle, and this should be guided by health services that support

The studies published by Sulistyo *et al.* (2018), Sharoni *et al.* (2018), Moradi *et al.* (2019), and Biçer and Enç (2016) evaluated the impact of behavior improvement on foot care, presenting statistical data that allowed for the meta-analysis. The compiled analysis of the behavior outcomes in the articles according to the SMD between groups resulted in an increase from -1.56 (-4.0; 0.9) in the first evaluation to 14.1 (9.3; 18.9) in the final evaluation. These data show that the intervention (health education aimed at promoting foot care) significantly improved the patients' foot care behavior. The Higgin's & Thompson's (I<sup>2</sup>) method was used to calculate the heterogeneity of the studies, showing low (25%), moderate (50%), and high (close to 75%) heterogeneity. The evaluation of heterogeneity regarding behavior analysis showed no heterogeneity, with 29% in the first evaluation (before intervention), but the value of 85% in the final evaluation of the experiment (after the intervention) indicated the high heterogeneity of results. The Baujat analysis (Baujat *et al.*, 2002) and the leave-one-out method were used to identify articles that caused this high heterogeneity. In both cases, Sulistyo *et al.* (2018) and Biçer and Enç (2016) contributed the most to the observed heterogeneity.

**Article analysis by knowledge modification:** Evidence shows that patients with DM who are more knowledgeable about the disease achieve better glycemic control for both glycosylated hemoglobin and fasting blood glucose. Thus, the acquisition of this knowledge is

essential for proper management of the disease by the patient (Chawla *et al.*, 2019). Of the selected studies, those published by Sulistyono *et al.* (2018), Sharoni *et al.* (2018), Moradi *et al.* (2019), and Biçer and Enç (2016) evaluated the impact of knowledge improvement on foot care and presented statistical data that allowed for the meta-analysis. The compiled analysis of the outcomes of the articles shows that the SMD between groups increased from -0.2 (-0.6; 0.2) in the first evaluation to 2.4 (1.2; 3.7) in the final evaluation. Thus, the intervention (health education aimed at promoting foot care) significantly improved foot care knowledge in the intervention groups compared to the control groups. The Higgins' & Thompson's (I<sup>2</sup>) method was used to evaluate heterogeneity, with 21% found in the first evaluation (before the intervention) presenting low heterogeneity, and 86% in the final evaluation of the experiment (after the intervention) showing high heterogeneity. The Baujat analysis and the leave-one-out method were used to identify the articles that caused the 86% heterogeneity observed in the second evaluation, showing that the articles published by Moradi *et al.* (2019) and Biçer and Enç (2016) contributed most to the observed heterogeneity.

**Article analysis by self-efficacy modification:** Self-efficacy is the belief of a person that he can successfully fulfill a desired behavior. The stronger the belief, the more effort the person puts into achieving the goal. People with high self-efficacy seem to be more successful in achieving the desired behavior<sup>30</sup>. However, self-efficacy improvement or development is not fast. In this systematic review, foot care self-efficacy was greater for people with DM after education on diabetic foot care than for people not receiving education. The studies conducted by Seyyedrasooli *et al.* (2015), Sharoni *et al.* (2018), and Biçer and Enç (2016) were selected to evaluate the impact of self-efficacy improvement on foot care and presented statistical data that allowed for the meta-analysis. The compiled analysis of the outcomes of the articles indicates that the SMD between groups increased from 0.6 (-1.1; 2.3) in the first evaluation to 9.6 (7.2; 12.0) in the final evaluation. Thus, the intervention (health education aimed at promoting foot care) significantly improved the self-efficacy of foot care in patients participating in the intervention groups compared to patients in the control groups. The Higgins' & Thompson's (I<sup>2</sup>) method was used to evaluate the heterogeneity of the studies, with 35% found in the first evaluation (before the intervention) considered above the upper limit of low heterogeneity (25%). In the final evaluation of the experiment (after the intervention), the 71% observed also showed heterogeneity among the results. An influence analysis was used to identify the articles that caused the heterogeneity. In this analysis, the articles published by Seyyedrasooli *et al.* (2015) were identified as an influence point at the initial time, and the article published by Sharoni *et al.* (2018) was identified as an influence point at the final time.

## DISCUSSION

**Health education interventions:** Health education strategies related research articles showed that receiving only written foot care materials was not enough to improve the behavior of type 2 DM patients (Bandura, 1997). This finding has important implications for the development of foot care education programs for people with DM. In addition, social support has been identified as critical for older patients in Vietnamese culture, and family income and self-efficacy in care have significantly improved foot skin (Bandura, 1997). Therefore, it is recommended to involve family members in educational intervention programs for such care, especially in the case of older adults. The combination of health education strategies involving the concepts of motivation, learning, and socialization to improve the effects of the educational strategy was highlighted as promoting knowledge and behaviors related to foot care (Sulistyono *et al.* 2018). The combination of learning and socialization concepts in the training field allowed participants to receive interactive learning about foot ulcer prevention within interactive strategies, including demonstrations and self-reflection with other participants, professionals, and the researchers themselves. However, according to Biçer and Enç (2016), there is a regression in behaviors achieved by

education after six months. Thus, the nurse needs to be attentive as well as periodically and creatively repeat the education session.

As for group and individual interventions, they can be associated and have similar results, but the participants have been shown to feel safer when they are in a group listening to the others' experience and supporting one another<sup>21</sup>. Another benefit resulting from group interventions is that health educators train more people in a shorter period. However, according to Corbett (2003), assessing each person individually results in improved knowledge and self-efficacy in people with DM. The main intervention method was the direct face-to-face transmission of information from the nurse professional to the patients. Only Moradi *et al.* (2019) did not use this method; instead, they used text messages to educate the intervention group. Biçer and Enç (2016) and Nguyen *et al.* (2019) associated face-to-face meetings with printed educational materials (pamphlets/booklets). Although increasingly accessible, none of the studies used the Internet as a means of knowledge or educational environment. The Internet presents a range of health-related information and is accessible and used by people with DM and their families (Brooks, 2001). Thus, professionals can certainly use the Internet to educate people on disease processes, but new skills and knowledge are needed by nurses to implement this technology in their practice. It is in this sense that health education can be thought of as a key strategy for promoting health, and knowledge and behavioral deficits related to DM are one of the factors that lead to negative attitudes toward the disease. Self-care is described as a major factor for psychological well-being, thereby improving adherence to treatment (Alpizar y Valenciano, 2018). Nursing professionals must pay attention to changes in life style and adaptive limitations to the new reality after DM diagnosis. These changes impact family and community life but should not be imposed (Carvalho y Gastaldo, 2008). This systematic review with meta-analysis has highlighted the evidence available in literature; the strategies used here can provide the academic framework necessary upon which to base foot care health education actions for people with DM.

## CONCLUSION

This analysis of the articles evidenced the leading role of nurses in generating health education knowledge focused on foot care for people with DM. The meta-analysis showed that health education actions can improve knowledge, behavior, and self-efficacy around foot care for people with DM. The sense of self-efficacy is related to knowledge and behavior. Therefore, the introduction of foot self-care education can decrease the incidence of foot ulcers and lower limb amputation.

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