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The Influence of Education on the Prevention of Foot Ulcer in Diabetic Patients: A systematic review

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Abstract:
Background*: Diabetic foot ulcer and lower limb amputation are common complication of diabetes mellitus that are associated with substantial morbidity, loss of quality of life, disability and a high social & economic burden on both patient and health resources. It is preventable if high risk individuals are identified by appropriate screening techniques and create awareness through health education to patient and family / care givers regarding foot care, foot hygiene and timely management of wounds.*
Materials and Methods*:*
Data was collected using literature searches from Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINNAHL), PubMed, EMBASE and Medline. To identify the search terms, the question was broken down into key components using the PICO format; Population: Diabetic patients; Intervention: Education on prevention of diabetic foot ulcer; Comparison: No comparison; Outcomes: knowledge and behavior of diabetic patients on foot care following the education. Non diabetic patients, studies not related to influence of education on prevention of foot ulcer, Patients with lower limb foot ulcer/ amputation were excluded from the study.
Results*: The search from database resulted in extracting 580 related articles on the keywords. After scrutiny, duplicates were removed and following screening, four studies were included in this systematic review on the basis of the inclusion criteria. These studies showed an increase in knowledge, willingness, motivation to learn and change in behavior following education on foot care by patients with diabetes. The other parameters such as body mass index, blood pressure also demonstrated a significant improvement following post education.*
Conclusion: *Diabetic foot ulceration is generally preventable. To minimize the burden of diabetic foot ulcers, improved screening and prevention programs as well as patient education should be provided to patients with diabetes.*
Key Word*: Diabetes, Foot ulcer, Education; Prevention; Foot care.*

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I. Introduction

According to epidemiological studies, the number of patients with diabetes mellitus increased from 30 million cases in 1985, 177 million cases in 2000, 285 million cases in 2010 and it is estimated that if situation continues, more than 360 million people by 2030 will have diabetes[1,2]. The world health organization (WHO) estimated that the diabetes population worldwide is currently 220 million and will be more than double by 2030. Diabetes is the fifth most common cause of death as per the reports of Department of Health US, 2009. The two main categories of diabetes are type 1 diabetes commonly known as insulin dependent diabetes and type 2 diabetes which is the non-insulin dependent diabetes. Type 2 diabetes poses a major public health challenge throughout the world. In addition to the increasing prevalence, patients are facing multiple complications, which can damage the eyes, nerves, kidneys and heart and one of the most common complication seen in the diabetic patients is foot ulceration. Once the skin barrier is breached, tissues are exposed to bacterial colonization, which eventually progress to infection causing foot ulceration[3]. Further, the WHO also reported that in the year 2012 there were 1.5 million death from complications of diabetes. If diabetes is unmanaged can lead to complications such as heart attack, stroke, blindness, kidney failure, nerve damage and extreme cases to lower limb amputation[4]. The most distressing complication that affects diabetic patients is diabetic foot ulcer (DFU)[5,6].

Diabetic foot ulcer is defined by WHO as foot in diabetes with neurological disorders, some degree of vascular involvement with or without metabolic complications of diabetes in lower extremity and prone to infection, scarring, with or without deep tissue damage. On the other hand, if these ulcers are not treated promptly will lead to infection, gangrene, amputation and even death.

Long term risk factors for foot ulceration and amputation include duration of diabetes, poor glycemic control, microvascular complication (retinopathy, nephropathy and neuropathy), peripheral vascular disease, foot deformities and previous foot ulceration or amputation[6]. Strong predictors of foot ulceration are altered foot sensation, foot deformities and previous foot ulcer or amputation of the other foot.

Among persons diagnosed with diabetes mellitus, the lifetime risk of developing a foot ulcer is estimated to be 15% (20). The annual population based incidence ranges from 1.0 to 4.0 and the prevalence ranges from 4 to 10% which indicates that lifetime incidence is 25% . Further, studies show that the risk of developing foot ulceration increases seven folds in patients with diabetic pheripheral Neuropathy[7]. An estimated 45 % to 60% of all ulceration in patients with diabetes are related to diabetic pheripheral Neuropathy and 40% are due to combined neuropathic and ischemic factors[6,7]. It is estimated that diabetic peripheral neuropathy (DPN) affects 50% of people with diabetes[8]. Peripheral neuropathy is the nerve damage caused by diabetes. When it affects the arms, hands, legs and feet it is called diabetic peripheral neuropathy. There is loss of protective sensation in the feet of diabetic patients leading to the development of foot ulcers[6,7].

According to the recent HSE figures, the number of diabetic patients receiving lower limb amputation surgery is increased from 393 people in 2013 to 440 people in 2014. About 80% of non-traumatic amputations among people aged 20 years and above occur in people with diagnosed diabetes [9]. Latest data shows that 2,400 people were hospitalized in 2015 as a result of diabetes related foot care complication, with 451 of those requiring lower limb amputation surgery[10].

On the World Health Day, the report over the concerns on the alarming rise in diabetics was presented. The number of adults living with diabetes was found rising and had quadrupled from the year 1980 with diabetics from 108 million to 422 million adults in the year 2014. The concern is that these foot problems not only effect physically, but has a significant financial impact. An Irish study showed that an average inpatient hospital treatment of diabetes related foot ulcer is 30,000 euro. Around £650 is spent on foot ulcers or amputations each year (NHS, 2012). In an US study, the estimated cost of treating a diabetic foot ulcer were $28,000 in 1999[11] and 18,000 dollars (with no amputation) and 34,000 dollars (with amputation) in a Swedish study[12].

Apart from these, diabetic foot problems have a considerable impact on the quality of life causing depression, reduced mobility and dissatisfaction with life[13]. Estimate suggest that up to one third (around 31%) of people experience depression associated with increased risk of mortality when they develop first foot ulcer causing a substantial loss of productivity.

Diabetic foot ulceration is preventable if high risk individuals are identified by appropriate screening program and given the appropriate foot care education[14,15]. If chronic complications of diabetes such as neuropathy, peripheral vascular disease and foot deformities are prevented, it may be possible to prevent the development of DFU and its consequences. All diabetic subjects should be offered a comprehensive foot-screening program and categorized as high, medium and low risk depending on previous foot ulcers, neuropathy, ischemia, deformity, smoking habit and vision. If the diabetic subjects are high or medium risk, they have to be screened annually and patients with low risk should be screened and referred to the podiatrist if their risk status changes[7].

Foot care education should be provided effectively and consistently. Nurses, especially the community health nurses can serve a pivotal role in the prevention and management of foot diseases among the diabetic patients by teaching patients to perform physical examination of their feet on a daily basis and also through community oriented programs and health assessments during home visits.

This systematic review will throw light on educating patients on foot care self-management, which is considered as the cornerstone to prevent diabetic foot ulcers. Appropriate education keeps the patient well informed on the risk factors and the importance of foot care, emphasizing the need for self-inspection, appropriate daily foot hygiene, use of appropriate foot wear.

II. Material And Methods

The primary outcome of the study measures the knowledge and behavior of diabetic patients on foot care following the education. The secondary outcome measures the systolic blood pressure, diastolic blood pressure, weight reduction in obese diabetic individuals.

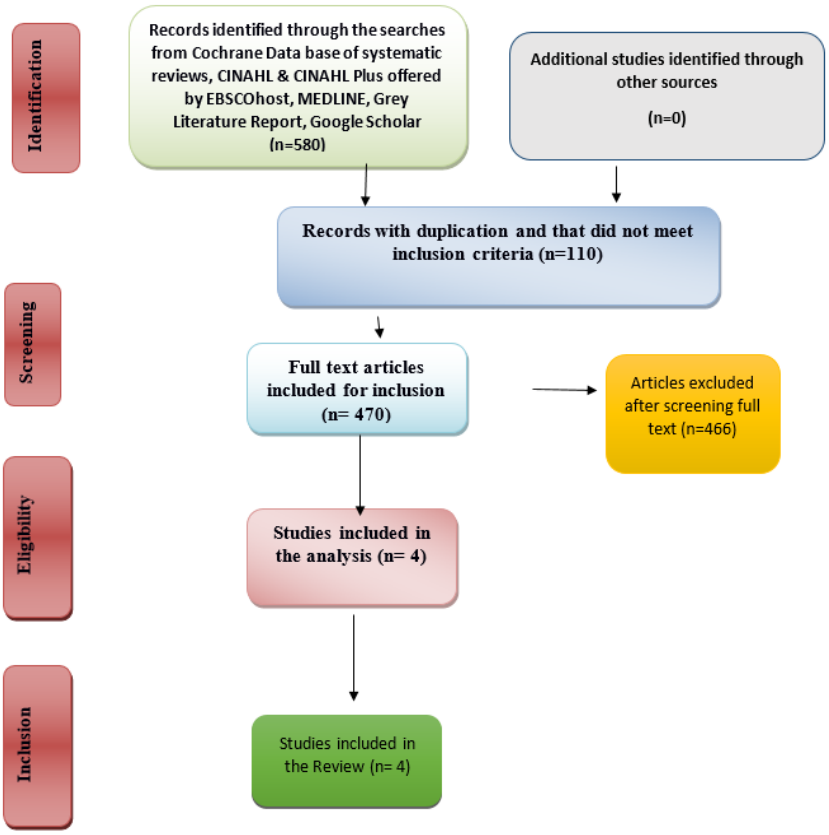
Search Strategy included all research studies that dealt with education on prevention of diabetic foot ulcers in diabetic patients.

The intervention in the study focused on written or verbal education on prevention of foot ulcers in diabetic patients. Three authors performed the search, conflicts were resolved through discussion of the full text content.

Search methods

A thorough literature search was carried out using the key words diabetes, diabetes mellitus, diabetic foot, podiatric care and prevention of diabetic foot, diabetes prevention, control and prevention of complication of diabetes, education, knowledge. The literature search was reduced to the studies carried out from the year 2009-2017. The data base searched was Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINAHL), EMBASE and Medline. To identify the search terms the question was broken down into key parts using the PICO format. Population included study participants who are adults aged 18 years and above with diabetes, Intervention included education on prevention of foot ulcer, Comparison - No comparison was done, Outcome included Knowledge and behavior of diabetic patients on foot care following the education. The record of the studies undertaken in this systematic review was maintained under PRISMA flow chart (2009) as shown in Figure 1. There were 580 articles selected from database based on the keyword. After duplicates were removed 470 articles remained. 112 full text databases underwent screening, 4 articles were considered eligible based on the inclusion criteria.

Figure 1: PRISMA flow chart of literature search of studies related to Education on the Prevention of Foot Ulcer in Diabetic Patients



Quality appraisal:

The EBL Critical Appraisal Checklist was utilized to assess the methodological validity and the content of included studies. If the overall validity of the study (Yes/Total) wass 75% or (No/Unclear/Total) 25% then the study was valid. Further, the study was critiqued by a second reviewer who was appointed by the program director for the appropriateness of decision making in instances, the writer had uncertainty regarding the included studies in the systematic review. Decisions regarding studies assessed as suitable were also reviewed by the second and third reviewer to confirm its inclusion into the systematic review.

Patients with diabetic foot ulcer complication were not included in the study. Also patients who were mentally disabled, profound deafness, cognitive impairment were excluded from the study.
Study participants were adults aged 18 years and above and diagnosed with diabetes mellitus. Participants with diabetic foot complications such as amputation of any underlying cause were excluded.

The type of Intervention in the study included administering a structured and pre-tested questionnaire to the subjects. The questionnaire involved four sections pertaining to awareness regarding diabetes, practice of diabetic care, practice of self-foot care and feet examination details. After collecting the questionnaire, each patient received 20 minute face to face education regarding self-care. After two weeks of health education, the same questionnaire was administered to the patients to identify the improvement in knowledge and practice.

Risk of bias: Risk of bias was scored for each study as ++ (very low risk of bias), + (low risk of bias) or – (high risk of bias). The quality of all included studies was performed at study level and was assessed employing the Cochrane collaborative tool for appraising the risk of bias (Cochrane Statistical Methods Group & Cochrane Bias Methods Group 2008). Studies included in the present systematic review were assessed across six domains: selection bias, performance bias, detection bias, attrition bias, reporting bias as shown in table 1.

Table 1: The Cochrane Collaboration's tool for assessing risk of bias

Domain	Support for judgement	Review authors' judgement
Selection bias.		
Random sequence generation.	Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.	Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence.
Allocation concealment.	Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment.	Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment.
Performance bias.		
Blinding of participants and personnel *Assessments should be made for each main outcome (or class of outcomes).*	Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Performance bias due to knowledge of the allocated interventions by participants and personnel during the study.
Detection bias.		
Blinding of outcome assessment *Assessments should be made for each main outcome (or class of outcomes).*	Describe all measures used, if any, to blind outcome assessors from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Detection bias due to knowledge of the allocated interventions by outcome assessors.
Attrition bias.		
Incomplete outcome data *Assessments should be made for each main outcome (or class of outcomes).*	Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomized participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors.	Attrition bias due to amount, nature or handling of incomplete outcome data.
Reporting bias.		
Selective reporting.	State how the possibility of selective outcome reporting was examined by the review authors, and what was found.	Reporting bias due to selective outcome reporting.
Other bias.		
Other sources of bias.	State any important concerns about bias not addressed in the other domains in the tool. If particular questions/entries were pre-specified in the review's protocol, responses should be provided for each question/entry.	Bias due to problems not covered elsewhere in the table.

Data extraction and synthesis:

The researcher extracted the details of four eligible studies that fulfilled the inclusion criteria and summarized them into the data extraction tool with reference to: authors, year of publication, tittle, research question objectives, study design, setting, sample and sample size, duration, outcome, analysis, results, conclusion and recommendation. The data were extracted independently and the suitable studies were evaluated and approved by the second reviewer and third reviewer. The narrative summary of the included studies indicating the geographical location, participants and sample size, study design, intervention and follow up was carried out for each study included in the systematic review. Further the data extracted was also presented in a tabular form as in table 2.

Table 2: Data extraction tool showing the narrative summary of the included studies in the systematic review.

Study -1	
Authors / Year of Publication	Vatankhah N., Khamseh M.E., Noudeh Y.J., Aghili R., Baradaran H.R., Haeri N.S.(2009)
Title of the study	The effectiveness of foot care education on people with type 2 diabetes in Tehran, Iran
Research question/ objectives	To evaluate the impact of a simple educational programe on the knowledge and practice of people with type 2 diabetes in relation to the foot at risk in Tehran , Iran.
Study design	Structured interview using a 32 item design questionnaire
Setting	Diabetic foot centre at the institute of endocrinology and metabolism affiliated to Iran university of Medical sciences.
Sample and sample size	One hundred and forty eight people with type 2 diabetes
Duration	6 months for first assessment and 12 months for second assessment
Outcome	Primary outcome: incidence of ulcer at 12 month Secondary outcome Incidence of ulcer at 6month and amputation
Analysis	Descriptive and analytic statistics
Results	One hundred and forty eight people with type 2 diabetes enrolled in the study. Mean age of the participants was 57 years . The total knowledge score of the studied population was 6.63 +/- 3.03. This value increased to 9.15 +/- 4.44 after 6 months of primary assessment and education .The average increase in total education score after education was 2.15 The applied educational intervention improved their knowledge and practice about diabetic foot care (P<0,0001 and P= 0.011.)
Conclusion/ Recommendation	The overall results of the study showed that educational intervention had an impact on improved knowledge and foot care behavior
	Study -2
Authors / Year of Publication	Nemcova J., Hlinkova E.(2013)
Title of the study	The efficacy of diabetic foot care education
Research question/ objectives	The aim of the study was to identify the efficacy of the education program on diabetic foot care
Study design	Survey
Setting	Hospital – vascular surgical outpatient department
Sample and sample size	100 –patients diagnosed with Type 2 diabetes (52 with diabetic foot syndrome and 48 were with ischemic disease of lower extremities
Duration	Six months
Outcome	The sample showed a higher score in knowledge, willingness and motivation to be educated after six months of education
Analysis	Paired t-test
Results	There was a statistically significant positive changes with education and the clinical parameters that were evaluated like reduction in weight (p = 0.047), decrease in BMI (p = 0.018), decrease in systolic (p = 0. 000) and diastolic (p = 0.000) blood pressure which shows a change in behavior towards self care
Conclusion/ Recommendation	The study shows that appropriate education ensures improvement in knowledge and willingness to change behavior to prevent diabetic foot complications.
Study -3	
Authors / Year of Publication	Goie T.T. Naidoo M.(2016)
Title of the study	Awareness of diabetic foot disease amongst patients with type 2 diabetes mellitus attending the chronic outpatients department at a regional hospital in Durban , South Africa
Research question/ objectives	To assess the level of awareness of DFD amongst patient with type 2 diabetes mellitus.
Study design	An observational descriptive cross sectional study was conducted.
Setting	Outpatient department of a regional hospital in Durban, South Africa.
Sample and sample size	Sample size of 280 was considered appropriate for the study. The inclusion criteria were T2 DM , patients who were >18 years and had been on treatment >12 months .
Duration	October 2014
Outcome	Study to measure knowledge before and after diabetes education. Knowledge score ranged from 0-8, attitude score 0-3, practice scores from 0-19.
Analysis	Descriptive analysis
Results	There was a positive relationship between attitude and gender with a positive coefficient of 0.168 with p value that was significant (p<0.05) .Men had significantly higher attitude compared to men.
Conclusion/ Recommendation	DFD causes deterioration in quality of life and affects quality of care for diabetic patients. It poses a serious medical, social and economic challenge for the healthcare system. Many of these foot problems could be reduced if primary and secondary prevention were prioritized in routine clinical care.
Study 4	
Authors / Year of Publication	Qadi M.A., Al Zahrani H.A.(2011)
Title of the study	Foot care knowledge and practice among diabetic patients attending primary health care centers in Jeddah city
Research question/ objectives	To assess patients understanding of their prior foot risk when presenting with a new diabetic foot

	ulcer.
Study design	Cross sectional study
Setting	Setting: The ministry of health -Primary health care centers in Jeddah.
Sample and sample size	There were 5-7 primary health centers in each sector. Targeted sample was to recruit 70 male and 70 female known diabetic. 747 total patients were randomly enrolled in the study.
Duration	12 weeks in the year 2009
Outcome	The study method was a questionnaire about the knowledge and practice of foot care for diabetic patients. The patients were told about the objective of the survey. One limitation in the study was that some diabetic patients belonging to higher socioeconomic classes, may not attend the health centers and take their follow up in private sectors.
Analysis	Data analysis was done using SPSS program version 16
Results	A positive correlation between knowledge score and the practice scores as spearman's rank correlation coefficient revealed , statistically significant correlation ($p<0.001$)
Conclusion/ Recommendation	There is weakness in foot care knowledge and more in the practice among diabetic patients living in Jeddah. The problem is patients with low educational level and those who are jobless. There is need to start well-structured foot care educational programs focusing on the low economic group to be delivered at various health sector. The program need to be in conjunction with a continuous program of periodic screening of high risk patients to prevent foot problems.

III. Results

Narrative overview: The review included four studies (Vatankhan et al. 2009[16], Qadi et al. 2011[17], Goie et al. 2010[18], Nemcova et al. 2013[19]). This systematic review included 1275 participants.

Geographical location: The four studies included in the systematic review were conducted in different geographic location; one study was conducted in South Africa, two studies in Middle East and one in Iran. The study conducted by Goie et al (2011) was carried out at a regional hospital in the city of Durban during October 2014 whereas the study by Nemcova et at. 2013 was conducted at a large hospital in Slovakia in a vascular surgical outpatient department between January and June 2009. The study by Qadi et al. 2011 was carried out at primary health centers in Jeddah and Vatankhah et al.2009 conducted the study in the diabetic foot center in Iran from October 2006 to July 2007.

*Participants:*A total of 1275 participants were included from the four studies taken for the systematic review. All the subjects were diagnosed with type 2 diabetes mellitus and were above 18 years of age. The study by Goie et al. 2011 selected a sample size of 280 participants with type 2 DM, of which 201 (71.8%) were female and 79 (28.2%) were males. Mean age of the study participants was 59 ±9.28 years. Eighty – four (30%) participants had been diagnosed with type 2 DM in the past 5 years. In the study conducted by Vatankhah et al. 2009, hundred forty- eight people with type 2 diabetes were included in the study. Qadi et al. 2011 included 747 patients with known diabetes, mean age was 52.7 ±11.9 years where male to female ratio was 1.02 :2 and mean duration of diabetes was 8.5 ±6.3 years . Further, Nemcova et al. 2013 included 100 diabetic subjects with type 2 diabetes mellitus, among whom 52 diabetics were with diabetic foot syndrome (DFS ; Wagner 3-5) and 48 diabetic patients with ischemic disease of l.ower extremities (IDLE). The average age of the participants was 61.08 years, Sample consisted of 47 women and 53 men and duration of diabetes ranged from 1-35 years.

Study setting: Among the four studies included in the systematic review, two of the studies namely, Goie et al. (2010) and Nemcova et al. (2013) were conducted in a hospital setting. The third study by Qadi et al. (2010) was conducted at a primary health center in Jeddah and the fourth study by Vatankhah et al. (2009) at a diabetic foot center.

Study design: The study design adopted by Nemcova et al. 2013 and Goie et al.2010 was a pre-experimental design; whereas Vatankhah et al. 2009 utilized an observational descriptive cross sectional study and Qadi et al .2010 adapted a cross sectional design .

Interventions and follow up: All the four studies included in the systematic review; Goie et al. 2010, Nemcova et al. 2013, Qadi et al. 2011, Vatankhan et al. 2009 dealt with the effect of education on prevention of foot ulcers in diabetic patients.

Vatankhah et al. 2009 conducted the study to evaluate the impact of educational program on the knowledge and practice of individuals with type 2 diabetes in relation to the foot risk in Tehran, Iran. One hundred and forty eight participants underwent a structured interview using a questionnaire about their knowledge on foot care and their personal foot care behaviors. The questionnaire consisted of 32 items. The first section consisting of 16 questions assessed knowledge of the participants on foot care, its etiology and the possible threats to their feet and the second section again of 16 questions on foot care practice comprised of questions on foot self-examination, footwear, care of toenails and also foot hygiene. The total score was obtained by summing the total of 16 knowledge questions and 16 practice questions for each participant. Analysis showed that the total knowledge and practice scores ranged from 0-16.

After a preliminary assessment, each participant underwent a 20 minute face to face educational program. The educational program was related to foot self-examination, how to trim toe nails, and prompt treatment of new lesions. In addition, the participants were given a brief explanation on the principal causes of foot ulcers (impaired circulation, loss of sensation, and secondary infection). Finally, each participant received a

booklet on information and procedures to perform on daily foot care and the risk factors of diabetic foot. Eventually, the knowledge in the field of foot care and their practice was evaluated using the same questionnaire after 6 months of the designed educational program.

In the study conducted by Qadi et al. 2011 the data was collected on the questionnaire about knowledge (9 questions) and practice (11 questions) of foot care for diabetic patients. A total of 747 diabetic patients were involved in the study. Data analysis was done using SPSS program version 16 for the 9 knowledge questions (one score was given for each correct answer) and the practice questionnaire had items with four options having the score as always = 3, often = 2, sometimes = 1, no = 0. Hence the total score was 33 for those who always behaved in healthy manner.

Analysis showed that the median score for knowledge was 7 of 9 and the median score obtained for practice was 14 of 33. The mean duration of diabetes among the participants in the study group was 8.5 years, however only 65.3% of the participants knew the importance of daily foot check as observed in the knowledge questions. The median practice score was observed to be low which highlights the need for improvement. There was no significant relation between knowledge median score and the studied sociodemographic variables (Nationality, Gender, Age groups, Education level, Type of job). However it was observed that with type of job; those who were jobless had a lower knowledge score ($p= 0.008$). Subsequently, it was observed that the behavior median score was significantly positively related to the educational level of the participants ($p=0.001$) and significantly less in participants who were jobless ($p<0.001$).

Also, in this study there was positive correlation observed between knowledge scores and the practice scores as spearman's rank correlation coefficient (spearman's rho) revealed statistically significant correlation ($p< 0.001$) with a coefficient accounted for 0.559. The majority of the participants in the study had a low level of education. Education proved to be statistically associated with higher prevalence risk with regard to ulceration of the feet. This means that the lower the education status, the greater the risk of ulceration. De Barardis et al. 2005 conducted a study on diabetic foot care in Italy, also advised to give more attention on patients with low socio economic level, as they found diabetic foot complication was more common in patients with lower income and with lower educational level.

The study conducted by Goie et al. 2016 where a total of 280 participants were selected by randomized sampling method. The mean age of the participants were 59±9.28 years. Ten participants (3.6%) had tertiary education of whom 60 % were females and fifty four (68 %) of the male subjects had no formal education. Eighty -four (30%) participants had been diagnosed with type 2 DM in the past 5 years. Sixty -five percent of the participants examined their feet every day and 22.2 % examined their feet only when they had a problem. There was a positive relationship between gender and attitude , with a positive Pearson coefficient ($r = 0.168$). Men had significantly higher attitude score than that of women. There was a positive relationship between education level and previous foot care education ($p<0.05$), with patients having higher level of education achieving a better score. There was a significant negative correlation between participants aged < 65 years likely to report a higher score for previous foot care education than people >65 years.

Nemcova et al. 2013 evaluated efficacy of foot care education, by using a structured assessment. Data was collected from 100 diabetics of which 47 were women and 53 were men. Of the 100 subjects, 52 diabetes were with diabetic foot syndrome (DFS: Wagner 3-5) and 48 diabetic subjects were with ischemic disease of lower extremities (IDLE).The average age of the respondents were 61.08 years. Forty – four respondents were diagnosed with type 2 DM from 1-10 years ago and other subjects were diagnosed with type 2 DM more than 11 years. Only 38 participants reported of having attended an educational activity about diabetic foot care previously.

The intervention used in the study was either an individual or group education which focused on compensation of diabetes mellitus and diabetic diet; self-testing of diabetic foot; right choice of footwear; solutions to problems with the foot; diabetic ischemic disease of lower extremities and foot exercises. The subjects were given a pre-test prior to the education and a post-test six months after the education. All the subjects in the study had a higher knowledge score, willingness and motivation to be educated to carry out activities to prevent the complications of diabetes mellitus following the education than before education .When the patients with DFS and IDLE were compared, patients with DFS had a statistically significant ($p= 0.028$) higher level of knowledge regarding foot care of diabetes (80.37%) than diabetic patients with IDLE (72.71%). There was a difference in willingness and motivation to be educated in patients with DFS & IDLE which was statistically significant ($p=0.037$). Patients with IDLE were more willing and motivated to be educated than patients with DFS (IDLE $x=78.55$. DFS $x= 70.43$). Comparison of their knowledge showed that patients with IDLE achieved significantly higher score than patients with diabetic foot. There was no difference in scores in the knowledge test between the individually educated patients and educated in groups, there was a statistically significant relationship ($p=0.001$) between the organizational form of education (individual vs group) and the willingness and motivation to be educated to perform activities in the prevention of DM complications. The paired t-test showed statistically significant positive changes in the clinical, objectively evaluated parameters of

the respondents who participated (n=65) where there was reduction in weight (p=0.047), decrease in BMI (p=0.018), decrease in systolic (p=0.000) and diastolic (p=0.000) blood pressure.

Outcome of quality appraisal

The outcomes measures evaluated from each of the included studies in the systematic review are summarized in table 3.

Table 3: Outcome measures evaluation in the included four studies in the systematic review

Outcome	Vatankhah et al. 2009	Qadi et al. 2011	Goie et al. 2016	Nemcova et al. 2013
Primary outcome				
Knowledge and behavior on foot care	•	•	•	•
Secondary outcome				
Systolic blood pressure			•	•
Diastolic blood pressure			•	•
Weight reduction	•	•		•

Primary outcomes:

All the four studies (Vatankhah et al. 2009., Qadi et al. 2011., Goie et al. 2016 and Nemcova et al. 2013) included in this systematic review provided data related to knowledge and foot care among diabetic patients. The study conducted by Vatankhah et al .2009, the total knowledge score of the study participants before education was 6.63 ±3.03. This value increased to 9.15 ±4.44 after 6 months of primary assessment and education. The practice score prior to education was 8.32±2.63 and it increased to 9.07±3.06 after education and secondary evaluation. The average increase in the knowledge score was 2.51 whereas the mean increase in total practice score was 0.77.

A step wise analysis was undertaken to assess if demographic variables had an effect on the knowledge and practice score of the study participants following education. Analysis showed that among the assessed demographic variables, the categorized BMI was the only variable that affected the education of these patients. Analysis showed that the knowledge score increase was statistically significant in both lean (BMI<25) and obese (BMI>25) groups ($p < 0.001$, paired samples t-test for both analysis). However the knowledge score after education was statistically higher in the lean diabetics (p=0.039, independent samples t-test), while it was the same value before education in two groups (p=0.808, independent samples t-test). Further, it was also observed that, the practice score of the lean diabetics increased significantly after education (p=0.002, paired samples t-test). However, this score did not increase significantly in the obese diabetics (p=0.080, paired samples t-test). Comparison of the practice scores showed that the scores differed significantly in the two groups after education (p=0.016, Mann-Whitney U test), whereas it was the same value before education (p=0.903, Mann-Whitney U test).

In the study conducted by Qadi et al. 2011 the median score of the knowledge was 7 of 9 which was favorable, while the median score of practice was 14 of 33 which needed improvement. There was no significant relation between the knowledge median score and the studied socio-demographic variables except for job status as those who were jobless had a lower knowledge median score with p= 0.008. Also, behavior median score was significantly positively related to educational level p=0.001 and was observed to be significantly less in jobless (p<0.001). There was no significant relation of knowledge and practice scores with the duration of diabetes. The Knowledge questionnaire showed that only 65.3% knew the importance of daily check of the foot.

Goie et al. 2016 identified in the study there was a positive relationship between gender and attitude. Men had higher attitude score than women with p value <0.05. Knowledge score ranged from 0-8, attitude score from 0-3 practice scores from 0-19. It was noticed that, individuals with higher level of education achieved better score. Footwear was inappropriate as many claimed wearing open footwear which exposed them to infection and trauma.

Secondary outcome:

Systolic and diastolic blood pressure: Two studies (Goie et al. 2010 and Nemcova et al. 2013) included blood pressure in their studies. In the study conducted by Goie et al .2016 there is a strong evidence that lifestyle modification such as losing weight, physical activity , follow dietary recommendations , ceasing smoking will help in the control of hypertension, dyslipidemia , diabetes and other cardiovascular diseases associated with diabetes and the diabetes itself (Fox et al .2015). In the study, conducted by Nemcova et al .2013 following the education there was a decrease in systolic (p=0.000) and diastolic (p=0.000).

Weight reduction: Weigh reduction was measured in Vatankhah et al. 2009, Qadi et al. 2011., and Nemcova et al.2013.

All included studies showed that education program improves knowledge and behavior in preventing diabetic foot ulcers among diabetic patients.

Quality Appraisal : All the studies were appraised using the EBL critical appraisal checklist . EBL critical appraisal checklist is used to check the validity of the included studies. EBL overall percentage of validity for the study conducted by Vatankhah et al.2009 were 64.28% , Goie et al.2016 overall validity were 67%, Qadi et al. 2011 about 60% of overall validity and Nemcova et al .2013 the overall validity were 64%. Studies were assessed across six domains including selection bias , detection bias, attrition bias, reporting bias .The results are summarized in table 5.

Table 4: Assessment of Risk for bias in the studies included in the systematic review

	Selection bias	Reporting bias	Performance bias	Detection bias	Attrition bias
Vatankhan et al 2009	**High**	**Low**	**Low**	**Low**	**Low**
Goie et al 2016	**High**	**Low**	**Low**	**Low**	**High**
Nemcova et al 2013	**High**	**Low**	**Low**	**High**	**Low**
Qadi et al 2016	**High**	**Low**	**Low**	**Low**	**High**

Judgements was done on five items for each of the four studies included.

In the study conducted by Goie et al. 2016 despite the systematic randomized sampling method used ,genders were not equally represented, with 201 (71.8%) were female and 79 (28.2%) were male participants in the study . Whereas the study conducted by Nemcova et al. 2013, selected 100 diabetics of type 2 diabetes mellitus of which 52 diabetics were with diabetic foot syndrome and 48 diabetic patients were with ischemic disease of lower extremities. In the study conducted by Qadi et al. 2011 there were 5-7 health centers in Jeddah. From each sector one center was chosen randomly. The targeted sample was to recruit 70 male and 70 female known diabetic patients from each center during the study period. Some centers were able to have the targeted sample, but some failed. This variability was due to the difference in total number of diabetic patients attending each center. Hence, the total patients enrolled in the study was 747. While in the study conducted by Vatankhah et al .2009 selected one hundred and forty – eight people with type 2 diabetes who underwent structured interview on diabetic foot care and behavior.

In the study conducted by Goie et al .2016 nineteen participants dropped out whilst filling in their answers, some saying that had to rush elsewhere and others had particular reasons. Whereas , in the study by Qadi et al. 2011 the limitation of the study, was that diabetic patients , from high socio – economic classes , did not come to the ministry of health centers and their follow – up was in private sectors or in other governmental health sectors.

IV. Discussion

The aim of this systematic review was to determine the impact of education on prevention of diabetic foot ulcers among diabetic patients. A thorough search of the literature gained four studies such as Vatankhan et al. 2009, Qadi et al. 2011 , Goie et al. 2016, Nemcova et al .2013 representing supporting the requirements of the review.

All the four studies included in the review included knowledge and practice of diabetic subjects on prevention of foot ulcers. The included studies supported the inclusion of education on prevention of diabetic foot ulcers. All the studies included in this systematic review showed an improvement in practice following the educational program.

Age: average age of the subjects were 60 years and above in the four studies included in the systematic review which shows that age could be a risk factor for diabetes mellitus and increases the tendency to the development of complications.

Gender: Majority of the participants in the studies included in the systematic review were males except in one of the studies. In the study conducted by Vatankhah et at. (2009), 65.5% of the participants were females and 34.5 % males, similarly male to female ratio was 1.02: 1 in the study conducted by Qadi et al.(2010) and there were 47 women and 53 men in the study by Nemcova et al. (2013); whereas in the study by Goie et al. (2016), among the total of 280 participants with type 2 DM, 201 (71.8%) were females and 79 (28.2%) were men.

Education: In the study conducted by Goie et al. (2016) ten participants (3.6%) had tertiary education of whom 60% were females and fifty four (68 %) were male subjects had no formal education, whereas in the study conducted by Qadi et al . (2010) about one third (32.6%) of the samples were illiterate and 11% completed the secondary level of education, while in the study by Vatankhah et al. 2009 about 20.9% were illiterate, 54% had 1-12 grade education. A low level of education was evident among the participants. This factor can have an impact on the comprehension of the guideline set by the health system, because the lower the education level, the less access to information and ability to understand.

Comorbities: The three most common comorbidities among the study sample conducted by Goie et al. (2016) were hypertension (57.5%), dyslipidemia (26.7%) and eye disease (7.2%), whereas in the study carried out by Qadi et al. (2010) almost one quarter (26.9%) of the study sample were suffering from hypertension and 15.5% indicated having hyperlipidemia. In contrary, peripheral neuropathy was found in 3% of the participants in the study conducted by Goie et al. (2016) whereas in the study by Qadi et al . (2010), 45.4 % reported having peripheral neuropathy.

Weight of participants: A more alarming findings from the study was that majority of the participants in the study had a high body mass index (BMI). In the study conducted by Vatankhah et al. 2009 the BMI<25 kg/m2 was 24.3% and the remaining 75.6% were of BMI value greater than 25kg/m2. Further, in the study conducted by Goie et al. (2016), ninety one per cent of the participants were either obese or overweight, similarly in the study conducted by Qadi et al. (2010) more one third (38.3%) of the samples were obese and 38.8% were overweight and less than a quarter (21.9%) were normal. Also, in the study carried by Nemcova et al. (2013), BMI before education was 30.60 and after education it was 30.11. The above finding throw a concern on the body mass index as obesity is shown to be a significant risk factor in the development of late complications among diabetic clients.

Foot care: Study conducted by Goie et al. (2016), sixty -five per cent of the participants examined their feet every day and 22.2 % examined their feet only when they had a problem, ninety -four per cent of the participants did not cut their nails by themselves, instead it was done by a family member, In contrary, the study conducted by Qadi et al. (2010) demonstrated that majority (91.2%) had knowledge about the importance of washing foot, but regarding practice of foot care, only 65.3% knew the importance of daily check of the foot, 25.6 % of the sample did not dry their feet after washing them, 25.4 % of the patients did not assign time to check their feet on a daily basis .

Further in the study conducted by Goie et al. (2016) the participants wore more than one type of shoe, and majority (83.2 %) preferred to wear open shoes such as sandals and flipflops, which made them prone to infection and trauma. Also, 88 % of the participants demonstrated wearing socks regularly. Also Qadi et al. (2010) reported that 49.8% of the participants do not wear fully covered shoes among whom 22.2 % of the males and 43.8% were females using the open shoes.

This has a concern as foot care knowledge and practice can play an important role in preventing diabetic foot ulcers.

Qadi et al .2010 there was a positive relationship between education level and previous foot care education with patients having higher level of education achieving better score. The median knowledge score was 7 of 9 and practice score 14 of 33. Those who were jobless had a lower knowledge median score with p=0.008. In the study conducted by Goie et al.2016 , although the knowledge score had high mean, participants had poor education of the most significant factors of all types of DFD namely the presence of foot infection/ ulcer , peripheral neuropathy and PVD.

Educational program (type of interaction): Patients educated in group have shown a statistically significant higher average score of willingness and motivation than patients educated individually. The educational environment can thus be a positive incentive as well as the type of interaction.

Limitation*:* The majority (66.5%) of the participants included in the study (Qadi, et al. 2011) reported that they had one or more complications of diabetes. In one study by Goie et al 2016 despite the randomized sampling the genders were not equally represented , with 201 female vs 79 males participants in the study. Although the knowledge score had a high mean, there was great variance demonstrated by high standard deviation. In the study conducted by Nemcova et al. 2013 after education showed there was a significant change in BP. The study did not confirm a decrease in glycol hemoglobin as being important in the reduction of complications of diabetes. Other limitations included are the outcome of the studies are not clearly described. Studies related to the systematic review were not considered as some of the studies were in foreign language.

V. Conclusion

The current systematic review emphasizes on educating clients on taking care of self. The review demonstrates improvement in knowledge and practice among diabetic clients to prevent diabetic foot ulcers. Patient education with an emphasis on aggressive approach to modify risk factors not only prevent complications of diabetes but also modify and adapt to lifestyle changes. There is a strong evidence that lifestyle modification such as all types of physical activity, losing weight , ceasing smoking and by following nutritional recommendations provide benefits in the prevention of HTN , dyslipidemia , diabetes and other cardiovascular diseases associated with type 2 DM and reduce diabetes itself.

Ongoing integrated motivation and education leading to behavior change should be given to diabetic patients at the first onset of symptoms of foot disease as the risk of developing DFD is significantly high. Regular screening of type 2 diabetes mellitus patients for sensory and vascular foot changes and patient education on preventative measures should be reinforced and stressed in al health care institutions. Those with a

positive features on the screening tool must have a tighter glycemic control and be a subject for intensive foot care educational programs. The effort of mass media is needed to enhance the foot care education. The medical community needs to establish and activate diabetic social groups to enhance foot care program and diabetes care in general.

DFD causes deterioration in quality of life posing serious medical, social and economic challenge for the healthcare system. Poor knowledge combined with poor self-care practices compromises holistic patient care. Many of these foot problems could be reduced if primary and secondary prevention were prioritized in routine clinical care. However the health system should empower diabetic patients with knowledge, skills and own foot care practices.

***Relevance to clinical practice*:**

Education is an important intervention that can change the knowledge and behavior of the diabetic patients. Individuals with one risk factor identified (neuropathy, ischemia, deformities) should have education every six months. It is essential to be aware that foot deformities such as neuropathy, shortening of Achilles tendon cannot be minimized by education. High risk patients with at least two risk factors or those having ulceration in previous times should receive ongoing education as a part of regular podiatric care. Improving knowledge by using smoking cessation intervention amongst type 2 DM patients, may be a good health strategy in decreasing the risks of DFD. There is weakness in foot care knowledge and is more prevalent in low educational level samples and those who are jobless. There is a need to start a well-structured foot care educational programs that focus on the low -socioeconomic group of communities. A systematic education to patients is a valuable tool that ensures knowledge, motivation and willingness to change behavior in order to prevent diabetic foot complications of diabetics. Hence nurses can use structured educational intervention to prevent development of diabetic foot ulcers patients.

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