Type 2 diabetes self-management education programs in high and low mortality developing countries: A systematic review

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ABSTRACT

Purpose: Although self-management education is a key factor in the care for diabetes patients, its implementation in developing countries is not well documented. This systematic review considers the published literature on diabetes self-management education in high and low mortality developing countries. The aim is to provide a state of the art of current practices, assess program outcomes, cultural sensitivity and accessibility to low literate patients.

Methods: The Cochrane Library, PubMed, MEDLINE, PsycInfo and PsycArticles databases were searched for peer-reviewed articles on Type 2 diabetes published in English between 2009 and 2013. The World Bank and WHO burden of disease criteria were applied to distinguish between developing countries with high and low mortality. Information was extracted using a validated checklist.

Results: Three reviews and 23 primary studies were identified, 18 of which were from low mortality developing countries. Studies from high mortality countries were mostly quasi-experimental, those from low mortality countries experimental. Interventions were generally effective on behavior change and patients' glycemic control in the short term (≤9 months). While 57% of the studies mentioned cultural tailoring of interventions, only 17% reported on training of providers, and 39% were designed to be accessible for people with low literacy.

Conclusions: The limited studies available suggest that diabetes self-management education programs in developing countries are effective in the short term, but must be tailored to conform to the cultural aspects of the target population.

Keywords: Type 2 diabetes, self-management education, cultural tailoring, developing countries, knowledge, gaps, effectiveness, systematic review.

Introduction

Diabetes mellitus (DM) is one of the most common chronic diseases worldwide.[1,2] While until recently it was considered a disease of the affluent, it is increasingly becoming a burden for developing countries. Approximately 80% of people with diabetes live in low- and middle-income countries,[3] and their number is estimated to increase by 170% between 2000 and 2025[4]. This makes the anticipated impact of the condition greater and more damaging in these countries than in more affluent parts of the world.[5]

Developing countries face a significant rise in healthcare expenditure due to the increasing prevalence of diabetes. In many countries, diabetes consumes 5% to 20% of the healthcare budget, and more than 50% of that cost is due to complications.[6] Together with pharmacological treatment, lifestyle changes such as increased levels of physical activity, a healthier diet, and smoking cessation have proven useful in altering the course of Type 2 diabetes (T2DM) and delaying the development of complications.[7] Consequently, the education of diabetes patients to manage their illness and adopt lifestyle practices to prevent complications is widely recommended, particularly in populations where economic resources are limited.[8-10] As such, diabetes self-management education (DSME) can be considered as a crucial way to address the diabetes problem in developing countries.

Despite the growing body of literature demonstrating positive effects of DSME,[11-15] its implementation in developing countries is a challenging task. Developing countries are often faced with low levels of education in the adult population, resource poor environments, and a health system designed to address infectious diseases, being less well prepared to tackle chronic conditions like

diabetes.[4] As the bulk of the literature documenting the effectiveness of DSME concerns programs that were developed, implemented and evaluated in developed countries,[11,14,16] their direct importance to developing countries with different socio-cultural and economic conditions is uncertain.

Cultural sensitivity of DSME

The challenge of addressing the diabetes epidemic in developing countries could be partially resolved by using culturally appropriate and context relevant interventions to delay diabetes and prevent its complications.[4] Culture refers to the behavior patterns, beliefs, arts and all other products of human work and thought, as expressed in a particular community.[17] For diabetes education to be effective in multi-cultural societies, both the educators and the content of programs should be *culturally sensitive*.[18] This can be achieved through *cultural tailoring*, which is defined as "the process of creating culturally sensitive interventions, often involving the adaptation of existing materials and programs for racial/ethnic groups".[19]

There are two levels of cultural sensitivity: (1) *Surface structure* involves matching the intervention materials and messages to observable "superficial" (although important) characteristics of a target population, such as familiar people, places, language, music, food and locations; (2) *Deep structure* requires an understanding of the cultural, social, historical and psychological forces that influence the target population. Whereas surface culture only increases the acceptance of programs, deep cultural factors have more influence on the effectiveness of programs.[19]

Literacy sensitivity of DSME

Literacy is defined by the United Nations Educational, Scientific and Cultural organization (UNESCO), as the ability to identify, understand, interpret, create, communicate and compute, using

printed and written materials associated with varying contexts.[20] A challenge to DSME in developing countries is that many patients with diabetes have low levels of literacy.[21-23] Health literacy which is linked to literacy entails people's knowledge, motivation and competences to access, understand, appraise and apply health information in order to make decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course.[24] People with low literacy understand little (50%) of what is told to them during medical consultations and they may be embarrassed by their situation and hide their low level of literacy from people who could possibly help (healthcare providers, family members and friends).[21,23] As a result, they have difficulties in managing their medication and lifestyle. Screening for low literacy and tailoring DSME programs to the level of the patients through working with communities to develop more accessible educational materials and interventions can address this problem and enhance program effectiveness.

DSME in developing countries

In light of the above, it appears that addressing the burden of diabetes in developing countries requires DSME programs that are culturally and literacy sensitive.[25] To document the extent to which existing DSME programs in developing countries meet these demands, this systematic review considers the published literature on DSME in developing countries, looking at cultural sensitivity and adaptation for low literacy as potential determinants of effectiveness.

To our knowledge, this is the first systematic literature review of DSME programs in developing countries with a focus on these socio-cultural and literacy aspects. A recent paper by Rawal et al[7] reviewed the evidence for the effectiveness of DSME in developing countries, but did not consider cultural sensitivity and low literacy. Moreover, the review only included studies that considered blood glucose or glycated hemoglobin A1C (A1C) as a primary outcome, thus limiting the review to seven studies from four countries, all of which are classified as low mortality countries. However, as

the primary goal of DSME is to enable patients to integrate self-management into their daily lives and adopt a healthier lifestyle, the core outcomes of DSME are essentially behavioral. Hence, it makes sense to also include studies in the review that evaluate DSME program effectiveness in terms of behavioral outcomes, and not only in terms of A1C level changes. In addition, it is possible that DSME programs are implemented differently in countries with a high mortality, where the health system is often less well equipped to address chronic conditions.

Therefore, this systematic review aimed to answer the following review questions: (1) What is the current status of DSME for T2DM in developing countries?; and (2) To what extent are cultural specificity, low literacy and low health literacy addressed in DSME programs in developing countries?

Methods

The process of conducting and reporting this review was underpinned by the PRISMA Statement for Systematic Reviews and Meta-Analyses.[26]

Information sources and search terms

To find existing systematic reviews on DSME programs in developing countries, the Cochrane Library was first consulted, but no reviews were found focusing specifically on developing countries. Consequently PubMed, MEDLINE, PsycInfo, PsycArticles and Google scholar were searched using combinations of the following search terms: review, diabetes, self-management education, patient education, programmes / programs, developing countries, Africa, Latin America and "by country"(only in PubMed). Reference lists from the identified articles were hand searched for additional relevant articles.

Eligibility criteria

The search was restricted to peer-reviewed articles published in English and with full text available. The initial search was from 1980 but because of time and resource constraints it was limited to the period 2009 until 2013 (November 13). To define developing country status, the World Bank list for developing countries was used. The WHO burden of disease criteria was applied to distinguish between high and low mortality countries.[27,28] Studies with a full description of the DSME intervention, from a developing country, and focusing on T2DM or pre-diabetes were considered for inclusion. Studies on T1DM or mixed T1DM and T2DM, without a clear indication of the type of DM, gestational DM and whose subjects were not diabetes patients were excluded. As no primary studies on pre-diabetes were found during the search; this review focuses on T2DM only. All the articles were selected for inclusion by the first author (LD) and a subsample of the studies was analysed for inclusion and exclusion by a second assessor (MH). Assessor agreement was 100%.

Study selection

Using the abovementioned procedure, 2289 articles were identified (2171 from electronic databases and 118 from hand search). After applying the inclusion and exclusion criteria, 28 publications remained, 25 of which were primary articles (representing 23 studies) and three were reviews (Fig 1).

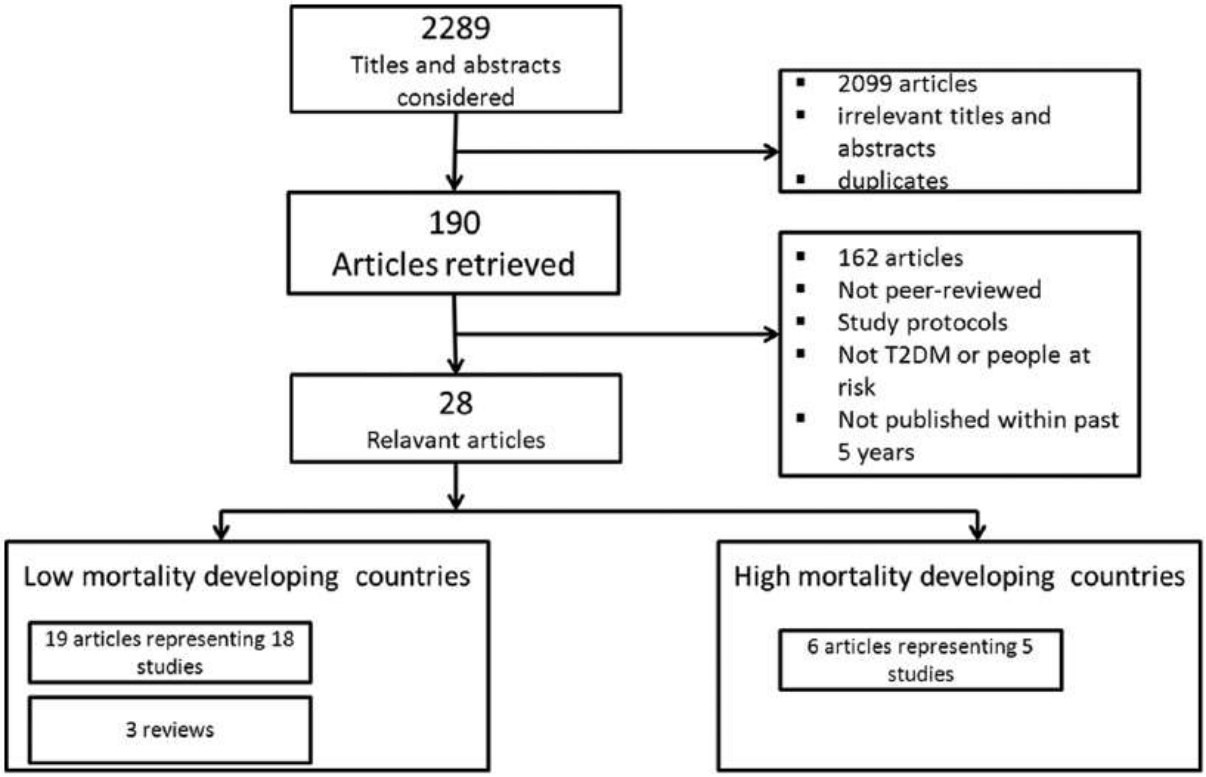

Figure 1. Flowchart of the selection process.

Study quality

Using a validated checklist for measuring study quality[29] (question 1-10), 22 articles were rated as having good quality, one article as fair quality and no articles as poor quality. Good quality was said to have a score of eight and above. All articles gave sufficient information about: study aims, outcomes measures, patient selection, description of intervention, results and statistical details. The main limitations observed in study quality were lack of reporting of adverse events and no report on characteristics of patients lost to follow-up.

Data extraction

An analysis of the existing reviews was performed separately. For the analysis of the DSME programs presented in the primary articles, the authors used a description tool developed and validated by an international consortium.[30] This tool was developed via a multiple Delphi process for

the Global Diabetes Survey (GDS), which is a global initiative to collect data on diabetes care quality on a yearly basis.[31] It consists of an online wiki-like survey with questions describing existing educational programs for diabetes and pre-diabetes prevention. The items used for the purpose of this review include program content, intervention, strategy, duration, program providers, training of the providers, and accessibility of the program to patients with low literacy. Although the primary interest for this systematic review was on health literacy, the primary studies found do not give information on health literacy but literacy levels. Due to the fact that there was only one paper on health literacy, the overall literacy levels of the patients will be discussed in this paper. In addition, program effectiveness on outcomes and tailoring of the program to the culture (surface and deep cultural aspects) were assessed. An intervention was said to be culturally sensitive (surface structure) if it was delivered in the local language, if local foods, symbols, objects were used and if local guidelines or country guidelines were incorporated in the design of the intervention. Deep structure was assessed as needs assessment, an understanding of cultural history, values and norms and incorporating this knowledge in the design of the program.[19] Data were summarized in tables and missing data according to the description tool were reported as "not reported" (NR).

Data extraction from the selected articles was done by the first author. A subsample of the articles was also evaluated by a second assessor, yielding an assessor agreement of 95%. The assessors then discussed the differences and consensus was reached (100%).

Results

Existing reviews

Three reviews evaluated the published literature on DSME programs in low mortality developing countries. The first review included 7 articles on DSME programs from 4 countries. Of these seven studies, 4 were concerned with prevention of complications in T2DM, and 3 were focused on

prevention of the development of T2DM. While considering lifestyle and other non-pharmacological interventions to prevent T2DM and its complications, this review only included studies with blood glucose measure or A1C as a primary outcome.[7] The main conclusion was that the reasonably consistent and positive results are significantly limited by the small number of studies. The second was a systematic review of 18 reports on DSME in Iran, published between 2002 and 2008.[32] Of these 18 studies, 11 were studies on T2DM, 4 were T1DM, 1 was mixed T1DM and T2DM and in 2 studies, the type of DM was unknown. Whereas the interventions seemed to have a positive effect on knowledge, self-monitoring of blood glucose and glycemic control, the review concluded that the findings were insufficient and too conflicting to draw firm conclusions. The third review gave a summary of the literature on DSME in mainland China, involving 34 studies published between 1989 and 2008.[33] Of these 34 studies, 18 were on T2DM, 6 were on mixed T1DM and T2DM, 1 was on Gestational DM, and in 9 studies, the type of diabetes was not mentioned. Only interventions with a duration of at least 3 months, and involving A1C and/or behavior change as outcome measures were included. This led to the conclusion that DSME programs in China have positive effects on the patient's knowledge and glycemic control, but that the effects on behavior change and on cardiovascular risks were variable. Long-term effects of the programs on quality of life and on medical complications were not assessed.

Study characteristics of identified studies

Of the 23 original studies that were identified in the 25 publications, 18 (78%) were from low mortality developing countries (Iran,[23,34-41] Argentina,[42,43] Turkey,[44,45] South Korea,[46] China,[47,48] Malaysia[49] and a combination of 27 selected developing countries[50,51]); five were from two high mortality developing countries (South Africa[52-54] and India[55-57]) (Tables 1 and 2). Most studies from low mortality developing countries were experimental and, except for one, those from high mortality developing countries were quasi experimental (Tables 1 and 2). A third of the studies (35%), only

Table 1 Study characteristics for T2DM in low mortality developing countries (n=18)

Reference	*Country*	*Study objective*	*Design*	*Inclusion criteria*	*Sample*	*Duration*
Negarandeh, et al.[23]	Iran	Explore the impact of pictorial image and teach back educational strategies on knowledge, adherence to medication and diet among patients with T2DM and low health literacy.	RCT	• >6 months duration of diabetes • Low health literacy (59 or lower on TOFHLA) • 18 years or older • Absence of mental, visual or learning abilities • Former participation in diabetes education research projects	135	9 weeks
Aliha, et al.[34]	Iran	Evaluate the effects of diabetes self-care group education and nurse-telephone follow-up on glycemic control and compliance with treatment orders in patients with T2DM attending to diabetes clinic	RCT	• Informed consent, access to telephone • Lack of difficulty in speech, hearing and vision • Absence of disease associated with physical & mental illness, excluded if admitted during study, changing treatment protocol or developing complications.	62	3 months
Samadi, et al.[39]	Iran	Determine the effect of quality of life education on self-concept of patients with T2DM.	RCT	• >30years old, • Cognitive ability to answer questions and consent given • Excluded if with prior *DSME within 1 year or having complications.	123	3 months
Bayat, et al.[35]	Iran	Assess the effectiveness of educational intervention based on extended health belief model on T2DM patients	RCT	• Being able to read and write • T2DM diagnosis by specialist	120	6 months
Farsaei, et al.[36]	Iran	Evaluate the effect of a clinical pharmacist-led patient education program for T2DM patients	RCT	• With uncontrolled T2DM A1C >7% • Able to read and write • Were in suitable therapeutic condition • Excluded if confused, unable to communicate verbally, or reached A1C<7% during 1st month	172	3 months
Sharifirad, et al.[40]	Iran	Determine the effectiveness of the HBM on nutrition education in T2DM patients.	Semi-Experimental study	• 30-60 years, not to be illiterate • At least 1 year attendance in Iranian Diabetes Association seminars,	88	NR (only 1 month follow-up)

				regulars follow-ups • No severe and chronic complication of diabetes		
Hazavehei, et a.,[37]	Iran	Determine the effects of educational program based on the Belief, Attitude, Subjective Norm, and Enabling Factors (BASNEF) Model on eye care among patients with insulin independent diabetes mellitus.	Experimental study	• 40-60 years, 5 year duration of diabetes • exposed to danger of ocular complications • Excluded if diagnosed with ocular or cardiac complications	100	4 months
Kashfi, et al.[38]	Iran	Evaluate the effect of educational program and jogging based on HBM on sugar control in type 2 patients	prospective quasi-experimental interventional study	• Without diabetes foot and cardiovascular side effects	100	3 months
Vatankhah, et al.[41]	Iran	Evaluate the impact of a simple educational program on the knowledge and practice of people with T2DM in relation to the foot at risk	NR	• Excluded if unable to answer questionnaire due to dementia, psychosis or profound deafness	148	9 months (6months follow-up)
Gagliardino, et al.[42]	Argentina	Implement an educational program in 10 Latin American countries and to evaluate its effect on the clinical, biochemical, and therapeutic aspects as well as the economic cost of diabetes	Randomised 2x2 design	• At least 2 years duration of diabetes, between 25-75 years old, excluded if T1DM, with severe complications, alcohol or drug addiction or inability to self-care	468	42 months
Perman, et al.[43]	Argentina	Compare the all-cause mortality rate in elderly T2DM patients who attended self-management educational workshops compared with those who did not.	Retrospective Cohort study	• Diagnosis of T2DM before Dec 31 2003 • ≥65 at Jan 1 2001 • Remain an affiliate of the health plan at least for 1 year after recruitment	1730	6 years
Atak, et al.[44]	Turkey	Evaluate the effect of patient education on knowledge, self-management behaviours and self-efficacy in patients with T2DM	RCT	• Had attended at least 1 follow-up visit • Able to give informed consent	80	1 month
Karakurt,	Turkey	Determine the effect of education given	Pre-post-test	• At least 6 months of DM duration,	100	9 months

et al.[45]		to patients with T2DM mellitus on self-care	experimental design	being Literate, no serious complications , • No psychiatric history volunteer to participate		
Song, et al.[46]	South Korea	Investigate the effects of a diabetes outpatient intensive management program (DOIMP) on A1C levels and adherence to control recommendations.	Randomised 2 group pre-post-test experimental design	• Able to perform SMBG • Take oral hypoglycaemic agents (OHAs) • Understand the study goals • Excluded if with complications	59	3 months
Shi, et al.[48]	China	Examine the effect of a hospital-based clinic intervention on glycemic control self-efficacy and glycemic control behaviour of Chinese patients with T2DM	RCT	• At least 1 year diagnosis • Able to communicate, verbally, read & write in mandarin • Willing to participate • No previous DSME • Excluded if <30, with type 1 or gestational diabetes or with complications.	157	5 months
Liu, et al.[47]	China	Develop a Chinese diabetes group visit program and to examine its effectiveness on self-management behavior, self-efficacy and health status for patients with T2DM	RCT	• Aged 35-80 years • Excluded if outside the age range or with -complications or physical disability	208	12 months
Al-haddad, et al.[49]	Malaysia	Measure the effectiveness of two different diabetes educational programs (less structured vs. structured).	Prospective observational Study	• T2DM patients • Able to communicate in Malaysian National language	74	8 months
Gagliardino, et al.[50,51]	27 developing countries	Evaluate the impact of diabetes education provided to patients with T2DM in non-controlled studies (real-world conditions) on quality of care, resource consumption and conditions of employment.	Cross Sectional & longitudinal Survey	• Excluded if with active participation in a clinical study or recent short-term insulin treatment	11 384	9 months

Abbreviations: T2DM = Type 2 diabetes mellitus, RCT = randomized controlled trial, TOFHLA = Test of functional health literacy in adults, DSME = diabetes self-management education, T1DM = type 1 diabetes mellitus, DM = diabetes mellitus, SMBG = self-monitoring blood glucose, HBM = Health Belief Model, NR = Not reported

Table 2 Study characteristics for T2DM in high mortality developing countries (n=5)

Reference	*Country*	*Study objective*	*Design*	*Inclusion criteria*	*Sample*	*Duration*
van der Does, et al.[54]	South Africa	Evaluate the Take Five School (TFS) group education program for patients with T2DM in South Africa.	Mixed Methods -Pre-post test	NR	84	1 month
Price, et al.[52,53]	South Africa	Determine the long-term (4 years) glycemic outcome of a structured nurse-led intervention program for T2DM patients in rural Africa.	Cohort study	NR	320	4 years
Mahant[56]	India	Evaluate the impact of a model program of diabetes on diabetes control.	Prospective study	• All included without bias for gender, age, duration of disease, severity or educational status.	1050	3 years
Mahajan, et al.[55]	India	Improve the health and blood sugar control in T2DM by giving health education, dietary advice and encouraging them for regular blood sugar monitoring and physical exercise.	Cross-Sectional	• >40years old	300	12 months
Malathy, et al.[57]	India	Assess the baseline levels of knowledge, attitude and practices of diabetes patients visiting two multispecialty hospitals and one private diabetes clinic regarding disease management.	RCT	• >30years old • Excluded paediatric & pregnant patients.	207	9 months

Abbreviations: T2DM = Type 2 diabetes mellitus, NR = Not reported, RCT = randomized controlled trial

one being from high mortality developing countries, referred to theories of behavior change as a theoretical basis for the interventions. Sample sizes ranged from 62 to 11,384 participants.

The professional background of the educators who provided the interventions varied across studies (reported in only eighteen studies) with nurses in 8/18 as the most common providers, followed by physicians/doctors 7/18, dietitians/nutritionists 5/18 and community support workers or health promoters 2/18. Only 4/18 studies reported using trained diabetes educators. The content of the educational interventions was comprehensive in most interventions, covering almost all the topics of diabetes education including basic knowledge of diabetes, diet, exercise, self-monitoring blood glucose, medication taking, reducing risks, problem solving and living with diabetes.

Intervention characteristics

In low mortality developing countries, the reported interventions were mostly delivered in groups (12 of 18 studies). Three studies used a telephone follow-up. Four interventions used face to face individual sessions and one of these included a telephone follow-up while two interventions used both group and individual delivery strategy (Table 3). Sixteen of the studies in low mortality countries were 12 months or less in duration and only two studies had a duration of 42 months and 6 years (Table 1). Eight studies provided written literature to the intervention group to supplement the educational sessions. Forms of teaching differed across the interventions and included lectures, group discussions, question and answer sessions. A few interventions used film demonstrations, illustrative materials and role plays.

In high mortality developing countries, two interventions were delivered in groups, two individually, and one using a combination of group and individual sessions. Education formats included discussions, individual counselling, and providing written literature to supplement the sessions. Only two studies had a duration of more than 1 year (Tables 2 and 4).

Table 3 DSME Intervention/programs characteristics for T2DM in low mortality developing countries

Reference	*Intervention for T2DM*	*Provider*	*Provider training*	*Theoretical model*	*Measures*	*Main Outcomes*	*Comments*
Negarandeh, et al.[23]	Two interventions and 1 control. Group. 1: Three weekly individual teach back sessions each lasting 20miutes. Group 2: Three weekly individual pictorial image sessions each lasting 20minutes. Control Group: received usual care-presentation of an educational brochure on diabetes control	Community health nurse	NR	NR	• Level of health functional literacy • Diabetes knowledge • Adherence to medication and diet	Statistically significant differences (P<0.05) between intervention and control	The intervention was effective all measures were significant in both intervention groups than controls.
Aliha, et al.[34]	Two group educational sessions for 60 minutes in 2 consecutive days using face to face lectures and film demonstration and 16 follow-up telephone calls by nurse (1st month 2 calls per week and 2nd and 3rd months 1 call per week) + booklet. Control group: Conventional care and usual education for diabetes patients	Diabetes nurse	Yes	NR	• FBS • A1C • Blood glucose 2hours after meals Blood Sugar (2hppBS) • Adherence to treatment	FBS, 2hppBS, A1C were statistically significant. Adherence increased from 6.5% to 90.3% in intervention group while in control it decreased from 12.5% to 0%.	The intervention was effective, in all measures there was a significant difference in intervention than control group.
Samadi, et al.[39]	Eight weekly face to face group quality of life educational sessions for 90 minutes + hand-out and 1 month telephone follow-up Control Group: received hand-out + education after follow-up.	Nurse, physiotherapist, nutritionist, orthopedist, psychologist	NR	NR	• Self-concept • Self-esteem • Body image • BMI	BMI was statistically significant P=0.004. Increased self-esteem and self-concept.	Intervention was effective, significant differences in all outcomes were observed in the case than control group after intervention.
Bayat, et al.[35]	Two 30-40 minutes individual face to face lectures via pamphlets and question and answer method + telephone follow-up.	NR	NR	HBM	• HBM constructs • Self-efficacy • At 3 and 6 months follow-up	Significant impact P<0.0001on extended HBM constructs.	The intervention showed a positive and significant impact on extended health model belief constructs. However, perceived

	Follow-up at 3 and 6 months						susceptibility and self-efficacy remained constant at 6 months
Farsaei, et al.[36]	Two group pharmacist-led educational sessions and weekly telephone follow-up and appointments for 3 months Control group: general education by nursing staff.	Pharmacist	NR	NR	• A1C • FBS	A1C decreased significantly in intervention than control ($p<0.001$)	Intervention was effective. Glycemic control was significantly decreased in intervention than groups
Sharifirad, et al.[40]	Four group sessions each lasting 40 minutes + One month follow-up.	NR	NR	HBM	• Nutritional knowledge • HBM Constructs • Nutritional practice • Weight, BMI, FBS	Statistically significant results ($P<0.001$) in intervention compared to control group in knowledge and perceived susceptibility. Behavior increased significantly ($P<0.001$) in intervention than in control.	Intervention significantly improved knowledge scores, and FBS compared to the control group but perceived severity, threat and benefits remained the same.
Hazavehei, et a.,[37]	Six group educational sessions using lectures, question and answer and group discussions, each session lasting 55-60 minutes over 1 month + 3 month follow-up	NR	NR	BASNEF Model	• BASNEF Model components • A1C • FBS • Eye care practice	A1C decreased significantly ($P<0.001$).	The BASNEF Model components, knowledge and all other outcomes were significantly improved in the intervention group compared to the control group after follow-up.
Kashfi, et al.[38]	3 sessions (each 60 minutes) of training on jogging and control of sugar + 3 months follow-up.	NR	NR	HBM	• HBM constructs • Practices • A1C • FBS	A1C decreased significantly ($P<0.001$).	Intervention was effective; all outcomes were significant in case than in control group after intervention.
Vatankhah, et al.[41]	Single 20minute individual face-to-face foot education session + Booklet and follow up after 6 months.	NR	NR	NR	• Knowledge • Foot care practice	Improved knowledge and practice about diabetes foot care ($p<0.0001$ and $P=0.011$)	Intervention effective in increasing knowledge and practice scores significantly.
Gagliardino, et al.[42]	Group structured educational courses: Group 1: Control Group 2: Physician education only Group 3: Patient education only	Trained educators	Yes	NR	• A1C • Lipid profile and BP • Psychological state	A1C decreased significantly ($p<0.05$) at 42 months. Largest decrease in groups where patients and physicians were educated.	All outcomes measures were significant in case groups being largest in combined programs after intervention but psychological state was significant in both

	Group 4: Patient and physician education Four weekly 90-120 minutes teaching sessions using illustrative materials + programme book and a reinforcement session at 6 months.						groups
Perman, et al.[43]	Four group education workshops for 2 hours per year and individual counselling on non-pharmacological treatment by physician assistants and follow- up through mails and delivery of educational material. Other "informal" education also available.	Diabetes educators (family physicians/endocrinologists)	YES	Patient Empowerment Model	• All-cause mortality	Crude hazard ratio after adjustment was decreased from 33% to 18% (HR 0.82; 95%CI:0.61-1.08).	Workshop attendants had 33% lower all-cause mortality rate at 6 years of follow-up but impact of intervention not clear.
Atak, et al.[44]	Two weekly group question-based patient centred sessions each lasting 45 minutes.	Researcher	NR	NR	• Knowledge • self-reported self-management	Significant differences in self-reported self-management between case and control groups, p values <0.05.	Limited effect on knowledge and behavior but significant on self-efficacy.
Karakurt, et al.[45]	Individual narrative, question and answer educational sessions, each lasting 45-60 minutes. Education repeated twice every other month + booklet.	Researcher	NR	NR	• Self-care activities • Metabolic control • A1C • Lipid profile	A1C decreased significantly ($p<0.001$) from pre-test to post-test. Triglycerides were statistically significant ($p<0.05$) after intervention.	Only high density lipoproteins, BMI and Waist circumference were not statistically significant after intervention.
Song, et al.[46]	2 day group and individual educational sessions + weekly telephone counselling. Patients free to call nurse at any time.	Endocrinologist, Nurse, physician, rehabilitation therapist, Dietitian, dermatologist, psychologist, pharmacist, ophthalmologist, physiotherapist	NR	NR	• A1C • Adherence to diet	A1C significantly decreased ($p<0.05$) in intervention group after the intervention. Significant difference in adherence ($p=0.0001$) was also observed in intervention after intervention.	Significant differences were observed overtime in A1C and Adherence to diet in intervention than control.
Shi, et al.[48]	Group education, with 4 weekly sessions, 1-2hours per session for a month using discussions, videos, demonstrations, role plays and written	Researcher	NR	Health Educational Strategies and Self-efficacy theory	• Glycemic control self-efficacy • Glycemic control behavior	Statistically significant improvements in Glycemic control self-efficacy and Glycemic control behavior ($p<0.05$) in experimental group compared to control	Intervention showed statistically significant improvement in glycemic control self-efficacy and glycemic control behavior

	literature. Telephone follow up, 2 calls each week, each 5-15 minutes for 4 months.					group.	immediately and four months after the intervention
Liu, et al.[47]	12 monthly interactive group sessions lasting 90 minutes + I hour for individual consultation.	General practitioner Nurse Preventive doctor	YES	The Cooperative Health Care Clinic Model	• Behaviors • Self-efficacy • Health status	Significant differences in behavior change ($p<0.05$) in case compared to control group.	Significant increase in self-efficacy and measures of illness. On average intervention group increased their exercise duration.
Al-haddad, et al.[49]	Group based monthly less structured versus structured teaching sessions each lasting 90-120 minutes for 4 months. Patient could call the researcher at any time.	Pharmacists Doctor Nurse	NR	NR	• A1C • BMI • BP	A1C significantly decreased ($p=0.004$) in the structured group than in the less structured group.	Significantly increase in A1C levels was observed in the less structured group while significantly reduced in the structured group. BMI and Diastolic BP were not significant.
Gagliardino, et al.[50,51]	Face to face consultation and referral to ad hoc structured group education programs with different degrees of complexity and number of sessions and a 9 month longitudinal follow-up.	Nurse Dietitian Educator	NR	NR	• Clinical- weight, height, WC, BP, Foot Evaluation. • Metabolic- A1C, lipid profile	A1C control significantly higher in case group.	Intervention significantly improved the percentage of patients achieving target values set by international guidelines.

Abbreviations: T2DM = type 2 diabetes mellitus, NR = Not reported, A1C = Glycated hemoglobin, FBS = Fasting blood glucose, 2hppBS = 2 hour after meals blood sugar, BMI = Body mass index, HBM = Health belief model, BASNEF = Belief, Attitude, Subjective Norm, and Enabling Factors, BP = Blood pressure, WC = Waist circumference

Table 4 DSME Intervention/programs characteristics for *T2DM in high mortality developing countries

Reference	*Intervention for T2DM*	*Provider*	*Provider training*	*Theoretical model*	*Measures*	*Main outcomes*	*Comments*
van der Does, et al.[54]	Weekly group education classes, each lasting 60 minutes for 4 weeks	Dietitian Heath Promoter Doctor	*NR	NR	• Self-care activities	No statistically significant reduction in smoking (p=0.08)	Intervention was effective in improving adherence to a diabetes diet, physical activity, foot care and the perceived ability to teach others was seen but no significant change in smoking or adherence to medication was noticed
Price, et al.[52,53]	Structured group nurse-led diabetes care 3 monthly group sessions using picture based flip-charts + booklet and reinforcements per each clinic visit for 4 years.	Nurses Community support workers	NR	Empowerment theory	• *BMI • *A1C	A1C decreased significantly compared to baseline at 6 and 18 and 24 months (P<0.001) and at 48 months it was (p=0.015)	There was significant improvement in A1C up to 18 months follow-up, but thereafter BMI was no longer significant and there was glycemic slippage**.**
Mahant[56]	30 minute counselling at 6 months visit for 3 years + booklet in Hindi	physician	NR	NR	• Knowledge • practices • Attitudes, blood glucose level • A1C	A1C and blood glucose level decreased significantly (P<0.05).	The intervention was effective especially in monitoring of blood and urine glucose test and knowledge about hypoglycemia.
Mahajan, et al.[55]	Monthly 45-minute group education and individual consultations + comprehensive medical treatment, eye care and monitoring of blood sugar.	Dietitian Doctors	NR	NR	• Life style • Self-care practices • Illness perception • Glycemic status	Significant improvements in lifestyle, self-care practices, illness perception and glycemic status	Intervention was effective in improving outcome measures

					• BMI		
Malathy, et al.[57]	Monthly counselling sessions each lasting 20-25 minutes for 3 months + hand-outs	Pharmacist	NR	NR	• Knowledge, Attitude, Practices (KAP), • Post Prandial Blood Glucose, • Lipid profile	*KAP scores of test patients improved significantly ($p<0.0001$)	Intervention proved to be effective

*T2DM = Type 2 diabetes mellitus, NR = Not reported, BMI = body mass index, A1C = Glycated hemoglobin, KAP = knowledge, attitude and practices

Tailoring to culture

Thirteen studies (57%) from both high and low mortality developing countries reported aspects of cultural sensitivity. Nine of these studies reported programs that were using the local language and incorporating the existing materials and local guidelines. Two studies from low mortality countries required speaking and understanding the local language as inclusion criteria for the program. Another nine studies required information on needs assessment of the target population before designing the intervention program. Two of these studies were from high mortality countries. All the studies from high mortality countries, except one, were accessible to people with low levels of literacy. Four studies from low mortality countries reported access to people with low literacy; five studies reported programs that excluded patients with low literacy. Other studies did not report on this issue (Tables 1 and 2).

Outcome measures

Different outcomes were measured across studies. The most commonly measured (in 70% of the studies) was behavior change (e.g. diet, physical exercise, self-monitoring of blood glucose (SMBG)). A1C was measured in less than half of the studies (49%). Other outcome measures included knowledge and other individual dispositions, fasting blood sugar (FBS), body mass index (BMI), lipid profiles- and psychological states (Table 3 and 4).

Effectiveness of DSME interventions

Nearly all the identified studies indicated a significant difference on outcome measures between the intervention group and the control group or from pre-test to post-test. Six studies (26%) did not find a significant difference between intervention and control groups or from pre-test to post-test on some of the outcomes measured, which included knowledge, psychological state, behavior and BMI. The change in A1C was significant in all the studies where this indicator was used as an outcome measure. In most studies, effectiveness of the interventions was only considered at short-term follow-

up. Four studies measured follow up over a longer period, but in one of them (with a 6 year follow-up) it was not clear whether the improvement was an effect of the intervention or of other factors. In the other study, with a 4 year follow-up, glycemic slippage was observed over time, indicating less impact at longer term follow-up.

Discussion

The limited studies available suggest that DSME programs in developing countries have positive effects on A1C, knowledge, glycemic control and behavioral outcomes on short term follow-up. This finding is consistent with existing literature which reports a positive impact on glycemic control after the delivery of interventions in developing and developed countries.[7,11-16]

Despite these positive results, the review also identified shortcomings in the DSME programs. Most interventions were provided by a range of health professionals. While this suggests progress in the provision of DSME, it is quite clear that developing countries are not equipped for this kind of implementation due to the shortage of health care professionals, especially in rural areas.[58] Therefore it is advisable that where there is not enough professional capacity, peers and community health workers can be trained to provide DSME while professional staff like nurses can be wisely used in supervisory and training roles for the non-professionals in these resource poor settings. This strategy has proven to be effective.[16,59-62]

Only a few studies in the current review reported on the training of the providers. This finding is consistent with the findings of the review by Lou et al, who found that of the 34 studies reviewed from China, not a single study mentioned training of providers.[33] Without training of providers, the quality of a DSME program cannot be guaranteed, since the information provided to patients is not adapted to the needs of the particular target group.

Furthermore, few studies reported on accessibility of the intervention by patients with low literacy levels. People with diabetes and low literacy are more likely to have poor glycemic control, find it difficult to read food labels, estimate portion sizes and therefore have low self-confidence in management of diabetes.[23,63,64] In previous studies, the use of pictorial aid and teach back strategies have been shown to enhance the comprehension and recall, and adherence for people with low literacy levels.[65,66]

Only a few interventions included in this review were guided by behavior change theories yet interventions supported by a theoretical framework have been found to have positive results on the participants.[35] In addition, significant improvement still needs to be effected with regard to the strength and rigor of the study designs used in the interventions.

Our review suggests that DSME interventions in developing countries address the surface cultural aspects such as language tailoring of reading materials. However, deep cultural factors were rarely reported. The results are similar to other reviews reporting that most interventions focus on surface structures of culture while ignoring its deep structures.[58] Rawal et al suggest that developing linguistically appropriate and context-specific lifestyle interventions that are tailored to the cultural, religious and socio-economic needs of the target population will enhance the sustainability of the interventions.[7]

Studies from both low and high mortality developing countries differed in many ways. There were more studies in the low mortality countries than in the high mortality countries, implying that very little research on the topic is being done in high mortality developing countries. Most interventions from high mortality countries were culturally sensitive and were accessible to people with lower levels of literacy, but did not report on provider training. Most importantly, of the entire interventions only one from a high mortality developing country used community support workers as providers in addition to nurses.

Limitations

There are a number of limitations of this review that should be mentioned. Firstly, it included only studies published in peer reviewed, English journals from 2009 to 2013, thus excluding useful information which may not have been peer reviewed, may be in other languages, published before 2009 or unpublished studies. Secondly, the results of this review may also have been affected by publication bias, in that only studies with positive results were published and those with negative results were unavailable or unpublished. Despite these limitations, however, we believe that the review provides a clear state of the art that may inform DSME educators in developing countries.

Conclusion

DSME programs have been shown to be effective in these limited numbers of studies from low and high mortality developing countries, especially on short-term follow-up. However, there are several gaps that need to be addressed if programs are to be sustainable. Guiding programs by behavior change theories, training professional and non-professional providers (community health workers, health promoters, peer support leaders), addressing the cultural sensitivity of programs, and making them more accessible to people with low literacy. These gaps if addressed could enhance the effectiveness of DSME programs in developing countries.

As such, the findings of this review have important implications for diabetes education in developing countries. Since diabetes continues to affect millions of people in developing countries, it is imperative that health workers providing education in developing countries continue to examine the sustainability and effectiveness of interventions by tailoring them to the culture and literacy levels of the target population. Many techniques can be used to address the burden of low literacy, such as the use of pictures and teach back techniques which have previously been proved successful.[23,65,66] In addition, as professional staff should be wisely used in resource poor settings, trained non-

professionals can be included to provide diabetes education with professional staff assuming a supervisory and training role.

Conflict of interest

None declared.

References

1. IDF. Position statement: Self-management education. 2011; http://www.idf.org. Accessed 16 October, 2013.
2. Pal K, Eastwood SV, Michie S, et al. Computer-based diabetes self-management interventions for adults with type 2 diabetes mellitus. *Cochrane Database Syst Rev.* 2013;3:Cd008776.
3. IDF. International Diabetes Federation Atlas. 2013; http://www.idf.org/diabetesatlas. Accessed 16 October, 2013.
4. Debussche X, Balcou-Debussche M, Besancon S, Traore S. Challenges to diabetes self-management in developing countries. *Diabetes voice.* 2009;54:12-14.
5. Paz-Pacheco E. Diabetes self management education: an effective response to the increasing burden in underserved communities. *Diabetes voice.* 2011;56(1):10-13.
6. WHO. Diabetes action now: An imitative of the World Health Organisation and the International Diabetes Federation. 2004; www.who.int/diabetes. Accessed 16 October, 2013.
7. Rawal LB, Tapp RJ, Williams ED, Chan C, Yasin S, Oldenburg B. Prevention of type 2 diabetes and its complications in developing countries: a review. *Int J Behav Med.* Jun 2012;19(2):121-133.
8. Ezenwaka C, Eckel J. Prevention of diabetes complications in developing countries: time to intensify self-management education. *Arch Physiol Biochem.* Dec 2011;117(5):251-253.
9. Funnell MM, Brown TL, Childs BP, et al. National standards for diabetes self-management education. *Diabetes Care.* Jan 2012;35 Suppl 1:S101-108.
10. AADE. Diabetes Education. 2013; www.diabeteseducator.org/export/sites/aade/_resources/pdf/Diabetes_Education_Definition.pdf. . Accessed 25 January, 2014.
11. Clement S. Diabetes self-management education. *Diabetes Care.* Aug 1995;18(8):1204-1214.
12. Norris SL, Engelgau MM, Narayan KM. Effectiveness of self-management training in type 2 diabetes: a systematic review of randomized controlled trials. *Diabetes Care.* Mar 2001;24(3):561-587.
13. Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM. Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. *Diabetes Care.* Jul 2002;25(7):1159-1171.

14. Steed L, Cooke D, Newman S. A systematic review of psychosocial outcomes following education, self-management and psychological interventions in diabetes mellitus. *Patient Educ Couns.* Sep 2003;51(1):5-15.
15. Deakin T, McShane CE, Cade JE, Williams RD. Group based training for self-management strategies in people with type 2 diabetes mellitus. *Cochrane Database Syst Rev.* 2005(2):Cd003417.
16. Clark M. Diabetes self-management education: a review of published studies. *Prim Care Diabetes.* Sep 2008;2(3):113-120.
17. Caballero AE. Diabetes in the Hispanic or Latino population: genes, environment, culture, and more. *Curr Diab Rep.* Jun 2005;5(3):217-225.
18. Millan-Ferro A, Caballero E. Role of Culture and Health Literacy in Diabetes Self-Management and Education. In: Weinger K, Carver C, eds. *Educating your patient with diabetes*. New York: Human Press; 2009.
19. AADE. Cultural sensitivity and diabetes education. *Diabetes Educ.* Jan-Feb 2012;38(1):137-141.
20. The Plurality of literacy and its implications for policy and programs. UNESCO Education Sector Position Paper. Paris.2004:13.
21. Boren SA. A review of health literacy and diabetes: opportunities for technology. *J Diabetes Sci Technol.* Jan 2009;3(1):202-209.
22. Habib SS, Aslam M. Risk factors, knowledge and health status in diabetic patients. *Saudi Med J.* Nov 2003;24(11):1219-1224.
23. Negarandeh R, Mahmoodi H, Noktehdan H, Heshmat R, Shakibazadeh E. Teach back and pictorial image educational strategies on knowledge about diabetes and medication/dietary adherence among low health literate patients with type 2 diabetes. *Prim Care Diabetes.* Jul 2013;7(2):111-118.
24. Sorensen K, Van den Broucke S, Fullam J, et al. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health.* 2012;12:80.
25. Muchiri J, Gericke G, Rheeder P. Needs and preferences for nutrition education of type 2 diabetic adults in a resource-limited setting in South Africa. *Health SA Gesondheid.* 2012;17(1):1-13.
26. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med.* Aug 18 2009;151(4):264-269, w264.
27. How we classify countries. 2013; http://data.worldbank.org/about/country-classifications. Accessed 15 October, 2013.
28. WHO. List of member states by WHO region and mortality stratum. 2013; http://www.who.int/mental_health/neurology/annexes_neuro_disorders_public_h_challenges.pdf. Accessed 09 December, 2013.
29. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health.* Jun 1998;52(6):377-384.
30. Van den Broucke S, Van der Zanden G, Chang P, Doyle G, Levin D, Pelikan J, Schilinger D, Schwarz P, Sorensen K, Yardley L, Reimenschneider H. Enhancing the effectiveness of diabetes self-management education: The Diabetes Literacy project. *Horm Metab Res.*In press.

31. Schwarz PE, Gallein G, Ebermann D, Muller A, Lindner A, Rothe U, Nebel IT, Muller G. Global Diabetes Survey--an annual report on quality of diabetes care. *Diabetes Res Clin Pract.* Apr 2013;100(1):11-18.
32. Baradaran HR, Shams-Hosseini N, Noori-Hekmat S, Tehrani-Banihashemi A, Khamseh ME. Effectiveness of diabetes educational interventions in Iran: a systematic review. *Diabetes Technol Ther.* Apr 2010;12(4):317-331.
33. Lou Q, Wu L, Dai X, Cao M, Ruan Y. Diabetes education in mainland China- a systematic review of the literature. *Patient Educ Couns.* Dec 2011;85(3):336-347.
34. Aliha JM, Asgari M, Khayeri F, Ramazani M, Farajzadegan Z, Javaheri J. Group education and nurse-telephone follow-up effects on blood glucose control and adherence to treatment in type 2 diabetes patients. *Int J Prev Med.* Jul 2013;4(7):797-802.
35. Bayat F, Shojaeezadeh D, Baikpour M, Heshmat R, Baikpour M, Hosseini M. The effects of education based on extended health belief model in type 2 diabetic patients: a randomized controlled trial. *J Diabetes Metab Disord.* 2013;12(1):45.
36. Farsaei S, Sabzghabaee AM, Zargarzadeh AH, Amini M. Effect of pharmacist-led patient education on glycemic control of type 2 diabetics: a randomized controlled trial. *J Res Med Sci.* Jan 2011;16(1):43-49.
37. Hazavehei SM, Khani Jeihooni A, Hasanzadeh A, Amini S. The Effect of Educational Program Based on BASNEF Model for Eye Care in Non-insulin Dependent Diabetic Patients. *J Res Health Sci.* 2010;10(2):81-90.
38. Kashfi SM, Khani Jeihooni A, Rezaianzadeh A, Amini S. The effect of health belief model educational program and jogging on control of sugar in type 2 diabetic patients. *Iran Red Crescent Med J.* Jul 2012;14(7):442-446.
39. Samadi N SM, Mahmoodi M. Impact of quality of life education on self-concept among type 2 diabetes patients. *J Diabetes Metab.* 2011;2(5):1-5.
40. Sharifirad G, Entezari MH, Kamran A, Azadbakht L. The effectiveness of nutritional education on the knowledge of diabetic patients using the health belief model. *J Res Med Sci.* Jan 2009;14(1):1-6.
41. Vatankhah N, Khamseh ME, Noudeh YJ, Aghili R, Baradaran HR, Haeri NS. The effectiveness of foot care education on people with type 2 diabetes in Tehran, Iran. *Prim Care Diabetes.* May 2009;3(2):73-77.
42. Gagliardino JJ, Lapertosa S, Pfirter G, et al. Clinical, metabolic and psychological outcomes and treatment costs of a prospective randomized trial based on different educational strategies to improve diabetes care (PRODIACOR). *Diabet Med.* Sep 2013;30(9):1102-1111.
43. Perman G, Beratarrechea A, Aliperti V, et al. Mortality in an elderly type 2 diabetic patients' cohort who attended a self-management educational workshop. *Prim Care Diabetes.* Oct 2011;5(3):175-184.
44. Atak N, Gurkan T, Kose K. The effect of education on knowledge, self-management behaviours and self-efficacy of patients with type 2 diabetes. *Int J Nurs Pract.* 2009;18(2):170-179.
45. Karakurt P, Kasikci MK. The effect of education given to patients with type 2 diabetes mellitus on self-care. *Int J Nurs Pract.* Apr 2012;18(2):170-179.
46. Song MS, Kim HS. Intensive management program to improve glycosylated hemoglobin levels and adherence to diet in patients with type 2 diabetes. *Appl Nurs Res.* Feb 2009;22(1):42-47.

47. Liu S, Bi A, Fu D, et al. Effectiveness of using group visit model to support diabetes patient self-management in rural communities of Shanghai: a randomized controlled trial. *BMC Public Health.* 2012;12:1043.
48. Shi Q, Ostwald SK, Wang S. Improving glycaemic control self-efficacy and glycaemic control behaviour in Chinese patients with type 2 diabetes mellitus: randomised controlled trial. *J Clin Nurs.* Feb 2010;19(3-4):398-404.
49. Al-haddad M, Ibrahim M, Sulaiman S, Maarup N. The impact of two diabetes educational programs on patients with diabetes in Malaysia. *J Clin Diagn Res.* . 2009;3:1633-1640.
50. Gagliardino JJ, Aschner P, Baik SH, et al. Patients' education, and its impact on care outcomes, resource consumption and working conditions: data from the International Diabetes Management Practices Study (IDMPS). *Diabetes Metab.* Apr 2012;38(2):128-134.
51. Chan JC, Gagliardino JJ, Baik SH, et al. Multifaceted determinants for achieving glycemic control: the International Diabetes Management Practice Study (IDMPS). *Diabetes Care.* Feb 2009;32(2):227-233.
52. Gill GV, Price C, Shandu D, Dedicoat M, Wilkinson D. An effective system of nurse-led diabetes care in rural Africa. *Diabet Med.* May 2008;25(5):606-611.
53. Price C, Shandu D, Dedicoat M, Wilkinson D, Gill GV. Long-term glycaemic outcome of structured nurse-led diabetes care in rural Africa. *Qjm.* Jul 2011;104(7):571-574.
54. van der Does AM, Mash R. Evaluation of the "Take Five School": an education programme for people with Type 2 Diabetes in the Western Cape, South Africa. *Prim Care Diabetes.* Dec 2013;7(4):289-295.
55. Mahajan H, Kambali T, Chokhandre M, Borle A, Padvi M. Health Intervention Impact Assessment on Glycemic Status of Diabetic Patients. *International Journal of Diabetes Research.* 2012;1(5):73-80.
56. Mahant S. Evaluating the impact of counseling on quality of life in type-2 diabetes mellitus patients. . *Int J Pharm Bio Arch.* 2013;2(6):137-141.
57. Malathy R, Narmadha M, Ramesh S, Alvin JM, Dinesh BN. Effect of a diabetes counseling programme on knowledge, attitude and practice among diabetic patients in Erode district of South India. *J Young Pharm.* Jan 2011;3(1):65-72.
58. Brown SA, Hanis CL. Culturally competent diabetes education for Mexican Americans: the Starr County Study. *Diabetes Educ.* Mar-Apr 1999;25(2):226-236.
59. Balagopal P, Kamalamma N, Patel TG, Misra R. A community-based participatory diabetes prevention and management intervention in rural India using community health workers. *Diabetes Educ.* Nov-Dec 2012;38(6):822-834.
60. Corkery E, Palmer C, Foley ME, Schechter CB, Frisher L, Roman SH. Effect of a bicultural community health worker on completion of diabetes education in a Hispanic population. *Diabetes Care.* Mar 1997;20(3):254-257.
61. Norris SL, Chowdhury FM, Van Le K, et al. Effectiveness of community health workers in the care of persons with diabetes. *Diabet Med.* May 2006;23(5):544-556.
62. Philis-Tsimikas A, Fortmann A, Lleva-Ocana L, Walker C, Gallo LC. Peer-led diabetes education programs in high-risk Mexican Americans improve glycemic control compared with standard approaches: a Project Dulce promotora randomized trial. *Diabetes Care.* Sep 2011;34(9):1926-1931.

63. Kandula NR, Nsiah-Kumi PA, Makoul G, et al. The relationship between health literacy and knowledge improvement after a multimedia type 2 diabetes education program. *Patient Educ Couns.* Jun 2009;75(3):321-327.
64. White RO, Wolff K, Cavanaugh KL, Rothman R. Addressing Health Literacy and Numeracy to Improve Diabetes Education and Care. *Diabetes Spectr.* Oct 2 2010;23(4):238-243.
65. Katz MG, Kripalani S, Weiss BD. Use of pictorial aids in medication instructions: a review of the literature. *Am J Health Syst Pharm.* Dec 1 2006;63(23):2391-2397.
66. Kripalani S, Robertson R, Love-Ghaffari MH, et al. Development of an illustrated medication schedule as a low-literacy patient education tool. *Patient Educ Couns.* Jun 2007;66(3):368-377.