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A systematic review of adherence to diabetes self-care behaviours: evidence from low- and middle-income countries

Adherence to diabetes self-care behaviours

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Author contributions

All authors have agreed on the final version and meet at least one of the following criteria (recommended by the ICMJE*):

1) Substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;

2) Drafting the article or revising it critically for important intellectual content.

Abstract

Aims: To determine diabetes patient's adherence to five self-care behaviours (diet, exercise; medication, self-monitoring of blood glucose [SMBG] and foot care) in low- and middle-income countries

Design: Systematic review

Data sources: We searched MEDLINE, CINAHL, PUBMED, SCOPUS, PsycINFO, EMBASE, Cochrane library and EMCARE for the period January 1990 to June 2017.

Review methods: Title, abstract and full text screening were done according to an eligibility criteria. A narrative synthesis of the literature was conducted.

Results: A total of 7,109 studies were identified of which 27 met the review eligibility criteria and were included. All the studies used self-report of adherence to diabetes self-care. Studies reported adherence rates in two major forms: 1) mean number of days participants performed a recommended dietary behaviour/activity during the past week

; and 2) proportions of participants adhering to a recommended self-care behaviour. Mean number of days per week participants adhered to a self-care behaviour ranged from 2.34.6 days per week for diet, 5.5-6.8 days per week for medication, 1.8-5.7 days per week for exercise, 0.2-2.2 days per week for SMBG and 2.2-4.3 days per week for foot care. Adherence rates ranged from 29.9-91.7% for diet, 26.0-97.0% for medication taking, 26.7-69.0% for exercise, 13.0-79.9% for self-monitoring of blood glucose and 17.0-77.4% for foot care.

Conclusion: Although most diabetes patients do not adhere to recommended self-care behaviours, adherence rates vary widely and were found to be high in some instances.

Impact

- Health services in low-and middle-income countries should monitor adherence to diabetes self-care behaviours rather than assume adherence and resources should be invested in improving adherence to the self-care behaviours.
- Large-scale accurate monitoring of adherence to diabetes self-care behaviour is needed and consideration should be given to choice of measurement tool for such exercise.

Key words: adherence, compliance, developing countries, diabetes, low-and middle-income countries, nurse, nursing, self-care, self-management, systematic review

INTRODUCTION

In the recent three decades there has been a four-fold rise in the number of people with diabetes, with the prevalence rising from 108 million people in 1980 to 422 million in 2014 (WHO, 2016). The rise in the prevalence of diabetes has been linked to increasing levels of physical inactivity, excess body weight, unhealthy dietary habits and an aging population (International Diabetes Federation, 2013; Wild, Roglic, Green, Sicree, & King, 2004). Within the last decade, the number of people living with diabetes has increased at a faster rate in low-and middle-income countries (LMICs) compared with higher income countries (HICs) (WHO, 2016). The WHO has projected that non-communicable diseases including diabetes will have a higher prevalence than infectious diseases, malnutrition and infant and maternal mortality combined in LMICs by the year 2030 (Levitt, 2008; World Health Organization, 2011). Globally, type 2 diabetes mellitus is the most prevalent, constituting over 90% of all diabetes cases (American Diabetes Association, 2005; International Diabetes Federation, 2015; WHO, 1999). In LMICs, people with diabetes are prone to poor glycaemic control, frequent hospital admissions, diabetic complications and premature deaths resulting from hyperglycaemia (Bazargan, Johnson, & Stein, 2003; Booth & Hux, 2003; WHO, 2016).

Diabetes is a life-long condition and its proper management requires the active participation of the individual with diabetes through the performance of self-care behaviours such as exercise, diet, self-monitoring of blood glucose (SMBG), medication taking and foot care (Cramer, 2004). Adherence to diabetes self-care behaviours has been shown to improve patient health outcomes such as reduced risk of diabetic complications, decreased emergency admissions at the hospital and improved quality of life outcomes. It is thus not surprising that clinical practice guidelines from the USA, UK and globally (American Diabetes Association, 2014; Conditions, 2008; Coyle, Francis, & Chapman, 2013; Group, 2014) have recommended that diabetes patients should regularly adhere to their self-care behaviours.

BACKGROUND

Given the improved health outcomes associated with adherence to self-care behaviours, it is important to have a clear understanding of the extent to which people with diabetes adhere to their recommended self-care behaviours (International Diabetes Federation Guideline Development Group, 2012). Adherence to self-care behaviours is likely to be of particular importance in LMICs given very scarce resources are available for managing complex health conditions such as diabetes complications, the lack of trained staff for diabetes management, inadequate equipment and resources and the lack of facilities for the diagnosis and management of diabetes (Levitt, 2008; Osei, Schuster, Amoah, & Owusu, 2003b).

To our knowledge, only two reviews have evaluated diabetes patients' adherence to self-care behaviours (Coyle et al., 2013; Stephani, Opoku, & Beran, 2018). Although, the review by Coyle et al included studies from LMICs, the authors did not evaluate data from LMICs separately. In addition, Coyle and colleagues' review contained studies published up to August 2012. The review by Stephani et al (2018) included studies from 10 countries in Sub-Saharan Africa (SSA); and as acknowledged by the authors, this limited the generalisability of the review findings to LMICs outside SSA. A review which includes studies from both SSA and non-SSA LMICs will provide a much wider synthesis of the evidence regarding adherence to diabetes self-care behaviours, making available findings that will be relevant to developing countries globally. As a result, a systematic review of the published literature from LMICs regarding adherence to self-care behaviours is needed to identify the extent of the challenge regarding self-care adherence among persons living with diabetes. These data can assist diabetes care planning in LMICs to target scarce resources where the need or benefit is likely to be greatest.

THE REVIEW

Aims

This systematic review evaluated the level of adherence to five self-care behaviours recommended for people with type 2 diabetes: diet, exercise, medication taking, SMBG and foot care.

Design

This systematic review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009). A protocol was registered at PROSPERO, an international prospective register of systematic reviews (registration number CRD42016035406) and subsequently published (Mogre, Johnson, Tzelepis, Shaw, & Paul, 2017).

Definition of key terms

Low-and middle-income countries*:* We defined low-and middle-income countries using the World Bank's 2016 Gross National Income (GNI) per capita of ≤US$1,025 for low-income countries and a GNI per capita of ≥US$1,026 but <US$12,475 for middle-income countries (The World Bank, 2016). This is a slight revision from our published protocol (Mogre, Johnson, Tzelepis, Shaw, & Paul, 2017) where we indicated we would use the 2015 World Bank's classifications.

Adherence*:* Following the definitions of Haynes (1979) and Rand (1993), the WHO defines adherence as "the extent to which a person's behaviour – taking medication, following a diet and/or executing lifestyle changes – corresponds with agreed recommendations from a health care provider" (WHO, 2003, p.3). We adopted this definition in this review.

Search methods and search strategy

We searched eight electronic databases: MEDLINE, CINAHL, PUBMED, SCOPUS, PsycINFO, EMBASE, Cochrane library and EMCARE. We searched EMCARE instead of The British Nursing Index listed in our published protocol (Mogre, Johnson, Tzelepis, Shaw, & Paul, 2017) because our medical librarian advised us that the EMCARE database would contain more relevant information. All searches were completed on 20 June 2017. The search strategy was developed by VM and reviewed by the research team and a medical librarian. As shown in additional file 1, the search strategy had terms relating to the following: self-care behaviours, diet, exercise, self-monitoring of blood glucose, medication taking, foot care, type 2 diabetes, low-and middle-income countries. Appropriate MESH headings of these terms as well as relevant free text words were used. Boolean operators were applied where necessary to cater for the different use of terms in the literature. Search results were limited to English and 1990 to present given that diabetes was being recognised during this timeframe as a disease that affects populations of developing countries or LMICs (King & Rewers, 1993). The search strategy was initially used in MEDLINE and subsequently used for the syntax and subject headings of the other databases. All searches were conducted by VM and the results reviewed by all members of the research team.

Search outcome

All search results were downloaded into the reference manager, ENDNOTE version X7 for screening purposes. Titles and abstracts were screened independently by two reviewers (VM and (FT or NJ or CP)) according to the eligibility criteria. The results of the two reviewers were compared and differences were resolved through discussions. Using the Cohen kappa, inter-rater agreement was k=0.334 demonstrating fair agreement. For articles where eligibility could not be determined through title and abstract screening, full text review was independently completed by two reviewers (VM and (FT or NJ or CP)). Where discrepancies

arose, these were resolved through discussion. The reference lists of all eligible articles and systematic reviews were searched to identify any additional relevant articles. We selected studies for inclusion based on the following eligibility criteria.

Study designs: All study designs were included (cross-sectional studies, baseline data from experiments [i.e. randomised or non-randomised trials], retrospective studies, prospective cohort studies and case control studies).

Type of data: Only quantitative studies.

Study participants: Studies that had type 2 diabetes patients from any of the LMICs were included. Those that had most (≥50%) of participants having type 2 diabetes were included. Studies that did not clearly state the type of diabetes participants had but reported the mean age of onset of diabetes of the participants to be ≥ 30 years and/or the mean age of participants to be ≥40 years were also included.

Time frame*:* From January 1990 - June 2017.

Setting: Population-based, community-based and clinical or hospital-based studies.

Outcomes: Studies that reported on adherence to diabetes self-care behaviours (either one or multiple self-care behaviour).

Language: Studies written in English.

To ensure the replicability of findings, only published studies were included.

Studies were excluded if they were case reports, conference proceedings, non-peer reviewed papers, opinion pieces, letters to the editor, commentaries, abstracts, did not report on adherence and/or barriers to any of the diabetes self-care behaviours and/or had most of the participants being younger than 18 years. Although we intended in our published protocol (Mogre, Johnson, Tzelepis, Shaw, & Paul, 2017) to investigate in one review adherence and

barriers to diabetes self-care, the barriers component is now a subject of another review and will be reported separately. However, the search terms/exclusion criteria still refer to the barriers component.

Data extraction

Data extraction was done using a standardized data extraction form similar to those used in previous reviews (Carbia, López-Caneda, Corral, & Cadaveira, 2018; Coyle et al., 2013; Pun, Coates, & Benzie, 2009; Sohal, Sohal, King-Shier, & Khan, 2015). Information regarding the following was extracted: author(s) name, year of publication, study objectives, study design, country of study, participants, sample size, sampling, recruitment procedures, methods, inclusion/exclusion criteria, type of self-care behaviour (s) investigated, how self-care behaviour was investigated, type of tool used to assess self-care behaviour, data analysis, theoretical underpinning, response rate, demographic characteristics, adherence rates, and reported conclusions. VM and CP independently extracted the data and discussed among themselves the findings wheredifferences were resolved. The outcome of the data extraction process was then discussed with the other members of the review team.

Quality appraisal

We used the National Heart, Lung and Blood Institute (NHLBI) Quality assessment tool for Observational and Cross-sectional studies to undertake quality appraisal (Jorgensen, 2015; NHLBI, 2014). This tool is widely used and has been recommended by Cochrane for the quality assessment of observational and cross-sectional studies (Carbia et al., 2018). Each study was graded using 14 criteria (a score of one was awarded if the response was ‘Yes’ and zero if the response was ‘no’, ‘not applicable”, ‘not reported’ or ‘cannot determine’ and each study was awarded a global score out of 100% (e.g.., 7/14 = 50%). A score >80% was

considered high quality; 60-80% and <60% considered medium and low quality respectively. All studies that were graded as poor quality were excluded from the review.

Data analysis and synthesis

Given the heterogeneity of the studies a systematic narrative synthesis was conducted. In presenting the characteristics and findings of studies, we used tables and narrative summaries. The analysis and synthesis process were informed by the Guidance of the Conduct of Narrative Synthesis in Systematic Reviews (Popay et al., 2006). VM conducted all data analysis and synthesis and discussed the findings with the other members of the review team.

RESULTS

Figure 1 presents the PRISMA flow chart. Our database searches identified 7,109 studies (PubMed = 3008; CINAHL = 312; MEDLINE = 630; SCOPUS = 579; PsychINFO = 37; EMBASE = 1160; Cochrane library = 924; EMCARE = 459) and 2,956 duplicates were removed. Title and abstract screening resulted in 145 studies for full text review. The most common reasons for exclusion were: not being about diabetes; reporting in other languages other than English; originating from a high income country; following a qualitative approach. Full texts of these articles were retrieved and evaluated against the eligibility criteria from which 48 studies were retained. Review of the reference lists of eligible studies resulted in the inclusion of 6 additional studies yielding a total of 54 studies. Data were extracted from these 54 studies for quality assessment from which 22 studies were excluded for having poor quality. Three studies were excluded for using qualitative approaches to assess adherence to diabetes self-care, 2 for reporting inconsistent adherence rates and the remaining 27 studies were included in this review.

General characteristics of included studies

The general characteristics of the included studies is presented in additional file 2. All the studies were published after 2006. The included studies were carried out in several LMICs. Five were from Ethiopia, five from Nigeria, three from Uganda, two Tanzania, one each from Belize, Brazil, Cameroun, China, Ghana, Honduras, India, Jordan, Libya, Malaysia, Nepal and Zambia. Twenty-four studies used a cross-sectional design and one each employed the following designs: case-control, single group pre-post and non-randomised controlled trials (only baseline data were used).

Two of the included studies recruited participants from the community while the remainder (N=25) recruited from institutions (i.e. hospitals). The included studies had 7620 participants (women = 4272 vs. men = 3348) with a mean (SD) and median sample size of 282 (165) and 230 (Interquartile range (IQR): 25 – 806) participants respectively. Most of the included studies (N=22) had more women participants than men. Twenty-four studies reported the mean ages of study participants, most (N=19) of which had mean ages between 50 and 60 years. The rest of the studies that reported age categories of participants found most of the participants were aged within the 50-60 years age category. Among the 13 studies that reported participants' mean duration of diabetes, all but one study (Kalyango, Owino, & Nambuya, 2008) reported that participants had been living with their diabetes for 5 or more years.

Self-care behaviours and prevalence of adherence

Most included studies, 16 out of 27 investigated and reported on more than one self-care behaviour. Of the 11 studies that reported on only one self-care behaviour, seven reported on medication taking only, two foot care practice only and one each reported on SMBG only,

diet only and physical activity only. Items of the questionnaires were either author-designed (N=6) or derived from previous studies (N=5) or adopted existing scales (N=16). Among studies that used existing questions, six used the summary of diabetes self-care activities questionnaire (SDSCA); four studies used the eight-item Morisky Medication Adherence Scale (8-MMAS) (all of which assessed medication taking only); two studies used the International Physical Activity Questionnaire (IPAQ); and one each used the diabetes self-management assessment tool (D-SMART), the self-care inventory tool and self-reported medication adherence and self-care dietary adherence scale.

Two studies combined adherence rates for all self-care behaviours investigated. Ayele et al (2012) found 39.0% of a sample of 222 diabetes patients adhered to recommended self-care practices. Using the SDSCA to evaluate adherence to self-care behaviours among a sample of 230 type 2 diabetes patients from Nepal, Bhandari and Kim, (Bhandari & Kim, 2016) reported a total mean (SD) adherence score of 3.6 (0.89) (maximum score = 7.0).

a. Diet

Fourteen studies evaluated adherence to diet (Shown in Table 1); all of which evaluated diet with other self-care behaviours except for one study (Worku et al., 2015) that investigated diet only. These studies reported adherence in varied forms: 1) number of days participants performed a recommended dietary behaviour/activity during the past week (N= 6); 2) percentage and/or number of participants adhering to a recommended diet, eating a particular type of food, or avoiding/limiting/minimising the intake of particular diet(s) (N=3); 3) number of times within a week participants followed a type of diet or meal (N=1); and 4) percentage of participants having good, fair or poor dietary adherence based on cut-off scores generated from participants' responses to items of a self-care questionnaire, most of which were Likert scales (N= 4). The mean number of days participants adhered to their dietary recommendations ranged from 2.3 days per week to 4.6 days per week. Regarding the

percentage of participants adhering to a recommended dietary practice, rates ranged from 29.9% of a sample of persons living with diabetes from South Western Nigeria reportedly having outstanding adherence (Adisa & Fakeye, 2014) to 91.7% of Nepalese diabetes patients avoiding sweets (Baumann et al., 2010). Among these studies the median adherence was 58.0% (IQR = 29.9% – 88.4%). Dekker et al (2017) found a sample of persons living with diabetes from Belize eating fruits and vegetables an average of 3 times per week.

b. ***Medication use/taking***

As shown in Table 2, 19 of the included studies reported on diabetes medication, making it the most frequently reported self-care behaviour. Three studies reported adherence as the mean number of days participants adhered to their diabetes medication during the last 7 days, all of which found participants adhering at least 5 days a week. Medication adherence rates ranged from 26.0-97.0% (median = 71%; IQR = 59.0% - 83.0%). Regarding good/high/strict adherence, rates ranged from 59.0% to 71.0%. Two studies investigated and reported treatment/anti-diabetic non-adherence (Kalyango et al., 2008; Piette, Mendoza-Avelares, Ganser, Mohamed, Marinec, Krishnan, et al., 2011). The study by Kalyango et al (2008) reported a non-adherence prevalence of 29.0%, while the study by Piette et al (2011) found 85.0% of persons with diabetes not adhering to their diabetes medication at least once during the past year. One study reported on the proportion of persons with diabetes using insulin only, insulin with oral agents, oral agents and those not using medication (Baumann et al., 2010). This study did not investigate whether participants adhered or not.

c. *Exercise*

Fourteen included studies evaluated patients' adherence to exercise (Table 3). All these included studies used self-reports. Adherence to physical activity or exercise was reported in varied forms including number of days of adhering to recommended exercise or physical activity in the last 7 or 3 days; and frequency/number of times participants engaged in physical activity or exercise within a week, percentage or number of participants engaging in exercise or type of physical activity. Six studies reported the number of days participants adhered to exercise in the last 7 days and most studies (N=4) found participants engaging in physical/exercise for less than 3 days in a week. Adherence rates ranged from 26.7% of elderly persons with diabetes from Brazil reportedly being sufficiently active (Bueno et al., 2017) to 69.0% of a sample of Nigerian type 2 diabetes individuals being physically active (Oyewole et al., 2014). The median adherence among these studies was 41.2% (IQR = 29.5% - 50.1%).

d. *SMBG*

As shown in Table 4, 13 included studies investigated SMBG from which six studies (Al-Amer et al., 2016; Ashur et al., 2016; Assah et al., 2015; Bhandari & Kim, 2016; Mogre, Abanga, et al., 2017; Mosha & Rashidi, 2009) reported the mean number of days participants performed SMBG in the last 7 days. The mean number of days on which SMBG was performed ranged from 0.2 to 2.2 days per week. Four studies reported on the percentage of participants that performed SMBG without indicating the number of times per day or within a week (Adisa & Fakeye, 2014; Baumann et al., 2010; Huang et al., 2014; Musenge et al., 2016). These studies reported rates from 13.0% to 79.9% (median = 18.5%; IQR = 14.5% - 51.5%). Two studies investigated the number of times participants monitored their blood

glucose in a day and/or within a week (Ayele et al., 2012; Mastura et al., 2007). Ayele et al (2012) found 18.0% of a sample of persons with diabetes from Ethiopia performing SMBG more than once a week. However, Mastura et al (2007) reported 16.4% performing SMBG once per day, 47.1% more than once per week and 36. 5% less than once a week.

e. *Foot care*

Ten included studies evaluated foot care among diabetes patients from which two studies investigated foot care only (Shown in Table 5). Six studies (Al-Amer et al., 2016; Ashur et al., 2016; Assah et al., 2015; Bhandari & Kim, 2016; Mogre, Abanga, et al., 2017; Mosha & Rashidi, 2009) reported foot care adherence according to the mean number of days diabetes patients adhered to foot care recommendations; mean days ranged from 2.2 days to 4.3 days in a week. Huang et al (2014) reported a mean foot care practice score of 77.47% among Chinese persons with diabetes (higher scores indicate better self-perceived overall foot-care). Three studies (Abdulrehman, 2015; Baumann et al., 2010; Desalu et al., 2011) reported on regular feet inspection from which rates ranging from 37% to 41% were reported. The study by Desalu et al (2011), investigated a wide range of foot care practices including feet inspection, washing of feet with warm water and inspection of the inside of footwear. Responses from these were used to classify participants into good, fair and satisfactory foot care practice. They found only 10.0% of participants had good foot care practices. In a study among a sample of persons with diabetes from India, Chellan et al (2012) reported a good foot care practice (with a different classification of factors considered to be good practice) prevalence of 36.0% among those without diabetic foot ulcer and 17.0% among those with diabetic foot ulcer disease. The median adherence was 36.5% (IQR = 13.6% - 59.2%).

DISCUSSION

This review identified that many diabetes patients from LMICs fail to adhere to self-care behaviours as recommended or agreed between the patient and healthcare provider. This is concerning given that poor adherence to diabetes self-care could lead to poor glycaemic control and subsequently development of acute and chronic complications (Bazargan et al., 2003; Booth & Hux, 2003).

The dietary adherence rates of 29.9 to 91.7% (median 58.0%, IQR: 29.5 - 88.4%) are similar to the 33 to 87% rate of adherence reported by Stephani et al in a systematic review of studies from sub-Saharan Africa (SSA) (Stephani et al., 2018). Although the adherence rates reported in this study for diet do not greatly differ from those reported among diabetes patients from high income countries (HICs) (Coyle et al., 2013), the capability of LMIC health services to manage diabetes complications are likely to differ from HICs, which suggests diabetes self-care adherence is an urgent challenge facing LMICs. It is also pertinent to note that the accuracy of the data regarding adherence to diet may also be weaker than some of the other self-report data.

It is unsurprising that self-care adherence to diet is poor, given the long-term nature of the behaviour (Carrara & Schulz, 2017; Sabaté, 2003); the complexity of changing both daily food choices and daily eating patterns (Sobal, Bisogni, Devine, & Jastran, 2006); social pressure (Cheng et al., 2016; Halali, Mahdavi, Mobasseri, Jafarabadi, & Avval, 2016; Heo, Lennie, Moser, & Okoli, 2009; Shultz, Sprague, Branen, & Lambeth, 2001) and the cultural meaning of food (Carrara & Schulz, 2017; Sobal et al., 2006).

The review identified medication taking as the self-care behaviour with the highest frequency and rates of adherence. This is consistent with the data from HICs (Coyle et al., 2013; Cramer, 2004; Krass, Schieback, & Dhippayom, 2015).The range of medication adherence

rate of 26.0 to 97.0% (median = 71.0%; IQR: 59.0 – 83.0%) appears similar to the 36.0 to 93.0% reported from a systematic review of 11 retrospective studies from HICs (Cramer, 2004) and the 38.5 to 93.1% reported from a systematic review of 27 studies, most of which were from HICs (Krass et al., 2015). A review of studies from SSA reported a medication adherence rate of 39.0 to 88.0% (Stephani et al., 2018). Although the adherence rates for medication taking are higher than those for the other self-care behaviours in this review, the wide variations among the studies and between the lowest and highest estimates show that many diabetes patients do not regularly adhere to their anti-diabetic medications in LMICs. Adherence to anti-diabetic medications may be more challenging for diabetes patients from LMICs due to a myriad of factors including lack of health insurance, poor income levels and lack of medicines, among others (Abdulrehman, 2015; Aikins, 2005).

Guidelines for glucose monitoring vary by individual and by medication, making it difficult to evaluate adherence rates, particularly in terms of frequency (Patton, 2015). The non-frequency data (i.e. the proportion of patients adhering to their recommended SMBG) suggests adherence is low (13-79%) in LMICs relative to most other behaviours. In HICs adherence to SMBG appears to be similarly variable and perhaps higher, varying from 40% to 97% (Coyle et al., 2013; Patton, 2015). Stephani et al (2018) reported SMBG adherence rates of 0 to 43% in SSA. Evidently, suboptimal adherence to SMBG is a concern in LMICs. Strategies for addressing this issue are essential given the findings that the frequency of performing SMBG is associated with improved HbA1c levels in diabetes patients (Bosi et al., 2013; Welschen et al., 2005).

Just like the other self-care behaviours, varying rates of adherence to exercise was reported ranging from 26.7% to 69.0% (median = 41.2%; IQR: 29.5 – 50.1%). Similar varying rates have also been reported from HICs where several studies have described patients' adherence to exercise as suboptimal (Qiu, Sun, Cai, Liu, & Yang, 2012; Shultz et al., 2001; Zhao, Ford,

Li, & Balluz, 2011). Several reasons could be responsible for the current situation including lack of time, social/cultural beliefs, poor perception of obesity as a health issue, non-receipt of self-care support to exercise and lack of exercise facilities, among others (Advika, Idiculla, & Kumari, 2017; Qiu et al., 2012).

Foot care was the least explored in the literature and one of the least adhered self-care behaviours. This finding is also similar to a review by Coyle et al (2013) which had most of the included studies from HICs. As has been widely reported in the literature (Bell et al., 2005; De Berardis et al., 2004; Litzelman et al., 1993; Sarkar, Fisher, & Schillinger, 2006), the included studies found patients reporting poor adherence to foot self-care. Inadequate foot care knowledge has been identified previously as a contributing factor to poor foot care practice among type 2 diabetes patients (Bonner, Foster, & Spears-Lanoix, 2016; Harvey & Lawson, 2009). Foot care education has been shown to improve foot care knowledge, foot care practice and decreased diabetic foot complications and amputations (Barth, Campbell, Allen, Jupp, & Chisholm, 1991; Bonner et al., 2016).

Limited access to support services has been reported as a barrier to adherence to diabetes self-care in the literature from LMICs (Levitt, 2008; Mbanya, Motala, Sobngwi, Assah, & Enoru, 2010; Osei, Schuster, Amoah, & Owusu, 2003a; Park et al., 2015) and it is likely to affect diabetes knowledge and adherence (Kiawi et al., 2006; Onwudiwe et al., 2011) . Limited access to support services may result in patients' poor understanding of the causes, symptoms and management of diabetes which is critical to the performance of recommended self-care behaviours (Kiawi et al., 2006; Onwudiwe et al., 2011). An important aspect of diabetes care is access to diabetes specialists or healthcare professionals specially trained for diabetes (Tripp-Reimer, Choi, Kelley, & Enslein, 2001; Zgibor & Songer, 2001). Critical to diabetes care is lifestyle advice including dietary advice. However, most diabetes patients from sub-Saharan Africa do not receive such care largely due to the unavailability of

specialists such as nutritionists and dieticians (Mogre, Johnson, Tzelepis, & Paul, 2019). Access to other specialists such as eye specialists, endocrinologists and even general diabetes educators is also inadequate in several LMICs (Bagonza et al., 2015; Kalyango et al., 2008; Worku et al., 2015). There is evidence from middle/high income countries that access to specialist care is associated with improved diabetes knowledge, improved SMBG and improved glycaemic control (Bloomfield & Farquhar, 1990; Ho, Marger, Beart, Yip, & Shekelle, 1997; Koproski, Pretto, & Poretsky, 1997; Schiel et al., 1997; Verlato et al., 1996).

There is evidence that affordability is associated with consumption of fruits and vegetables in the general population. In a prospective study that investigated consumption, availability and affordability of fruits and vegetables in 18 countries including LMICs, Miller et al found that consumption was associated with the affordability of fruits and vegetables (Miller et al., 2016). Unaffordability has been frequently reported by previous studies as a barrier to dietary recommendations (including the consumption of fruits and vegetables) in people with type 2 diabetes (Aikins, 2003, 2005; Worku et al., 2015). Unaffordability is associated with poor income levels and having low income levels may result in inability of people with type 2 diabetes to purchase recommended fruits and vegetables, thereby affecting consumption. The situation is even more precarious in LMICs in that unaffordability co-exists with issues of accessibility and availability of fruits and vegetables (Lekoubou, Awah, Fezeu, Sobngwi, & Kengne, 2010; Tewahido & Berhane, 2017).

Strengths and Limitations

The review by Stephani et al (2018) provides a firsthand overview of adherence to diabetes self-care behaviours among diabetes patients from SSA, providing a platform for future studies to build on. However, authors reported adherence rates, only from studies that described adherence in terms of proportions but not those that described adherence in terms of frequency or number of days or times patients adhered to a self-care behaviour within a

day or a week. Given that a good proportion of published studies adopt these approaches of reporting adherence, the Stephani et al (2018) approach does not provide a complete picture of the situation of adherence to self-care behaviours among diabetes patients from SSA and other developing countries, the focus of the current review. The current review quantifies the extent to which people in LMICs with diabetes adhere to each of the recommended self-care behaviours and also identifies the variability in methods of measuring and reporting adherence. Our review thus provides a comprehensive, broader and varied synthesis of the adherence data recognising the nuances and complexity of the literature on adherence to diabetes self-care.

The adherence literature in general has several limitations. First, there is no 'gold standard', widely accepted accurate method of assessing adherence to self-care behaviours (Farmer, 1999; Wabe, Angamo, & Hussein, 2011) resulting in the adoption of varied assessment measures by the authors. This made it difficult to make comparisons across studies (Coyle et al., 2013; Toobert & Glasgow, 1994). Self-reports were the most widely used measures of adherence, due to their ease of application and low cost (McNabb, 1997; Nemes, Helena, Caraciolo, & Basso, 2009), but may be vulnerable to social desirability bias (Hebert et al., 1997; Toobert & Glasgow, 1994). Reliability could be improved by adopting specific items in interviews (Freund, Johnson, Silverstein, & Thomas, 1991) or questionnaires (Hanson et al., 1988) and also by adopting instruments that meet psychometric standards of reliability and validity (Nunnally & Bernstein, 1994).

Our findings are also limited by there being only a fair level (rather than high level) of agreement between the two independent reviewers during the screening process to identify eligible studies. However, this was minimised by discussions among the independent reviewers regarding inclusion/exclusion of studies and subsequent adjudication by another member of the review if required. We also note that all the included studies were published

from 2006 onwards with none published between 1990 and 2005. This was due to pre-2006 studies being relatively few in number (17% of the total citations identified in the search strategy) and not meeting the review inclusion criteria. It would appear that very little relevant research was occurring on the review topic in LMICs prior to 2006.

Another important limitation in the literature was the lack of a common strategy of quantifying levels of adherence. While some authors assessed adherence in terms of the relative frequency of performing self-care behaviours (i.e. never, sometimes, often, always, etc) (Rwegerera, 2014b), others reported on the number of times patients performed self-care behaviours in a day or a week, while others enumerated the percentage of time patients adhered to a recommended self-care behaviour. Several studies also used terms such as regular/irregular (Shobhana, Begum, Snehalatha, Vijay, & Ramachandran, 1999) and good/bad (Rozenfeld, Hunt, Plauschinat, & Wong, 2008) to describe the frequency of adhering to self-care behaviours without providing clear definitions of these terms. These point to the high heterogeneity of the included studies, a limitation that did not allow for us to conduct a meta-analysis. Given that a patient's adherence to one self-care behaviour may not be associated with his/her adherence to another self-care behaviour, it is important to measure each self-care behaviour separately rather than combining scores to yield a single adherence score (Johnson, 1992; Toobert & Glasgow, 1994). It is important to note that the median adherence rates reported in this systematic review for the ranges of adherence rates should be interpreted with caution as they do not originate from primary data but from secondary data (i.e. the included studies) with varying sample sizes.

CONCLUSION

Adherence to diabetes self-care behaviours is inadequate among persons with diabetes LMICs especially for diet and SMBG. This is a concern given the poor health outcomes associated with poor self-care (for example, blindness, amputations etc) particularly in countries where health-care resources are inadequate and/or scarce. There is also the need to understand the barriers, facilitators of and diabetes patients' attitudes towards self-care to inform the design of interventions. In addition, the measurement variability identified in the review also makes it clear that health services must monitor these behaviours rather than expect adherence; and that large-scale accurate monitoring of adherence in a health district or nation requires a considered approach to choice of measurement tool.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figure legend

Figure 1: PRISMA flow chart for the selection of studies

Table 1: Adherence to diet

Author(s)	Year	Country	Sample size	Measure	Adherence rates
Bhandari and Kim (2016)	2016	Nepal	230	Mean (SD) number of days participants adhered to diet during the last one week	4.3(1.45)
Mosha and Rashidi (2009)	2009	Tanzania	121	Mean (SD) number of days participants adhered to general diet during the last one week	4.6(2.6)
				Mean (SD) number of days participants adhered to specific diet in the last one week	1.4(2.2)
Al-Amer et al (2016)	2016	Jordan	220	Mean (SD) number of days participants adhered to general diet during the last one week	2.3(2.4)
Ashur et al., (2016)	2016	Libya	523	Mean (SD) number of days participants adhered to general diet during the last one week	2.9(2.6)

Assah et al (2015)	2015	Cameroun	192	Mean (SD) number of days participants adhered to general diet during the last one week	3.8(2.4)
Mogre et al (2017)	2017	Ghana	187	Mean (SD) number of days participants adhered to general diet during the last one week	4.4(1.5)
				Mean (SD) number of days participants adhered to specific diet in the last one week	4.4(1.3)
Dekker et al (2017)	2017	Belize	25	Mean number of times participants ate fruits and vegetables in the past week	3 times
				% Using vegetable oil to cook	68.0%
Hintsa et al (2017)	2017	Ethiopia	409	% Adherent to diet	43.5%

Huang et al (2014)	2014	China	364		
				% Having good adherence	55.2%
				% Having fair adherence	25.6%
				% Having poor adherence	19.2%
Emmanuel and Otovwe (2015)	2015	Nigeria	350	% Having partial adherence to diet treatment	32.6%
				% Having strict adherence to diet treatment	67.4%
Worku et al (2015)	2015	Ethiopia	403	% Having poor dietary practice	51.4%
Adisa and Fakeye (2014)	2014	Nigeria	176	% Having outstanding adherence (≥8 self-reported dietary adherence score)	29.9%
				% Having poor dietary adherence (<8 SRDAS)	70.1%

Ayele et al (2012)	2012	Ethiopia	222	Adherence to dietary recommendation in the last 3 days	58.0%
Baumann et al (2010)	2010	Uganda	340	Avoid sweets	91.7%
				Limit fatty food	88.4%
				Eat what I can afford/what is available	27.3%
				Eat anything I want	16.3%

Table 2: Adherence to medication taking

Author(s)	Year	Country	Sample size	Measure	Adherence Rates
Al-Amer et al (2016)	2016	Jordan	220	Mean (SD) number of days participants adhered to medications in the last 7 days	6.5(1.4)
Bhandari and Kim (2016)	2010	Nepal	230	Mean (SD) number of days participants adhered to medications in the last 7 days	6.8(1.1)
Mosha and Rashidi (2009)	2009	Tanzania	121	Mean (SD) number of days participants adhered to diabetes medications during the last 7 days	5.5(2.8)
Bagonza et al (2015)	2015	Uganda	521	Adherent to anti-diabetic medication	83.0%
Jackson et al (2015)	2015	Nigeria	303	Highly adherent to diabetes medications	68.0%
Kalyango et al (2008)	2008	Uganda	402	Prevalence of non-adherence	29.0%
Kassahun et al (2016)	2016	Ethiopia	309	High medication adherence	37.0%
				Medium adherence	38.0%

				Low adherence	25,0%
Rwegerera et al (2014a)	2014	Tanzania	216	Good adherence at one week	60.0%
				Good adherence at 3 months	71.0%
Piette et al (2011)	2011	Honduras	85	Taking diabetes medication	89.0%
				Having at least one-episode of cost related non-adherence in the prior year	85.0%
Adisa and Fakeye (2014)	2014	Nigeria	176	Medication adherence	53.0%
Ayele et al (2012)	2012	Ethiopia	222	Adherence to drugs	78.0%
Baumann et al (2010)	2010	Uganda	340	Insulin Insulin + Oral medication Oral medication No medication	62.9% 27.9% 3.9% 5.3%
Ashur et al., (2016)	2016	Libya	523	Low medication adherers	36.1%
				Moderate and high medication adherers	63.9%
Hintsa et al (2017)	2017	Ethiopia	409	**Medication adherence**	

			84	Cases	95.0%
			325	Controls	97.0%
Huang et al (2014)	2014	China	364		
				Good adherence	65.4%
				Fair adherence	28.6%
				Poor adherence	9.0%
Emmanuel and Otovwe (2015)	2015	Nigeria	350	Partial medication adherence	40.0%
				Strict medication adherence	59.0%
Bueno et al (2017)	2017	Brazil	806	Average use of drugs per elderly	2.2
Gelaw et al (2014)	2014	Ethiopia	270	Adherence to anti-diabetic regimen	72.2%
Musenge et al (2016)	2016	Zambia	198	Adherence to treatment regimen as prescribed	26.0%

Table 3: Adherence to exercise

Author(s)	Year	Country	Sample size	Measure	Adherence rates
Al-Amer et al (2016)	2016	Jordan	220	Mean (SD) number of days participants adhered to exercise in the last 7 days	1.8(2.0)
Ashur et al., (2016)	2016	Libya	523	Mean (SD) number of days participants adhered to exercise in the last 7 days	2.5(2.3)
Assah et al (2015)	2015	Cameroun	192	Mean (SD) number of days participants adhered to exercise in the last 7 days	2.3(1.7)
Bhandari and Kim (2016)	2016	Nepal	230	Mean (SD) number of days participants adhered to exercise in the last 7 days	4.2(2.8)
Mosha and Rashidi (2009)	2009	Tanzania	121	Mean (SD) number of days of participating in at least 30 minutes of physical activity in the last 7 days	5.7(2.4)

				Mean (SD) number of days of participating in a specific exercise session in the last 7 days	1.2(2.3)
Mogre et al (2017)	2017	Ghana	187	Mean (SD) number of days participants adhered to exercise in the last 7 days	4.8(2.1)
Ayele et al (2012)	2012	Ethiopia	222	Had exercise for 30 minutes per day in the last three days	31.1%
				Did not exercise for 30 minutes per day in the last three days	25.7%
Baumann et al (2010)				**Being active**	
	2010	Uganda	340	Regular program of exercise	39.0%
				Activities of daily living	54.0%
				Limited ability to exercise	7.0%
Hintsa et al (2017)	2017	Ethiopia	409	Adherence to exercise	42.0%

Huang et al (2014)	2014	China	364	**Exercise management**	
				Good	50.8%
				Fair	41.8%
				Poor	7.4%
Bueno et al (2017)	2017	Brazil	806	Prevalence of active and inactive individuals	26.7% and 73.3%
Musenge et al (2016)	2016	Zambia	198	Did not engage in any type of regular exercise	59.6%
Dekker et al (2017)	2017	Belize	25	Engage in activities that increases their breathing including walking or domestic work for at least once a week	48.0%
Oyewole et al (2014)	2014	Nigeria	350	Physically inactive and active	31.0% and 69.0%

Table 4: Adherence to SMBG

Author(s)	Year	Country	Sample size	Measure	Adherence rates
Al-Amer et al (2016)	2016	Jordan	220	Mean (SD) number of days of self-monitoring blood glucose in the last 7 days	2.1(2.3)
Ashur et al., (2016)	2016	Libya	523	Mean (SD) number of days of self-monitoring blood glucose in the last 7 days	1.2(1.9)
Assah et al (2015)	2015	Cameroun	192	Mean (SD) number of days of self-monitoring blood glucose in the last 7 days	1.2(1.5)
Bhandari and Kim (2016)	2016	Nepal	230	Mean (SD) number of days of self-monitoring blood glucose in the last 7 days	0.6(0.9)
Mosha and Rashidi (2009)	2009	Tanzania	121	Mean (SD) number of days of self-monitoring blood glucose in the last 7 days	0.2(0.5)
Mogre et al (2017)	2017	Ghana	187	Mean (SD) number of days of self-monitoring blood glucose in the last 7 days	2.2(0.7)
Ayele et al (2012)	2012	Ethiopia	222	Monitored blood glucose once a week	42.0%
Baumann et al	2010	Uganda	340	Monitoring of blood glucose	15.0%

(2010)				at home	
Huang et al (2014)	2014	China	364	% performing blood sugar monitoring	79.9%
Musenge et al (2016)	2016	Zambia	198	% Reporting SMBG	13.0%
Adisa and Fakeye (2014)	2014	Nigeria	176	% Self-monitoring blood glucose % keeping record of measurements	22.0% 92.0%
Mastura et al (2007)	2007	Malaysia	170	Performance of SMBG	15.0%
				% Performing SMBG at least once per day	16.4%
				% Performing SMBG more than once per week	47.1%
				% performing < once per week	36.5%

Table 5: Adherence to foot care

Author(s)	Year	Country	Sample size	Measure	Adherence rates
Ashur et al (2016)	2016	Libya	523	Mean (SD) number of days participants practiced foot care during the last 7 days	2.3(2.6)
Assah et al (2015)	2015	Cameroun	192	Mean (SD) number of days participants practiced foot care during the last 7 days	4.3(2.6)
Bhandari and Kim (2016)	2016	Nepal	230	Mean (SD) number of days participants practiced foot care during the last 7 days	2.2(2.4)
Mosha and Rashidi (2009)	2009	Tanzania	121	Mean (SD) number of days participants practiced foot care during the last 7 days	3.6(2.8)
Mogre et al (2017)	2017	Ghana	187	Mean (SD) number of days participants practiced foot care during the last 7 days	2.9(2.2)
Al-Amer et al (2016)	2016	Jordan	220	Mean (SD) number of days participants practiced foot care during the last 7 days	2.4(2.5)
Huang et al (2014)	2014	China	364	% Foot care practice	77.4%
Chellan et al (2012)	2012	India	203	**Diabetic Foot Ulcer group**	
				Poor practice of foot care	40.0%
				Average practice of foot care	44.0%
				Good practice of foot care	17.0%
				Without Diabetic Foot	

				Ulcer group	
				Poor practice of foot care	9.0%
				Average practice of foot care	55.0%
				Good practice of foot care	36.0%
Desalu et al (2011)	2011	Nigeria	352	Mean foot care practice score	5.7
				% Having regular inspection of feet	40.9%
				% Regularly washing their feet with warm water	46.0%
				% Inspecting the inside of their foot wear	47.7%
				% Having good foot care practice (Score ≥70)	10.2%
				% Having satisfactory foot care practice (Score = 50-69%)	40.3%
				% Having poor foot care practice (Score<50)	49.4%
Baumann et al (2010)	2010	Uganda	340	% Having feet checked	41.0%

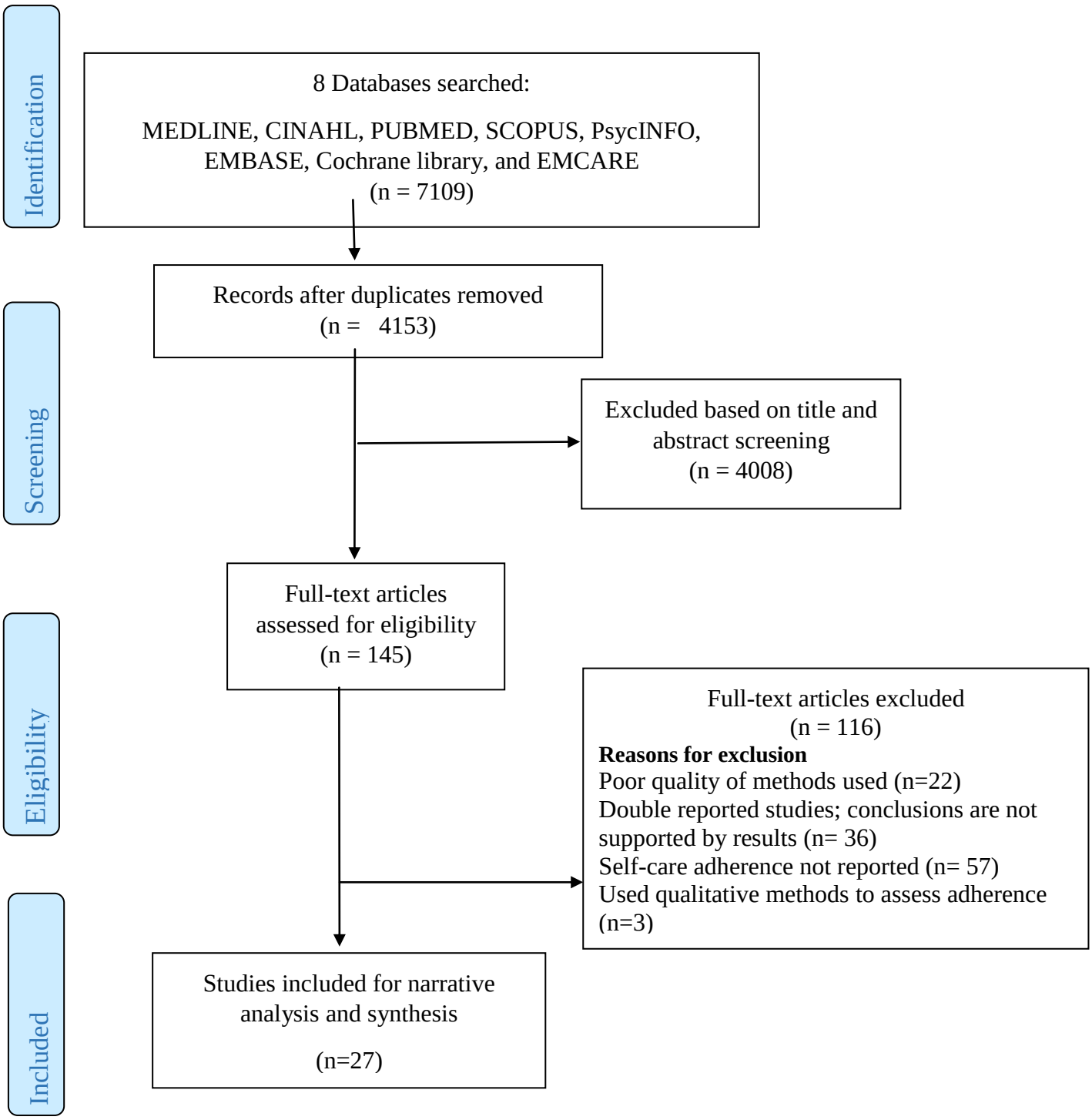

Figure 1: PRISMA flow chart for the selection of studies