

Knowledge and practice of diabetic foot care – A scoping review

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Highlights

- Participants among the various studies had varying degrees of foot-care knowledge.
- Participants among the various studies had varying degrees of foot-care practices.
- Many people had knowledge of various aspects of foot care, but fewer people practiced proper foot care.
- Knowledge and practice regarding specific exercises for the legs and feet was not mentioned in any of the studies.

Abstract

Background and aims: This review aims to systematically map global evidence on foot-care knowledge and practices in relation to diabetes mellitus (DM) and identify areas that need further research.

Methods: Database searches were undertaken using Google Scholar, Medline (PubMed), Academic Search Complete (EBSCOhost), and Medline (EBSCOhost). Studies were initially sought by title and focused on knowledge of diabetic foot ulcer burden. The framework by Arksey and O'Malley and the PRISMA-SCR guidelines were used to guide the methodology. The themes explored were principles of foot-care knowledge and practice and these were reported using content analysis. The mixed-methods appraisal tool (MMAT) was employed to appraise the quality of the primary studies.

Results: Fifty-eight studies published between 2008 and 2018 met the inclusion criteria. Participants in various studies had varying degrees of foot-care knowledge and practice, including foot inspection, foot hygiene, glycaemic control, and foot protection. Many people had knowledge

of the various aspects of foot care but fewer practiced proper foot care. The MMAT showed the majority of the articles to be of high quality.

Conclusions: Level of foot-care knowledge and practice varied in the studies. A need for intervention on foot care was highlighted.

Keywords: Diabetic foot-care knowledge; Diabetic foot-care practice; Diabetic self-care activities

1. Introduction

Diabetes mellitus (DM) is characterised by chronic hyperglycaemia and disturbances in carbohydrate, lipid, and protein metabolism, resulting from deficiencies in insulin secretion and/or action [1]. Hyperglycaemia is responsible for the acute, short-term, and late complications of DM that affect body organs and systems, including retinopathy, heart disease, nephropathy, neuropathy, and diabetic foot disease, all of which result in a compromised quality of life [1,2]. Diabetic foot ulceration (DFU) is one of the devastating complications of DM and is the primary cause of hospital admission, amputation, and death [1].

Foot problems account for more hospital admissions than do any of the other long-term complications among patients with diabetes [3]. The lifetime risk of developing a foot ulcer is reported at 15–25% [3,4]. Up to 50% of DFUs and resultant amputations can be prevented by effective identification and education [3].

Proper foot-care behaviour and practice is aimed at protecting the feet of people living with DM and include the daily examination of feet for redness, ulcers, cuts, bruises, the washing, drying of feet especially between the toes, moisturising the top and bottom of feet, checking the insides of shoes before wearing them, protecting the feet from extreme hot and cold temperatures, trimming of toenails across while also seeking early care for lesions on the foot and having regular foot examinations done by a health care professional [[3], [4], [5], [6], [7], [8], [9]].

There is indisputable evidence that DFU and amputation are sequelae of poor foot-care practices [10,11]. Improved knowledge on self-management of foot care will reduce the barriers to identification of the early onset of DFU [4]. Well-managed foot-care education can be implemented to mitigate against factors contributing to diabetic foot disease [4]. While diabetic amputation rates are increasing in South Africa [12], there is a dearth of research regarding patients' understanding of the aetiological factors for DFU and ways of avoiding them. Reviewing global literature on foot-care knowledge and practice will provide trends on the level of foot-care knowledge and the degree of foot-care practice worldwide. The review was undertaken to obtain a global perspective on

knowledge and foot-care practices present from 2008 to 2018 to identify the gaps and trends present in the literature and to determine if additional interventions are necessary.

2. Methods

2.1. Design

This review was undertaken on articles on diabetic foot-care knowledge and practice between 2008 and 2018. The methodology was based on the framework described by Arksey and O'Malley [13] and involved constructing the research question, identifying and selecting relevant studies, recording and extracting the data, as well as collating, summarizing, and reporting the results. The PRISMA-SCR guidelines were used to present the data obtained [14].

2.2. Identification of the research question

The review adopted the Population-Concept-Context (PCC) framework that assisted to establish the eligibility of the research question for this review (Table 1). The research question was: What is the state of global evidence on diabetic foot-care knowledge and practice?

Table 1
Eligibility criteria.

Criteria	Determinants	Inclusion criteria	Exclusion criteria
Population	Patients with diabetes or type 2 diabetes mellitus	Articles with data on foot-care knowledge and practices	Articles with data reflecting other lower limb problems, diabetes co-morbidities
Concept	Foot-care knowledge and practice/behaviours	Articles with data on knowledge and practice of foot care Articles published between 2008 and 2018 Articles published in English	Articles only presenting results in the form of knowledge and practice of foot-care scores Articles not presenting any evidence on the principles of foot care related to this review
Context Sources of evidence	Global literature	Articles presenting evidence from all countries Grey literature in the form of thesis, abstracts, reports, and reviews only was not included in this review	

2.3. Identification of the study selection and search strategy

Evidence of foot-care knowledge principles and foot-care practice techniques were included in the data extraction tool (Supplementary File 1). Peer-reviewed journal abstracts were used to conduct the review. Articles not written in English and those published before 2008 or after 2018 were excluded. Grey literature in the form of reports and thesis was excluded. All study designs except review articles were included. Articles addressing DM and foot-care knowledge and practice were included. The following electronic databases were used to search for studies on knowledge and practice of foot care among patients with DM, namely Google Scholar, Medline (PubMed), Academic Search Complete (EBSCOhost), and Medline (EBSCOHOST). Key phrases used for the search included 'diabetic foot-care knowledge, diabetic foot-care practice, diabetic self-care activities.' Synonyms related to these search phrases were also included to ensure the identification of articles with associated words and phrases. Such phrases included 'diabetic foot-

care principles, diabetic foot self-care knowledge, and behaviors, diabetic foot-care education, foot-care strategies.' Identified articles were saved and imported to EndNote Library for review. The interlibrary loan service offered by the University of KwaZulu-Natal Library and Addington Hospital Library was approached to access articles that were not available on the online platform.

2.4. Selection of articles

From the articles generated through the keywords chosen, the researcher (PM) screened titles for eligibility. Thereafter abstracts were reviewed by two independent reviewers (PM and RN). The selected full articles were then reviewed again by the same two reviewers independently. Where the two reviewers could not reach a consensus, the articles were presented to a third reviewer and expert in the field of surgical and non-surgical research for a decision (TEM). The selected articles were extracted for data by the principal investigator (PM).

2.5. Quality appraisal of included primary studies

Included primary studies were appraised for quality using the Mixed Methods Appraisal Tool (MMAT) version 2018 (McGill) [15]. The tool was applied by two independent reviewers (PM and RN) and it was utilised to examine the appropriateness of the aim of the study, adequacy and methodology, study design, participant recruitment, data collection, data analysis, presentation of findings, authors' discussions, and conclusions. A score of 20 was allocated to each question for every article, which eventually provided a score out of 100. Calculation of the overall percentage quality score was done. The scores were graded ranging from $\leq 50\%$, which was regarded as low quality, 51–75%, which was average quality, and 76–100%, which was regarded to be of high quality. For qualitative and quantitative studies, the score was a number of criteria met by each study divided by 5 [15]. For the mixed methods studies the domains comprised qualitative, quantitative, and mixed methods components. The score was 20% when one criterion was met, 40% when two criteria were met for a domain, 60% when three criteria were met for a domain, 80% for four criteria met, and 100% when all criteria were met for all domains [15].

2.6. Recording and data extraction

A data extraction tool was used to extract the appropriate data. This tool was designed for abstract screening, full article screening, and data extraction. Titles were screened by PM and the citation was imported to the EndNote Library. Data were extracted by PM from the eligible articles, using the data extraction sheet. Data included author names, country, year of publication, study design, study, and geographical setting, study aim, population age, type of DM, foot-care knowledge and foot-care practice principles, scores on knowledge and practice, significant findings, and conclusions. Content analysis [16] was used to analyse data. Content analysis is a research

method that is considered highly flexible and used in quantitative, qualitative, and mixed modes of research frameworks. It is regarded as a systematic, rigorous approach to analysing data and employs a broad selection of analytical methods to generate findings and place them into context [16]. Proportions of patients adhering to the parameters under various themes were expressed as median and interquartile range.

2.7. Collating, summarizing, and reporting the results

Using the content analysis approach, the sourced evidence was presented using themes. The themes and sub-themes were generated based on the data extracted from the articles (See Supplementary File 1). This included the characteristics of the included studies, knowledge, and practice of various foot-care principles. Median values accompanied by interquartile ranges were also reported under themes. The results from this study in relation to future research, policy, and health implications were reported.

3. Results

3.1. Screening

Two hundred and seventy-one articles were identified through the database search (Fig. 1). One hundred and fifty-three were excluded through abstracts, leaving 118 records, which were assessed for full eligibility. Preliminary exclusions at the abstract stage included duplicates (149); articles required payment [2] and articles not available in full text [2] making 118 articles available for full screening. Of these, 60 articles were excluded as per exclusion criteria, and 58 articles fulfilled the inclusion criteria and progressed to the data extraction phase for final analysis. The exclusions for the 60 articles included full articles not written in English, no representation of evidence for the principles of foot care for this review, and some articles only reporting in the form of knowledge and practice scores.

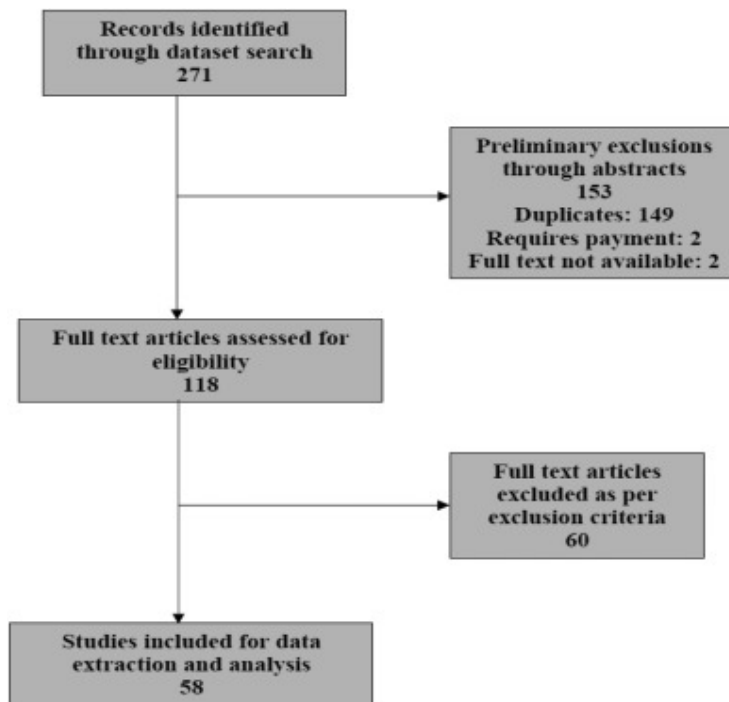


Fig. 1. Flow diagram showing the pathway of data collection.

3.2. Characteristics of the included studies

Table 2 lists the characteristics of the various articles. Various study designs were employed by the papers examined but the majority were cross-sectional studies. Fig. 2 shows the number of publications on the subject over the years. The articles reviewed were from 22 countries and, as shown in Fig. 3, the highest number of articles were from India (n = 13) followed by the USA (n = 6), Pakistan, and Saudi Arabia (n = 5). The other countries published 1–3 papers. Table 3 describes the number of articles addressing knowledge and practice of various aspects of foot care. The papers were not homogeneous with regard to the number of aspects of foot care that they examined. The four main themes were (i) glycaemic control, (ii) foot-care knowledge, (iii) foot-care practice, and (iv) physical activity.

Table 2
 Characteristics of the included studies.

Information	Studies (n)
Age mean and/or range)	58
Gender stated	57
Type of DM	
Type 2	23
Type 1 & 2	9
Not stated	26
Study settings	
Hospitals	31
Clinics	12
Healthcare Centre & Hospital	4
Hospital and/or Diabetic Centre	3
Population-based questionnaire	2
Diabetes Research Centre	1
Setting not stated	5
Geographical Setting	
Rural & Urban	5
Rural	4
Suburban	1
Geographical setting not stated	45
Study Design	
Cross-sectional	50
Qualitative	2
Randomized control trial	1
Non-randomized control trial	1
Study type not stated	4

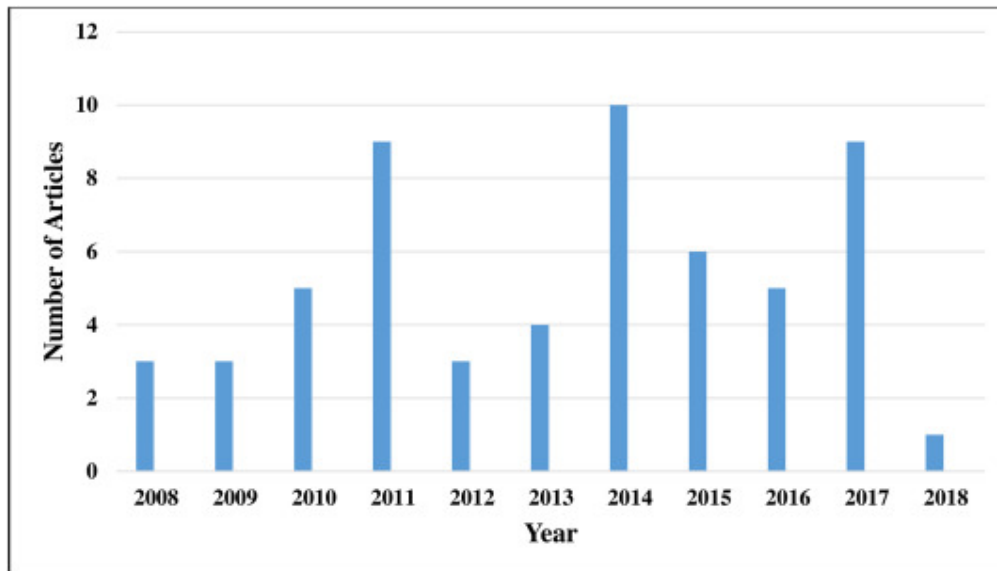


Fig. 2. Bar Graph showing the number of articles published per year.

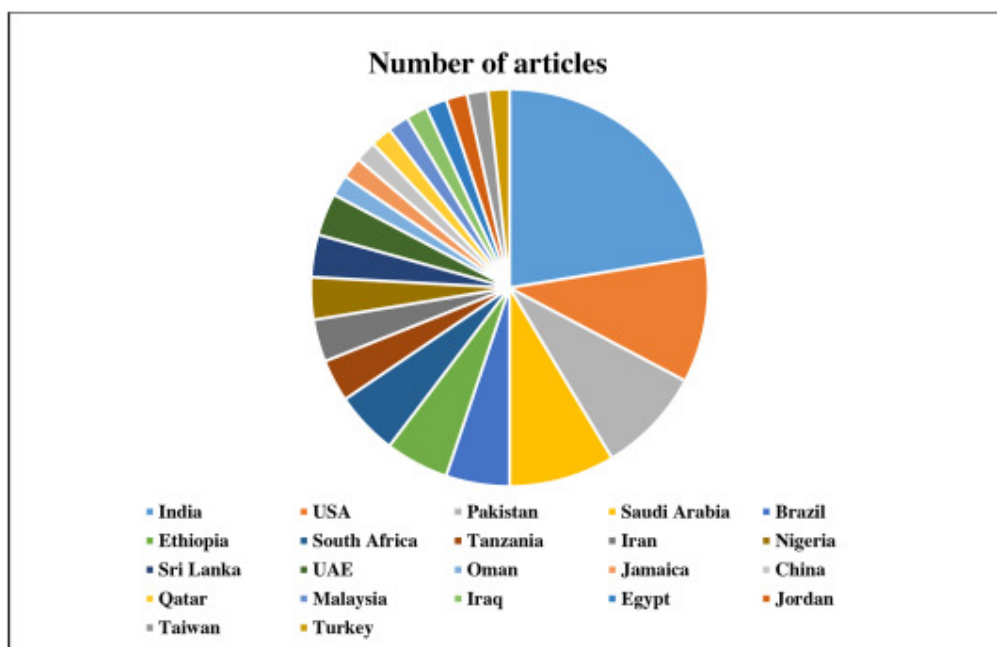


Fig. 3. Pie graph showing number of articles produced per country.

Table 3

Number of papers describing knowledge and practice of foot care.

Parameter	Knowledge	Practice
Knowledge that DM causes foot ulcer	8	—
Knowledge on glycaemic control	11	—
Knowledge on diet	4	—
Knowledge on physical activity	4	—
Exercises for lower limbs	0	0
Foot inspection/examination	17	44
Footwear inspection	9	33
Foot washing	14	34
Skin care (e.g., moisturisers)	7	26
Foot drying	10	27
Nail trimming	7	20
Application of foot protection (not walking barefoot)	15	33
Use of special shoes	8	18
Checking of ambient temperature	7	18

4. Glycaemic control and other factors of diabetes that can lead to DFU

Eight articles reported on participants' knowledge that DM can lead to foot ulcers. Between 23.2% and 93.3% (median 76.7%; IQR 60–78%) of participants were aware that DM has the potential to lead to the development of foot ulcers [7,8,[17], [18], [19], [20], [21], [22]]. Knowledge about glycaemic control was reported in 12 papers. Between 51% and 98.2% (median 78%; IQR 69–94%) of participants knew that maintenance of glycaemic control is of importance in the control of diabetes [7, 18,21,[23], [24], [25], [26], [27], [28], [29], [30], [31]]. Five papers addressed the role of dietary control in diabetes. Five papers reported that 74.8–95% (median 75.2%; IQR 75–95%) of participants were aware of the importance of dietary control in keeping sugar levels within the normal range [7, 18,29,31,32]. In a study by Perera et al., 60% of the participants in the same study

had knowledge of the normal blood sugar levels and the need for regular blood sugar measurements to assess control [33]. The same study revealed that participants understood the role played by regular exercise in maintaining glycaemic control and further understood the importance of supplementing medical glycaemic control by adhering to an appropriate diet [33]. The participants mean knowledge score was 68% and 70% for those participants who had a good or very good score [33]. In the same study, the vast majority of patients could not recognize the symptoms of hypoglycaemia or hyperglycaemia and 40% believed that diabetes could be cured. Tewahido and Berhane reported that participants did irregular self-monitoring of blood sugar, and dietary and physical exercise recommendations were inadequately practised by most of the participants [31]. These authors reported that most patients demonstrated close adherence to medication prescriptions [31]. In the same study, most participants recognised diet as an essential component of self-care practice for people with DM [31]. Bonner et al. reported that the majority of the participants lacked understanding of the role of uncontrolled DM in the aetiology of lower extremity complications [34]. A major limitation of these studies is that most did not report on the awareness of participants that poor glycaemic control in DM can lead to reduced foot sensation resulting in inevitable development of DFU and amputation. In only one article, 54.4% of participants reported being aware of this cause-and-effect relationship [7]. Similarly, none of the studies commented on the participants' knowledge that following a proper diet and regular physical activity is important for the control of DM.

5. Foot self-care knowledge and practice

5.1. Foot care knowledge

Table 4 lists studies that addressed the knowledge of the various aspects of foot care among patients with DM.

5.1.1. Foot and footwear inspection

Seventeen articles addressed the knowledge of patients regarding inspection and examination of feet regularly. Between 29.5% and 95.1% (median 56%; IQR 50–68%) of patients in the various studies knew that inspection of their feet regularly conferred benefit in reducing the incidence of DFU [6,17,18,20,21,[23], [24], [25],27,30,33,[35], [36], [37], [38], [39], [40]]. Nine papers on footwear inspection reported that 38.6–73.3% (median 64%; IQR 40–71%) of participants were aware of the importance of inspecting the inside of their footwear before donning [6,21,[23], [24], [25],27,30,35,37]. None of the articles reported on whether participants knew the mechanism by which footwear can cause injury to the foot leading to DFU.

Table 4

Proportion of patients with knowledge of various aspects of foot care.

Author	Year	Country	N	Foot ulcers can develop	Glycaemic control	Diet	Physical activity	Foot inspection	Footwear inspection	Foot washing	Skin care ^a	Foot drying ^b	Nail trimming	Foot protection ^c	Special shoes ^d	Ambient temperature ^e
Akoko and Lutfi [23]	2014	Tanzania	1085		68.8%			29.5%	39.9%		61.2%	18.7%	47%	95%	32.1%	54.5%
Algshaneh et al. [17]	2017	Saudi Arabia	519	76.7%				45.3%		61.3%	60.5%		93.8%	52.6%		36%
Desalu et al. [24]	2011	Nigeria	352		94.3%			84.1%	38.6%	94.3%						
Dixit et al. [66]	2011	India	323												9.7% & 30.5%	
Ekore et al. [5]	2010	Nigeria	137							25.5%		25.5%		22.6%		
George et al. [6]	2013	India	212					74.5%	49%							
Goie and Naidoo [18]	2016	South Africa	200	59.6%	88.6%	95%		83.6%								
Hasnain and Sheikh [25]	2009	Pakistan	150		78%			41.3%	73.3%	83.3%	70.7%	30.7%	60%	77.3%	48.7%	55.3%
Jindasa and Jeevantha [26]	2011	Sri Lanka	110		93.6%					82.7%			75.5%	88.2%	68.2%	
Kumhar et al. [52]	2014	India	125											23%		
Muhammad-Lutfi et al. [27]	2014	Malaysia	157		93.6%			70.1%	66.9%	85.4%	62.4%	80.3%	53.5%	82.8%	70.7%	32.2%
Mustafa et al. [8]	2017	Pakistan	90	87.8%												
Policarpo et al. [19]	2014	Brazil	85	50.6%								45.9%	43.5%			
Olson et al. [39]	2009	USA	1836					50%			40%			57%		47%
Perera et al. [33]	2013	Sri Lanka	150					68%								
Al Zahrani and Qadi [36]	2011	Saudi Arabia	747					65.3%		91.2%		63.1%		77.8	47.9%	
Rheeder et al. [20]	2008	South Africa	140	93.3%				86.6%		96.7%				88.3%		
Saber and Daoud [40]	2018	Iraq	250					73.6%		76%				31.2%		
Saurabh et al. [7]	2014	India	103	54.4%	91%	91%	91%									
Seid and Tsige [21]	2015	Ethiopia	313	78%	98.1%			67.7%	68.1%	93.3%				71.9%		
Sutariya and Kharadi [30]	2016	India	103		90.3%			95.1%	43.7%	84.5%	65%	54.4%	53.4%	92.2%	23.3%	54.4%
Ali et al. [37]	2016	Pakistan	139					36.7%	64%	34.5%		38.1%		66.5%		41%
Abu-Qamar [35]	2014	Jordan	1085					56%	71%	81.4%		59.7%				
Chin et al. [38]	2013	Taiwan	277					83.4%								
Nagarathnam et al. [28]	2014	India	100		84%		84%			58%	24%	61%		13%	72%	
Taksande et al. [22]	2017	India	200	23.2%												
Padma et al. [32]	2012	India	117			75.2%	61.7%									
Shah et al. [29]	2009	India	300		51.3%	74.8%	83.2%									

^a Skin care such as use of moisturising creams.^b Drying feet after washing.^c Avoidance of barefoot walking.^d Use of special shoes manufactured for patients with DM.^e Checking of ambient temperature (such as water, hot water bottles, any utensils used).

5.1.2. Foot care and maintenance

Knowledge about the importance of washing feet was addressed in 14 papers. Between 25.5% and 96.7% (median 81.4% IQR 76–91%) of participants among various studies were aware of the importance of washing feet [5,17,20,21,[24], [25], [26], [27], [28],30,[35], [36], [37],40]. Seven studies addressed the knowledge of patients regarding the need to moisturise the skin and reported that 24–70.7% (median 60.5%; IQR 40–61%) of participants knew that moisturising their feet was important for people living with DM [17,23,25,27,28,30,39]. Ten papers addressed participants' knowledge on drying the feet after washing and reported that 18.7–80.3% (median 59.7%; IQR 19–61%) of participants knew that the drying of feet after washing was necessary especially for people living with DM [5,19,23,25,27,28,30,[35], [36], [37]]. Only three papers specified whether participants had knowledge of drying the feet especially between the toes [5,19,37]. However, none of the articles reported on whether participants had knowledge of the impact of drying between the toes on the prevention of fungal infections which is common in web spaces and is a precursor for DFU. The knowledge relating to trimming toenails appropriately was reported in seven articles and 43.5–93.8% (median 47%; IQR 47–76%) of patients understood the need for nail trimming as well as the correct technique of trimming their nails [17,19,23,[25], [26], [27],30].

5.2. Foot self-care practice

Table 5 describes the proportion of patients who applied the practice of foot care. The proportions are variable in the selected studies with some studies showing low proportions and others showing high proportions. Tewahido and Berhane observed inadequate self-care practices among participants in their study [31].

Table 5
Proportion of patients practicing various aspects of foot care.

Author/s	Year	Country	n	Foot inspection	Footwear inspection	Foot washing	Skin care ^a	Foot drying ^b	Nail trimming	Foot protection ^c	Special shoes ^d	Ambient temperature ^e
Abu-Qamar [35]	2014	Jordan	1085	50.5%			51.1%	57.4%		76.7%		
Agha et al. [41]	2014	Pakistan	786	64.9%		87.5%						
Algshaneh et al. [17]	2017	Saudi Arabia	519	61.3%	45.3%	60.5%		49.9%	93.8%	52.6%		36%
Anselmo et al. [45]	2010	Brazil	60	65%	77%	88%	88%	88%	83%	95%	8.7%	
Baghianimoghadam et al. [46]	2011	Iran	100	22%		90%		10%				
Carlesso et al. [65]	2017	Brazil	80				56.3%		73.7%		87.5%	3.7
Chandalia et al. [67]	2008	India	300							99.4/55% ^f		
Chiwanga and Njelekela [4]	2015	Tanzania	404	37.9%	36.9%	92.8%		52.7%		41.6/86.9% ^f		
Deribe et al. [68]	2014	Ethiopia	216								87.5%	3.7
Desalu et al. [24]	2011	Nigeria	352	40.9%	47.7%	46%			33.9%		61.9%	
Dikeukwu and Omole [49]	2013	South Africa	120	47.5%	43.3%	86.7%				75%		
Dixit et al. [66]	2011	India	323				59%			60%		
D'Souza et al. [64]	2016	Oman	160			87.6%				56%	33.57%	
Ekore et al. [5]	2010	Nigeria	137	19.7%	19.7%				2.9%			
Gayle et al. [50]	2012	Jamaica	72	62.5%	86.1%	97.2%	90.3%	90.2%		84.7%	13%	48.6%
George et al. [6]	2013	India	212	71.7%	44.3%		29.2%			89.6/12.7% ^f		
Goie and Naidoo [18]	2016	South Africa	200	65.2%	87.5%		35%	92.9%	94.6%	52.9%		88%
Goweda et al. [51]	2017	Saudi Arabia	350	77.1%	64.3%	96.3%	62.3%	39.1%		66%	39.1%	48.6%
Hasnain and Sheikh [25]	2009	Pakistan	150	35.3%	76%	88.7%	63.3%	28%	62%	56.7%	21.3%	50.7%
Jindasa and Jeewantha [26]	2011	Sri Lanka	110	65.5%		65.5%			40.9%	48.2%	26.4%	
Jordan and Jordan [9]	2011	USA	118		68%							
Kumhar et al. [52]	2014	India	125	21%	31%	96%	37%			99/59% ^f	0%	
Li et al. [53]	2014	China	5961	41%								
Al-Kuwari et al. [44]	2011	Qatar	392	52.3%								
Muhammad-Lutfi et al. [27]	2014	Malaysia	157	56.7%	56.1%	80.9%	55.4%	74.5%		77.1%	59.9%	22.3%
Mohamed et al. [63]	2017	UAE	74	84.9%	77.79%	74.1%	84.9%		89.1%	44.4%		52.1%
Mustafa et al. [8]	2017	Pakistan	90	68.9%	83.3%	86.7%	45.6%	57.8%	74.4%	90%		87.8%
Nagarathnam et al. [28]	2014	India	100			58%	24%			13%	72%	
Polcarpo et al. [19]	2014	Brazil	85		54.1%	100%	43.5%	64.7%				
Al Odhayani et al. [42]	2015	Saudi Arabia	350	16.9%	36%	88.6%		43.4%			53.4%	38.3%
Olson et al. [39]	2009	USA	1836	32%	33%		58%	24%		59%		34%
Al Zahrani and Qadi [36]	2011	Saudi Arabia	747	69.9%	56.2%	99.2%		74.4%	77.1%	81.5%		
Rajasekharan et al. [54]	2015	India	290	28.3%	13.4%	64.8%		70.7%				
Saber and Daoud [40]	2018	Iraq	250	62.4%	34.4%	95.2%			61.6%			23.2%
Saeed et al. [55]	2010	Pakistan	100	17%	25%	73%	27%	23%	19%	64%		
Salmani and Hosseini [57]	2010	Iran	80	22.5%	20%	25%			32.5%	57.5%	47.5%	47.5%
Saurabh et al. [7]	2014	India	103	48.3%	48.3%	78.7%	28.7%	80.6%	71.7%	98.3/8.3% ^f	0%	
Scollan-Koliopoulos et al. [58]	2010	USA	70	7.1%	20%	60%		60%				
Seid and Tsige [21]	2015	Ethiopia	313	41.2%	61.3%	49.5%	27.5%	69.3%	66.5%	82.7/73.5% ^f		84.7%
Shah et al. [29]	2009	India	300	56%								
Solan et al. [60]	2016	Saudi Arabia	250	68%	76%		62.2%	57.2%		56%		
Somroo et al. [61]	2011	India	100	17%		73%	27%	23%		64%	24%	
Srinath et al. [62]	2017	India	400	24.3%	7.75%	29.3%		2.8%				
Sutariya and Kharadi [30]	2016	India	103	56.3%	40.8%	52.4%	54.4%	45.6%	31.1%	85.4%	42.7%	11.7%
Taksande et al. [22]	2017	India	200	0%						85.5%	0%	
Tewahido and Berhane [31]	2017	Ethiopia	13									
Borges and Ostwald [47]	2008	USA ^f	226	91%	58%		78%	84%	38%	69%		93%
Bundesmann and Kaplowitz [48]	2011	USA	1438	33%								
Al-Kaabi et al. [43]	2015	UAE	422	62%		62%				80%	10%	
Chin et al. [38]	2013	Taiwan	277	47%								
Sen et al. [59]	2015	Turkey	104	80.8%	77.9%	71.2%	35.6%	69.2%	76.9%	59.6%		
Saleh et al. [56] ^f	2012	Egypt	160	36.7%	13.3%	93.3%	0%	10%	2%	66.7%		1.7%
Padma et al. [32]	2012	India	117	12.8%								

^a Skin care such as use of moisturising creams.

^b Drying feet after washing.

^c Avoidance of barefoot walking.

^d Use of special shoes manufactured for patients with DM.

^e Checking of ambient temperature (such as water, hot water bottles, any utensils used).

^f The first figure refers to foot protection outdoors and the second figure refers to foot protection indoors.

5.2.1. Foot and footwear inspection

Forty-four studies on foot inspection reported that 0–91% (median 41%; IQR 33–56%) of participants practiced foot inspection regularly to ensure healthy feet

[4], [5], [6], [7], [8], 17, 18, 21, 22, [24], [25], [26], [27], 29, 30, 32, 35, 36, [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [57], [58], [59], [60], [61], [62], [63]].

One Indian study demonstrated that none of the patients actually practiced foot inspection [22].

Thirty-three studies on footwear inspection demonstrated that 7.8–87.5% (median 36.9%; IQR 33–56%) of participants practiced inspection of footwear before using them

[4], [5], [6], [7], [8], [9], [17], [18], [19], 21, 24, 25, 27, 30, 36, 39, 40, 42, 45, 47, [49], [50], [51], [52], [54], [55], [56], [57], [58], [59], [60], 62, 63].

5.2.2. Foot care and maintenance

Thirty-four articles that investigated the practice of foot washing reported that 25–100% (median 73%; IQR 58–93%) of participants practiced regular foot washing

[4, 7, 8, 17, 19, 21, [24], [25], [26], [27], [28], 30, 36, [39], [40], [41], [42], [43], 45, 46, [49], [50], [51], [52], [54], [55], [56], [57], [58], [59], [61], [62], [63], [64]].

In the 26 studies that addressed skin care such as moisturising the skin, 0–90.3% (median 37%; IQR 24–56%) of participants practiced skin moisturising [6, 7, 18, 19, 21, 25, 27, 28, 30, 35, 39, 43, 45, 47, [50], [51], [52], 55, [59], [60], [61], 63, 65, 66].

As reported in 27 studies, 2.8–92.9% (median 57.4%; IQR 39–71%) of participants dried their feet after washing

[4, 7, 8, [17], [18], [19], 21, 25, 27, 30, 35, 36, 42, [45], [46], [47], 50, 51, [54], [55], [56], [57], [58], [59], [60], [61], [62]].

In 20 articles, the proportion of patients who practiced proper nail trimming ranged from 2% to 94.6% (median 66.5%; IQR 34–77%)

[5, 7, 8, 17, 18, 21, [24], [25], [26], 30, 36, 40, 45, 47, [55], [56], [57], 59, 63, 65].

5.3. Observations from qualitative studies

Two qualitative studies have addressed the understanding of foot care by people living with DM. Tewahido and Berhane observed that patients generally lacked proper information regarding the importance of self-care and how it should be implemented [31]. Similarly, Bonner et al. found that the majority of participants lacked understanding of basic diabetic foot care among people living with DM [34].

6. Foot protection

6.1. Knowledge of foot protection

Fifteen studies assessed the participants' understanding of the importance of foot protection. The studies sought to establish participant's understanding of the implications of walking barefoot.

These studies demonstrated that 13–95% (median 57%; IQR 57–83%) of participants had knowledge of the importance of foot protection

[5,17,20,21,23,[25], [26], [27], [28],30,36,37,39,40,52]. A selection of eight studies addressed the knowledge of the need to use specialised protective shoes for patients with diabetes. About 9.7–72% (median 32.1%; IQR 32–48%) of participants knew of the need for people living with DM to use specialised shoes [23,[25], [26], [27], [28],30,36,66]. The various articles that reported participant’s knowledge on specialised shoes for patients with DM did not compare patients with and without DFU. Seven studies reported on participants’ knowledge on checking the temperature of various items that make contact with the body before use. Examples include checking the temperature of the water before using it, checking the hot water bottle or other equipment that comes into contact with their body. About 32.2–55.3% (median 47%; IQR 47–54%) of patients were aware of the importance of checking for temperature before using various items [17,23,25,27,30,37,39].

6.2. Practice of foot protection

Thirty-three studies addressed the practice of walking barefoot by people living with DM and found that 8.3–99.4% (median 66%; IQR 59–80%) of patients avoided walking barefoot [4,[6], [7], [8],17,18,21,22,[25], [26], [27], [28],30,35,36,39,43,45,47,[49], [50], [51], [52],[55], [56], [57],[59], [60], [61],63,64,66,67]. Eighteen studies noted that 0–87.5% (median 39.1%; IQR 10–53%) of patients living with DM used special shoes [19,[24], [25], [26], [27], [28],30,43,45,50,51,57,61,64,65]. None of the patients reported in three studies that they wore special shoes [7,22,52]. The 18 studies that investigated temperature checking found that 1.7–93% (median 34%; IQR 34–49%) of participants checked the temperature of these items before use [8,17,18,21,25,27,30,39,40,42,47,50,51,56,57,63,65,68].

7. Physical activity

In five studies, authors reported that 61.7–91% (median 83.2%; IQR 83–84%) of participants were aware of the role of physical activity in maintaining glycaemic control [7,28,29,32,34]. Shah et al. in India reported that 83.2% of participants were aware that exercise was beneficial in controlling DM while 84.1% thought that exercise was only beneficial among obese individuals [29].

7.1. Quality appraisal

The MMAT was used to assess the quality of the articles. Following review, the articles were scored as a percentage. Only one article [29] scored 20%, two articles scored 40% [47,52], 15 articles scored 60% [5,7,9,20,22,32,33,36,39,42,48,57,[65], [66], [67]], 21 articles scored 80% [4,17,19,23,24,27,28,30,35,38,40,41,43,45,46,51,53,58,59,61,63] and 19 articles scored 100% [6,8,18,21,25,26,31,34,37,44,49,50,[54], [55], [56],60,62,64,68]. Apart from the three articles that scored 40% and below, the reviewers (PM, RN) were of the view that the majority of the articles

were moderate to good according to the MMAT criteria and the overall quality score of the appraised studies was substantial.

8. Discussion

This review was aimed at systematically mapping global evidence regarding diabetic foot-care knowledge and practice over 11 years and to distinguish areas that require additional research. The review studied the well-recognised and specific self-care components that are known to prevent or delay diabetic complications in 58 articles published globally. Many studies on diabetic foot-care knowledge and practice emanated from Asian countries, followed by African countries, North America, and Europe. It is of interest that studies from Brazil and India show low proportions of patients with knowledge of DM as a causative factor for DFUs, whereas studies in South Africa, Ethiopia, and Saudi Arabia revealed a higher proportion of participants with this knowledge.

The included studies were heterogeneous in design and carried varying degrees of knowledge and practice of various aspects of foot care. This heterogeneity was seen across different countries and within countries, demonstrating that knowledge of the various factors associated with effective foot care varies in various countries and various populations within countries. In addition, the components of foot care addressed in the studies were variable, and not all articles addressed all the principles of foot care. For example, there was variable knowledge of the role of glycaemic control in the prevention of DFUs. Disappointingly, some patients in the included studies were unaware of the role played by diet and physical activity in glycaemic control over and above the anti-diabetic medication. It was also apparent in the evaluated studies that the various foot-care activities were not followed regularly. The available literature did not provide information on how to correct this lack of knowledge and practice. Furthermore, whereas a few studies reported on interventions towards foot-care knowledge and practice, none of them commented on interventions to improve this lack of knowledge and practice.

The variability in the findings of this review was consistent with other findings in the international literature. Lakshmi et al. reported poor foot-care practices among patients living with DM, the majority of whom were wearing improper footwear [69]. They also confirmed that poor glycaemic control and loss of touch sensation in patients living with DM are associated with the development of foot ulcers [69]. Magbanua and Lim-Alba observed good foot-care knowledge among Filipino respondents but noted the unsatisfactory practice of foot care [70]. Al-Qaddah et al. in Jordan, documented variations between knowledge and practice of diabetic foot self-care in that satisfactory knowledge were associated with inadequate practices of foot self-care [71].

South Africa is one of the countries where the burden of disease including non-communicable diseases (NCDs) is closely associated with the vast socioeconomic inequalities [72]. Although it is traditionally regarded as a disease of lifestyle and that it is concentrated among

the higher rather than the lower socioeconomic groups, DM and its complications are becoming more evenly distributed across socioeconomic groups in South Africa [73], and a low socioeconomic status appears to be closely associated with a higher frequency of such health problems [73]. This is because low literacy levels and poor socioeconomic circumstances are associated with the lack of knowledge and practice of foot care [24]. Evidence suggests that the poor rates of treatment and control of diabetes and its complications are attributable to poor adherence to diabetes education and medication in South Africa [74].

Key areas in dealing with diabetes should be early diagnosis and prevention of complications and, as such, aggressive implementation of cost-effective interventions can help improve patient outcomes. These interventions include blood glucose control, through a combination of diet, physical activity, and medication as well as education programmes to reduce the development of complications such as DFU. Specific intervention strategies such as diabetic foot management education can advance better foot-care practices by providing the education and self-care skills needed, not only to manage the disease but also increase the willingness for patients to actively involve themselves in effective foot self-care practice [24,34,40]. Implementation of such interventions will also improve concordance between knowledge and practice of foot self-care at primary healthcare centres and hospitals by promoting the training of both patients and healthcare workers on proper foot-care practices, [40].

DM imposes a significant financial burden on the public healthcare system in South Africa [75]. In 2018, treatment of all prevalent cases resulted in a cost equivalent to 12% of the total national health budget, and it is projected that direct costs will grow if current care regimens are maintained [75]. Most of the premature deaths from NCDs, including diabetes, are largely preventable by enabling health systems to respond more effectively and equitably to the communities' health-care needs [1,76]. To ensure the realisation of countries' responses to these healthcare needs, the World Health Assembly endorsed the WHO Global Action Plan for the Prevention and Control of NCDs 2013–2020 in May 2013 [76]. The objectives of this Action Plan are to (i) prioritise the prevention and control of NCDs, (ii) reduce modifiable risk factors for NCDs and underlying social determinants, (iii) strengthen health systems to prevent and control NCDs, and (iv) to promote and support national capacity for high-quality research and development for the prevention and control of NCDs [76].

Based on the findings of this review, we share the view of others that strategies involving preventative care, as well as education of patients and healthcare providers on foot care coupled with a multidisciplinary approach to management and monitoring will assist in reducing the rate of DFUs and subsequent amputation [49]. A country with such diverse socioeconomic groupings like South Africa provides a fertile ground for the development of diabetic complications. Thus, it would appear that instituting a well-planned and strategic diabetic self-management education programme would be invaluable in communities such as ours. The review has also highlighted

gaps in knowledge and practice by people living with DM, not only in South Africa but worldwide. Establishing an educational tool to improve knowledge and establishing implementation strategies for diabetes self-management programmes in South Africa is one way of contributing to the realisation of the mandates of the Global Action Plan for South Africa. South Africa is a middle-income country, and a need exists to establish an intervention to pre-empt diabetic complications including DFUs. This is the subject of an ongoing research project at Addington Hospital by the same authors, which is investigating the effectiveness of a foot-care education module on improving foot-care knowledge and behaviour.

8.1. Implications for research

The number of studies reviewed here reporting on glycaemic control was very small, suggesting that the data on patients' knowledge of diabetes as a cause of DFU are limited. It is apparent from these studies that knowledge on the importance of knowledge of various aspects of foot care and protection was variable. Similarly, the practice of various aspects of foot care was variable. Although many articles reported on the proportion of patients walking barefoot, very few reported on the use of special shoes for people living with DM. Very few studies researched physical activity knowledge and practice among participants and none of those articles assessed the knowledge or practice of specific exercises for the feet or lower limbs. This emphasises the need for further research on the effects of DM on the development of DFU, and the role of physical activity in relation to diabetic control as well as specific exercises for the lower limbs and feet. The findings in this study underscore the need exists for translational research to improve knowledge and practice of the various aspects of foot care among people living with DM in an attempt to improve patients' knowledge to acceptable levels.

8.2. Strengths and limitations

This scoping review consisted of a detailed evaluation on the assessment of literature on foot-care knowledge and practice among patients with DM worldwide. The majority of the studies were verified by the MMAT as being of good quality. The review does have some limitations. Studies on foot-care knowledge and practice involved patients with DM and not the general populations. Only studies in English were included and some potential articles which may have contributed additional knowledge were excluded as they did not fulfil the inclusion criteria. The studies were heterogeneous in design and in the data collected and this made it difficult to come to consistent conclusions among studies. While not investigating intervention on foot care, studies highlighted the need for intervention but did not offer suggestions towards the implementation of these interventions. The absence of a standardized and validated tool to assess foot care knowledge and practice, which would be beneficial in studies exploring different populations, is another important

limitation in these studies. Despite these limitations, we believe that we have addressed the aim of this study which was to systematically map global evidence on foot-care knowledge and practices in relation to DM and identify areas that require further investigation. Whereas the various articles reviewed, explored knowledge and practice of foot care in DM, the various studies did not actually quantify the knowledge by the participants of the relationship between the foot-care principle studied and the development of DFU as well as the resultant need for amputation.

9. Conclusion

There are variable gaps in foot-care knowledge and practice among many people with DM in the international literature, with knowledge and practice on a range of almost none to more than adequate. The need for intervention on education, awareness, and practice of foot care by relevant stakeholders was highlighted in the majority of the papers. The dearth of studies on intervention attests to the need for research in intervention directed at foot-care practice rather than just the assessment of knowledge and practice. Treatment of DM and DFU with resultant possibility of amputation together with patient education and self-management strategies are possible in the South African context. We recommend that, in addition to patient education, healthcare professionals should also be trained on foot care as this will likely yield positive results with regards to foot-care education.

Author contributions

Study concept: PM, SR, TEM.

Study design: PM, SR, TEM.

Protocol design: PM, SR, TEM.

Literature search: PM, RN.

Critique of methodology: TMT.

Draft and subsequent versions: PM, TMT, TEM.

A critical review of the draft manuscript and final version: PM, SR, RN, TMT, TEM.

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Ethical considerations

This aspect of research is part of a larger study by the researcher, PM, and ethical approval was obtained from the University of KwaZulu-Natal Biomedical Research Ethics Committee (BREC/00000236/2019).

Declaration of competing interest

All the authors declare no conflict of interest.

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References

- [1] World Health Organisation. Global report on diabetes. Geneva, Switzerland, https://apps.who.int/iris/bitstream/handle/10665/204871/9789241565257_eng.pdf. [Accessed 16 February 2019].
- [2] Chawla A, Chawla R, Jaggi S. Microvascular and macrovascular complications in diabetes mellitus: distinct or continuum? *Indian J. Endocrinol. Metabol.* 2016;20(4):546e51.
- [3] Boulton AJ. The diabetic foot. *Medicine* 2015;43(1):33e7.
- [4] Chiwanga FS, Njelekela MA. Diabetic foot: prevalence, knowledge, and foot self-care practices among diabetic patients in Dar es Salaam, Tanzania-a cross-sectional study. *J Foot Ankle Res* 2015;8(1):20.
- [5] Ekore RI, Ajayi IO, Arije A, Ekore JO. Knowledge of and attitude to foot care amongst type 2 diabetes patients attending a university-based primary care clinic in Nigeria. *Afr. J. Primary Health Care Family Med.* 2010;2(1):1e3.
- [6] George H, Rakesh P, Krishna M, Alex R, Abraham VJ, George K, et al. Foot care knowledge and practices and the prevalence of peripheral neuropathy among people with diabetes attending a secondary care rural hospital in southern India. *J Fam Med Prim Care* 2013;2(1):27e32.
- [7] Saurabh S, Sarkar S, Selvaraj K, Kar SS, Kumar SG, Roy G. Effectiveness of foot care education among people with type 2 diabetes in rural Puducherry, India. *Indian J. Endocrinol. Metabol.* 2014;18(1):106e10.

- [8] Mustafa A, Iqbal M, Parvez MA. Assessment of knowledge, attitude and practices of diabetics regarding their foot care. *Ann Punjab Med Coll* 2017;11(1):43e7.
- [9] Jordan DN, Jordan JL. Foot self-care practices among Filipino American women with type 2 diabetes mellitus. *Diabetes Ther* 2011, 2(1):1-8.
- [10] Pourkazemi A, Ghanbari A, Khojamli M, Balo H, Hemmati H, Jafaryparvar Z, et al. Diabetic foot care: knowledge and practice. *BMC Endocr Disord* 2020;20(1):1e8.
- [11] Ul-Haq N, Durrani P, Nasim A, Riaz S. Assessment of knowledge and practice of diabetes mellitus patients regarding foot care in tertiary care hospitals in Quetta, Pakistan. *Specialty J Med Res Health Sci* 2017;2(4):35e43.
- [12] Pillay S, Lutge E, Aldous C. The burden of diabetes mellitus in KwaZulu-Natal's public sector: a 5-year perspective. *S Afr Med J* 2016;106(4):384e8.
- [13] Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8(1):19e32.
- [14] Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169(7):467e73.
- [15] Hong QN, Pluye P, Flaborgues S, Bartlett G, Boardman F, Cargo M, et al. Mixed methods appraisal tool (MMAT), version 2018. Registration of Copyright; 2018. p. 1148552.
- [16] White MD, Marsh EE. Content analysis: a flexible methodology. *Libr Trends* 2006;55(1):22e45.
- [17] Alghshaneen MA, Almuhanna MF, Almuhanna AM, Alghobaish FF, Alajji NA, Alabdullah HJ, et al. Diabetic foot awareness among diabetic patients in Saudi Arabia. *Egypt J Hosp Med* 2017;68(2).
- [18] Goie TT, Naidoo M. 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. *Afr. J. Primary Health Care Family Med.* 2016;8(1):1e8.
- [19] Policarpo NdS, Moura JRA, Melo Júnior EBd, Almeida PCd, Macêdo SFd, Silva ARVd. Knowledge, attitudes and practices for the prevention of diabetic foot. *Revista Gaucha De Enfermagem* 2014;35(3):36e42.
- [20] Rheeder P, Venn M, De Korte E, Van Zyl D. Knowledge of foot care in people with diabetes in a tertiary care setting. *J Endocrinol Metabol Diabetes S Afr* 2008;13(3):105e8.
- [21] Seid A, Tsigie Y. Knowledge, practice, and barriers of foot care among diabetic patients attending Felege Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia. *Adv Nurs* 2015. 2015.

- [22] Taksande BA, Thote M, Jajoo U. Knowledge, attitude, and practice of foot care in patients with diabetes at central rural India. *J Fam Med Prim Care* 2017;6(2):284e7.
- [23] Akoko L, Lutfi A. Challenges of foot care among patients attending diabetic clinic: a low resource country experience. *East Central Afr J Surg* 2014;19(3): 22e8.
- [24] Desalu O, Salawu F, Jimoh A, Adekoya A, Busari O, Olokoba A. Diabetic foot care: self reported knowledge and practice among patients attending three tertiary hospital in Nigeria. *Ghana Med J* 2011;45(2):60e5.
- [25] Hasnain S, Sheikh NH. Knowledge and practices regarding foot care in diabetic patients visiting diabetic clinic in Jinnah Hospital, Lahore. *JPMA The J Pakistan Med Assoc* 2009;59(10):687.
- [26] Jindasa C, Jeewantha M. Study to determine the knowledge and practice of foot care in patients with chronic diabetic ulcers. *Int J Collab Res Intern Med Public Health* 2011;3(3):115e22.
- [27] Muhammad-Lutfi A, Zaraihah M, Anuar-Ramdhan I. Knowledge and practice of diabetic foot care in an in-patient setting at a tertiary medical center. *Malays Orthop J* 2014;8(3):22e8.
- [28] Nagarathnam M, Bhavani KL, Deepthi S. Assessment of knowledge on foot care among diabetic patients attending tertiary care hospital in Andhra Pradesh, India. *J Soc Wound Care Res* 2014;7(1):29e32.
- [29] Shah VN, Kamdar P, Shah N. Assessing the knowledge, attitudes and practice of type 2 diabetes among patients of Saurashtra region, Gujarat. *Int J Diabetes Dev Ctries* 2009;29(3):118e22.
- [30] Sutariya PK, Kharadi A. Knowledge and practice of foot care among the patients of diabetic foot: a hospital based cross-sectional study. *Int Surg J* 2016;3(4):1850e5.
- [31] Tewahido D, Berhane Y. Self-care practices among diabetes patients in Addis Ababa: a qualitative study. *PloS One* 2017;12(1):e0169062.
- [32] Padma K, Bele SD, Bodhare TN, Valsangkar S. Evaluation of knowledge and self-care practices in diabetic patients and their role in disease management. *Natl J Commun Med* 2012;3(1):3e6.
- [33] Perera D, De Silva R, Perera W. Knowledge of diabetes among type 2 diabetes patients attending a primary health care clinic in Sri Lanka. *East Mediterr Health J* 2013;19(7):644e8.
- [34] Bonner T, Harvey IS, Sherman L. A qualitative inquiry of lower extremity disease knowledge among African Americans living with type 2 diabetes. *Health Promot Pract* 2017;18(6):806e13.
- [35] Abu-Qamar M. Knowledge and practice of foot self-care among Jordanians with diabetes: an interview-based survey study. *J Wound Care* 2014;23(5): 247e54.

- [36] Al Zahrani HA, Qadi MA. Foot care knowledge and practice among diabetic patients attending primary health care centers in Jeddah City. *J King Abdulaziz Univ Med Sci* 2011;98(282):1e34.
- [37] Ali R, Farooq U, Jadoon RJ, Alam MA, Qureshi A, Shah SU. Are we telling the diabetic patients adequately about foot care? *J Ayub Med Coll Abbottabad* 2016;28(1):161e3.
- [38] Chin YF, Huang TT, Hsu BRS. Impact of action cues, self-efficacy and perceived barriers on daily foot exam practice in type 2 diabetes mellitus patients with peripheral neuropathy. *J Clin Nurs* 2013;22(1e2):61e8.
- [39] Olson JM, Hogan MT, Pogach LM, Rajan M, Raugi GJ, Reiber GE. Foot care education and self management behaviors in diverse veterans with diabetes. *Patient Prefer Adherence* 2009;3:45e50.
- [40] Saber HJ, Daoud AS. Knowledge and practice about the foot care and the prevalence of the neuropathy among a sample of type 2 diabetic patients in Erbil, Iraq. *J Fam Med Prim Care* 2018;7(5):967e74.
- [41] Agha SA, Usman G, Agha MA, Anwer SH, Khalid R, Raza F, et al. Influence of socio-demographic factors on knowledge and practice of proper diabetic foot care. *Khyber Med Univ J* 2014;6(1):9e13.
- [42] Al Odhayani AA, Tayel SAS, Al-Madi F. Foot care practices of diabetic patients in Saudi Arabia. *Saudi J Biol Sci* 2015;24(7):1667e71.
- [43] Al-Kaabi JM, Al Maskari F, Cragg P, Afandi B, Souid A-K. Illiteracy and diabetic foot complications. *Primary Care Diabetes* 2015;9(6):465e72.
- [44] Al-Kuwari M, Mesmar M, El-Jack I. Knowledge and practice of type 2 diabetic patients attending primary health care in Qatar. *Middle East J Family Med* 2011;9(4):3e10.
- [45] Anselmo MI, Nery M, Parisi MC. The effectiveness of educational practice in diabetic foot: a view from Brazil. *Diabetol Metab Syndrome* 2010;2(1):45.
- [46] Baghianimoghadam MH, Sharifirad G, Afkhami AM, Mashahiri MR, Baghianimoghadam B, Zulghadr R, et al. Foot care in diabetic patients, based on health belief model in yazd-Iran (2009). *Iran J Diabetes Obes* 2011;3(1).
- [47] Borges WJ, Ostwald SK. Improving foot self-care behaviors with Pies Sanos. *West J Nurs Res* 2008;30(3):325e41.
- [48] Bundesmann R, Kaplowitz SA. Provider communication and patient participation in diabetes self-care. *Patient Educ Counsel* 2011;85(2):143e7.

- [49] Dikeukwu R, Omole OB. Awareness and practices of foot self-care in patients with diabetes at Dr Yusuf Dadoo district hospital, Johannesburg. *J Endocrinol Metabol Diabetes S Afr* 2013;18(2):112e8.
- [50] Gayle KA, Reid MKT, Younger NO, Francis DK, McFarlane SR, Wright-Pascoe RA, et al. Foot care and footwear practices among patients attending a specialist diabetes clinic in Jamaica. *Clin Pract* 2012;2(4):216e20.
- [51] Goweda R, Shatla M, Alzaidi A, Alzaidi A, Aldhawani B, Alharbi H, et al. Assessment of knowledge and practices of diabetic patients regarding diabetic foot care, in Makkah, Saudi Arabia. *J Fam Med Health Care* 2017;3(1):17e22.
- [52] Kumhar M, Saini T, Dara N. Foot wear and footcare knowledge-an independent risk factor for diabetic foot in Indian diabetics. *Indian Med Gaz* 2014;148(1):25e8.
- [53] Li R, Yuan L, Guo X-H, Lou Q-Q, Zhao F, Shen L, et al. The current status of foot self-care knowledge, behaviours, and analysis of influencing factors in patients with type 2 diabetes mellitus in China. *Int J Nurs Sci* 2014;1(3):266e71.
- [54] Rajasekharan D, Kulkarni V, Unnikrishnan B, Kumar N, Holla R, Thapar R. Self care activities among patients with diabetes attending a tertiary care hospital in Mangalore Karnataka, India. *Ann Med Health Sci Res* 2015;5(1):59e64.
- [55] Saeed N, Zafar J, Atta A. Frequency of patients with diabetes taking proper foot care according to international guidelines and its impact on their foot health. *JPMA The J Pakistan Med Assoc* 2010;60(9):732.
- [56] Saleh N, Shebl A, Hatata E, Refiei M. Impact of educational program about foot care on knowledge and self care practice for diabetic older adult patients. *J Am Sci* 2012;8(12):1444e52.
- [57] Salmani N, Hosseini SV. Foot self care in diabetic patients. *Iran J Diabetes Obes* 2010;2(2):37e40.
- [58] Scollan-Koliopoulos M, Walker EA, Bleich D. Perceived risk of amputation, emotions, and foot self-care among adults with type 2 diabetes. *Diabetes Educat* 2010;36(3):473e82.
- [59] Şen H, Şen H, Aşık M, Özkan A, Binnetoglu E, Erbağ G, et al. The importance of education in diabetic foot care of patients with diabetic neuropathy. *Exp Clin Endocrinol Diabetes* 2015;123:178e81. 03.
- [60] Solan YM, Kheir HM, Mahfouz MS, Al-Faify AA, Hakami DT, Al Faifi MA, et al. Diabetic foot care: knowledge and practice. *J Endocrinol Metabol* 2016;6(6): 172e7.
- [61] Somroo JA, Hashmi A, Iqbal Z, Ghori A. Diabetic foot care-a public health problem. *J Med* 2011;12(2):109e14.

- [62] Srinath K, Basavegowda M, Tharuni NS. Diabetic self care practices in rural Mysuru, southern Karnataka, India-a need for diabetes self management educational (DSME) program. *Diabetes & metabolic Syndrome. Clin Res Rev* 2017;11:S181e6.
- [63] Mohamed OMI, Ofiaeli NE, Syeed A, Elhassan A, Al Tunaiji M, Al Hammadi K, et al. Assessment of behaviors, risk factors of diabetic foot ulcer and footwear safety among diabetic patients in primary care setting, Abu Dhabi, UAE. *Middle East J Family Med* 2017;15(3):12e24.
- [64] D'Souza MS, Ruppert SD, Parahoo K, Karkada SN, Amirtharaj A, Jacob D, et al. Foot care behaviors among adults with type 2 diabetes. *Primary Care Diabetes* 2016;10(6):442e51.
- [65] Carlesso GP, Gonçalves MHB, Moreschi Júnior D. Evaluation of diabetic patients' knowledge about preventive care of the diabetic foot. *J Vascular Brasileiro* 2017;16(2):113e8. Maringá, PR, Brazil.
- [66] Dixit S, Maiya A, Khetrpal H, Agrawal B, Vidyasagar S, Umakanth S. A questionnaire based survey on awareness of diabetic foot care in Indian population with diabetes: a cross-sectional multicentre study. *Indian J Med Sci* 2011;65(10):411e23.
- [67] Chandalia H, Singh D, Kapoor V, Chandalia S, Lamba P. Footwear and foot care knowledge as risk factors for foot problems in Indian diabetics. *Int J Diabetes Dev Ctries* 2008;28(4):109e13.
- [68] Deribe B, Woldemichael K, Nemera G. Prevalence and factors influencing diabetic foot ulcer among diabetic patients attending Arbaminch Hospital, South Ethiopia. *J Diabetes Metabol* 2014;5(1):1-7.
- [69] Lakshmi N, Patel N, Parmar P, Garasiya K, Chaudhary M. Study the foot care practice among diabetic patients in Ahmedabad city, Gujarat. *Int J Med Sci Publ Health* 2018;7(5):333e8.
- [70] Magbanua E, Lim-Alba R. Knowledge and practice of diabetic foot care in patients with diabetes at Chinese general hospital and medical center. *J Asean Fed Endocrine Soc* 2017;32(2):123e31.
- [71] Moh'd Al-Qaddah R, Abdallah Al Eyadeh M, Ma'en Zaid Abu-Qamar D, Younes N, Al-Ryalat D, Haddad F. Knowledge and practice of foot care among diabetics at King Hussein medical center, Jordan. *J Roy Med Serv* 2016;23(3): 55e63.
- [72] Omotoso KO, Koch SF. Assessing changes in social determinants of health inequalities in South Africa: a decomposition analysis. *Int J Equity Health* 2018;17(1):181e94.
- [73] Ataguba JE, Akazili J, McIntyre D. Socioeconomic-related health inequality in South Africa: evidence from general household surveys. *Int J Equity Health* 2011;10(1):48e57.

[74] Mutyambizi C, Booysen F, Stokes A, Pavlova M, Groot W. Lifestyle and socio-economic inequalities in diabetes prevalence in South Africa: a decomposition analysis. *PloS One* 2019;14(1):1e21. e0211208.

[75] Erzse A, Stacey N, Chola L, Tugendhaft A, Freeman M, Hofman K. The direct medical cost of type 2 diabetes mellitus in South Africa: a cost of illness study. *Glob Health Action* 2019;12(1):1636611.

[76] World Health Organization. Global action plan for the prevention and control of noncommunicable diseases 2013-2020. 2013.

https://apps.who.int/iris/bitstream/handle/10665/94384/9789241506236_eng.pdf;jsessionid%406C83311AF785D7B01046B68092C4E04?sequence%41. [Accessed 30 July 2020]. 9241506237