TBM

SYSTEMATIC REVIEW

A review of diabetes prevention program translations: use of cultural adaptation and implementation research

Rachel G. Tabak, PhD, RD,[1] Kàimi A. Sinclair, PhD, MPH,[2] Ana A. Baumann, PhD,[3] Susan B. Racette, PhD,[4] Anne Sebert Kuhlmann, PhD, MPH,[5] Michelle D. Johnson-Jennings, PhD,[6] Ross C. Brownson, PhD[1,7]

[1]Prevention Research Center in St. Louis, Brown School, Washington University in St. Louis, 621 N. Skinker Boulevard, St. Louis, MO 63130, USA

[2]College of Nursing, Department of Health Policy and Administration, Washington State University, 1100 Olive Way Suite 1200, Seattle, WA 98101, USA

[3]Brown School of Social Work, Washington University in St. Louis, 600 S. Euclid, CB 8217, St. Louis, MO 63110, USA

[4]Program in Physical Therapy, Department of Medicine, Washington University School of Medicine, 4444 Forest Park Avenue, Campus Box 8052, St. Louis, MO 63108, USA

[5]College for Public Health & Social Justice, Saint Louis University, Salus Center, 309, 3545 Lafayette Ave, St. Louis, MO 63104, USA

[6]Research for Indigenous Community Health (RICH) Center, Social and Administrative Pharmacy, Pharmacy Practice and Pharmaceutical Practices, University of Minnesota, 232 Life Sciences, 1110 Kirby Drive, Duluth, MN 55812, USA

[7]Division of Public Health Sciences and Alvin J. Siteman Cancer Center, Washington University School of Medicine, Washington University in St. Louis, St. Louis, MO, USA

Correspondence to: R Tabak
rtabak@wustl.edu

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Abstract

The Diabetes Prevention Program (DPP) has been shown to prevent type 2 diabetes through lifestyle modification. The purpose of this study was to describe the literature on DPP translation, synthesizing studies using cultural adaptation and implementation research. A systematic search was conducted. Original studies evaluating DPP implementation and/or cultural adaptation were included. Data about cultural adaptation, implementation outcomes, and translation strategies was abstracted. A total of 44 were included, of which 15 reported cultural adaptations and 38 explored implementation. Many studies shortened the program length and reported a group format. The most commonly reported cultural adaptation (13 of 15) was with content. At the individual level, the most frequently assessed implementation outcome (n=30) was adoption. Feasibility was most common (n=32) at the organization level. The DPP is being tested in a variety of settings and populations, using numerous translational strategies and cultural adaptations. Implementation research that identifies, evaluates, and reports efforts to translate the DPP into practice is crucial.

Keywords

Diabetes prevention, Translation, Cultural adaptation, Implementation

Implications

Practice: Practitioners should consider translational strategies and cultural adaptation including those used in major national initiatives (e.g., the YMCA program, the CDC's National DPP) to increase program relevance, satisfaction, and participation.

Policy: Support from policymakers is important as translational challenges are multilevel and multifactorial, reflecting the diverse nature of individuals, health systems, and communities.

Research: Researchers can provide detailed reporting of adaptations and lessons learned during translation so the DPP can be effectively adapted for populations that experience a disproportionate burden of obesity and diabetes.

INTRODUCTION

Nearly 26 million people in the USA–8.3 % of the population–have diabetes, and 90–95 % have type 2 diabetes [1]. Diabetes in adults is the leading cause of new cases of blindness, kidney failure, and non-injury amputations of the feet and legs. In 2007, the cost associated with diabetes was $174 billion [1]. Diabetes and its complications are largely preventable [2, 3]; obesity, physical inactivity, and unhealthy eating account for over half of new cases [4, 5].

Racial/ethnic minorities are at substantially higher risk for type 2 diabetes and continue to experience greater rates of hospitalization due to diabetes-related complications and 50–100 % higher morbidity and mortality than their white counterparts [6–8]. To address such health disparities effectively, interventions need to attend to cultural factors to increase engagement of ethnic minority populations in prevention programs [9–11]. Despite calls for sensitive treatment for multicultural populations, with the aim of decreasing health disparities and ensuring access to quality services [12], much remains to be learned about how to adapt interventions [13–16].

Several landmark studies have shown reduced incidence of type 2 diabetes among adults in response to lifestyle interventions. Results from the Diabetes Prevention Program (DPP) showed that through a lifestyle intervention, incidence of type 2 diabetes could be reduced by 58 % [17]. The two major goals of the DPP lifestyle intervention were a minimum of 7 % weight loss/weight maintenance and a minimum of 150 min/week of physical activity. The DPP included (1) individual case managers or "lifestyle coaches"; (2) frequent contact; (3) a structured, 16-session core curriculum including behavioral self-management strategies; (4) supervised physical activity; (5) a maintenance intervention; (6) a "toolbox" of adherence strategies; (7) tailoring of materials and strategies to address ethnic diversity; and (8) an extensive network of training, feedback, and clinical support, to reach these goals [17]. Prevention through lifestyle changes exceeded that achieved by the medication metformin [17]. The DPP results mirror those in the Finnish

Diabetes Prevention Study [18]. Together, these interventions laid the groundwork for diabetes prevention through lifestyle intervention. While randomized trials have shown that primary prevention is possible, population-level approaches are needed for widespread benefit [5, 19]. Translation research focuses on dissemination of efficacious interventions to a target audience, including intervention adaptation [20]. For the purposes of organizing the current review, translation research is a broad domain that encompasses both cultural adaptation and implementation research. Translation and implementation of the DPP is occurring in a variety of settings and to diverse populations [21–24].

To extend the reach of programs such as the DPP, the literature on cultural adaptation of evidence-based interventions (EBI) offers guidance on how to adapt an intervention to increase its fit for the target population [25]. Some frameworks inform modification of the intervention content, such as the Ecological Validity Model (EVM) [26], whereas others inform the cultural adaptation process [27]. Cultural adaptation is the systematic modification of an EBI to consider language, culture, and context to be compatible with the participant's cultural patterns, meanings, and values [28]. Culture, in this context, is defined as "the belief systems and value orientations that influence customs, norms, practices, and social institutions, including psychological processes (language, caretaking, practices, media, educational systems) and organizations" [29].

The EVM by Bernal et al. [26] serves as a guide for organizing the literature on modifications to the DPP. This cultural adaptation framework was developed to strengthen ecological validity for intervention outcome research and describes eight dimensions of an intervention that can be adapted. Modification of the *language* is more than the translation of the materials. It is the adaptation of the materials in a culturally appropriate way, ensuring the message is received as intended. *Persons* refers to client and provider variables, and the relationship between these individuals; *metaphors* are symbols and concepts shared with the target population; and *content* refers to cultural knowledge (i.e., social, economic, historical and political values, customs and traditions). *Concepts* refers to the constructs of a theoretical model: how the problem/intervention is conceptualized and communicated with the participant. The *goals* of the intervention should be aligned between the provider and the participant, with support from the cultural values of the target population. The seventh dimension refers to the *methods* or procedures for achieving the intervention goals. Finally, the culturally sensitive *context* considers the clients' context (e.g., economic, political, developmental) during the intervention.

There are several frameworks that can guide the process of adaptation and which help investigators decide when and whether an intervention should be adapted [25]. Meta-analyses have identified moderators that indicate when and which cultural groups would benefit from a culturally adapted intervention [30]. For example, culturally adapted interventions seem to be more beneficial when modifications of the intervention are related to participants' explanatory models of illness and when the use of metaphors corresponds with participants' cultural perspectives [30]. Even when cultural adaptation is thought to be appropriate, the adaptations are often not as carefully documented as those conducted in developing interventions; investigators conducting translation research may simply assume that "adaptation happens" [31]. Determining the efficacy of the adapted EBI is hindered in the absence of a description of what was adapted.

Implementation research seeks to develop and apply the scientific methods to promote uptake of EBIs into routine health care in clinical, organizational, public health, or policy contexts [32]. Building on efficacy and effectiveness research that focuses on *what* works, implementation research explores *how* implementation of an effective program works *in specific contexts* [33]. Translation strategies refer to the systematic processes, activities, and resources that are used to integrate interventions into usual settings [34], such as pre-service and in-service training, ongoing consultation and coaching, staff and program evaluation, administrative support, and systems interventions [35]. Proctor and colleagues [36, 37] have suggested a taxonomy of implementation outcomes that are critical to evaluate as part of implementation studies. These outcomes include acceptability, adoption, appropriateness, cost, feasibility, fidelity, penetration, and sustainability. Implementation outcomes help improve our understanding of which implementation strategies work best with specific interventions, settings, and conditions. Tests of implementation strategies should be guided by available theories, conceptual models, and/or frameworks to ensure essential contextual and process elements related to implementation are not overlooked [38, 39]. Implementation frameworks also provide a systematic way to evaluate interventions and facilitate replication across settings.

To better understand the current state of DPP translations, we systematically reviewed the literature. The goals of this review were to: 1) synthesize studies using cultural adaptations when testing or evaluating diabetes prevention interventions and 2) inventory implementation research occurring within translation studies.

METHODS

Data sources

We searched Academic Search Complete [MEDLINE (PubMed) CINAHL; CINAHL PLUS; GLOBAL HEALTH; SOCIAL WORK ABSTRACTS; PSCYINFO/ARTICLES/CRITIQUES; GLOBAL HEALTH ARCHIVE] and Google Scholar from January 2004 to December 2013. Studies of DPP translations were identified using the following terms: "Diabetes Prevention Program," "DPP," "dissemination and implementation," "evaluation," "implementation

outcomes," "outcomes," "translation," "translating," and "translation." Additional studies were extracted from the reference lists of identified articles.

Study selection

The searches were restricted to English-language articles published in peer-reviewed scientific journals. Articles were excluded from the review if they were letters, editorials, literature reviews, perspective articles, re-analysis of an existing trial, descriptions of the DPP, or non-empirical. Articles that met the following criteria were selected for abstraction: (1) the intervention was the DPP or an adaptation of the DPP, and (2) the article reported original research or evaluation on an implementation of the DPP. Articles were screened for inclusion by two authors and discrepancies were discussed until agreement was reached.

Using this search strategy, we identified 67 citations (Fig. 1), of which 62 were deemed relevant through abstract review (four articles were excluded because they were reviews; one was eliminated because it was a duplicate of another article). Fourteen articles were excluded because they did not involve original research on implementation of the DPP program (i.e., they were perspective articles, re-analysis of an existing trial, or description of the DPP), leaving 48 articles. An additional four articles were identified from reference lists, resulting in 52 articles selected for full-text review, and of these, eight articles were eliminated because they mentioned the DPP but were not using the DPP intervention.

Data extraction

Two authors independently reviewed and coded the articles to ensure compliance with the inclusion criteria. To assess the extent to which adaptation and implementation of the DPP have been reported, the articles were categorized based on program characteristics, such as program name and setting (Table 1). Further, included studies were evaluated to determine (1) translational strategies and/or cultural adaptations, (2) implementation strategies, or (3) both. A checklist for coding implementation and adaptation was developed through an iterative process by the study authors. Two reviewers coded a sample of 10 % of the articles. Upon achieving substantial agreement (>90 %), one reviewer coded each of the remaining articles.

We coded three aspects of the adaptation and implementation process: (1) translational strategies, (2) cultural adaptation, and (3) implementation. To evaluate what adaptations had been made to meet the needs of study subjects or particular cultural groups, we used the eight categories of the EVM framework: language, persons, metaphors, content, concepts, goals, methods, and context [26]. To assess how the adaptation was made, we extracted descriptions of the process of adaptation. To operationalize this, our review identified articles reporting cultural adaptation of the DPP; that is, studies that explicitly accounted for clients' culture, ethnicity, or race. Studies that only translated the materials into a different language were considered to have adapted the intervention, but this was not considered to be a cultural adaptation. We also evaluated whether a framework of adaptation was used, such as those outlined by Bernal and Domenech Rodriguez [25]. We coded studies that were empirical and designed to test an implementation strategy or set of strategies or explored issues related to implementation as implementation studies [40, 41]. These studies were coded for study design, implementation strategy, implementation outcomes, and whether or not a conceptual model or framework was used to guide the study and/or implementation effort. For the implementation outcomes, we relied on Proctor and colleagues' taxonomy that includes acceptability, adoption, appropriateness, cost, feasibility, fidelity, penetration, and sustainability [42].

RESULTS

Program characteristics

A total of 44 papers were reviewed (Table 1). Most studies implemented the DPP in churches (n=8), medical settings (n=18), or community centers (n=10) (Table 1). Fewer programs targeted the intervention to a specific population; eight targeted African-Americans, four involved Latinos, and three Native Americans. While most studies included both an implementation and outcome evaluation component (n=35), we identified three studies that primarily reported on implementation; six studies primarily assessed

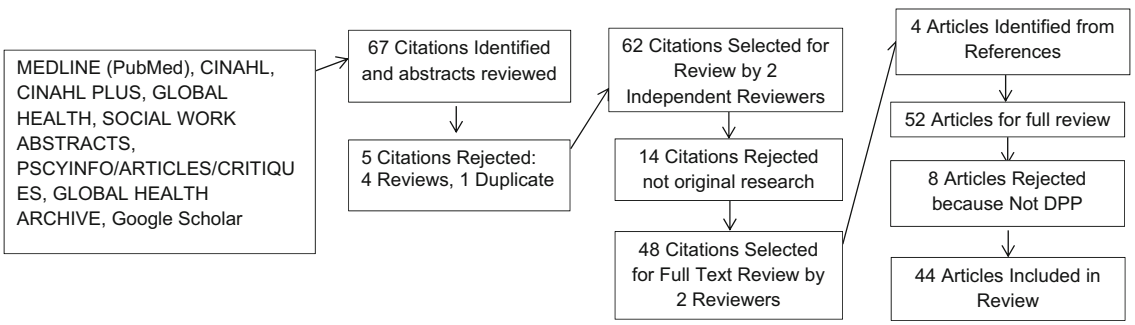

Fig 1 | Procedures used to review the literature on implementation and adaptation of the Diabetes Prevention Program (DPP), January 2004–December 2013

Table 1 | Characteristics of diabetes prevention program translational studies

Authors and year (Ref. No.)	Setting	Sample (No. of subjects)	Study design	Implementation or effectiveness	Cultural adaptation (yes/no)
Ackermann and Marrero, 2007 [56]	YMCA	Community, adults (NR)	1 group, pre/post trial	E	No
Aldana et al., 2005 [57]	Worksite	Employees (37)	1 group, pre/post trial	I/E	No
Amundson et al., 2009 [58]	Health care facilities	Adults (295)	4 group pre/post trial	I/E	No
Boltri et al., 2008 [59]	Church	African-Americans (26)	Pilot, 1 group pre/post	I/E	Yes
Boltri et al., 2011 [60]	Church	African-Americans (37)	Quasi-experimental, 2 non-random groups 6 and 16 weeks	I/E	Yes
Brown et al., 2010 [61]	Tribal center	Northern Plain Indian tribal members (31)	Pre-intervention focus group	I	Yes
Dallam and Foust, 2013 [62]	Worksite	Employees (264)	3 groups, quasi-experimental	E	No
Davis-Smith, 2007 [63]	Church	African-Americans (10)	Pilot, 1 group pre/post	I/E	Yes
DeJoy et al., 2013 [64]	Worksite	Mostly white adult males (67)	1 group, pre/post trial	I/E	No
Dodani et al., 2009 [65]	Church	African-Americans (NA)	Pilot, 1 group pre/post	I/E	Yes
Dodani and Fields, 2010 [66]	Church	African-Americans (40)	Pilot	I/E	Yes
Guyse et al., 2011 [67]	YMCA	Adults (265)	1 group, pre/post trial	I/E	No
Harwell et al., 2011 [68]	Clinical diabetes education programs	Adults (989)	1 group, pre/post trial	E	No
Jiang et al., 2012 [69]	Health care program	American Indian and Alaska Natives (2553)	1 group, pre-post; analyzed (non)completer	E	Yes
Katula et al., 2010 [70]	Diabetes Care Center	Adults (300)	Randomized controlled trial	I/E	No
Katula et al., 2011 [71]	Diabetes Education Program	Adults (301)	Randomized controlled trial	I/E	No
Kramer et al., 2009 [72]	Primary Care Clinic	Adults (93)	Two-phase, non-randomized prospective design	I/E	No
Kramer et al., 2011 [73]	Clinical Diabetes Program	Adults (81)	Single group prospective intervention study	E	No
Kramer et al., 2013 [74]	Clinical Diabetes Program	Hispanic Women in WIC (27)	Single group prospective intervention study	I/E	Yes
Krukowski et al., 2013 [75]	Senior Centers	Older adults (116)	Cluster randomized control trial	I/E	No
Lawlor et al., 2013 [76]	Clinical Diabetes Program	Adults (301)	Randomized controlled trial	E	No
Ma et al., 2013 [77]	Primary Care Clinic	Adults (241)	Randomized controlled trial	I/E	No
Matvienko and Hoehns, 2009 [78]	University	Adults (29)	Pilot	I/E	No
Mau et al., 2010 [79]	Community sites	Native Hawaiians and other Pacific Islanders (239)	Focus group, followed by pilot	I/E	Yes
McBride et al., 2008 [80]	Cardiac rehab program	Adults (37)	3 arms, pre- and post-test	I/E	No

McTigue et al., 2009 [81]	Primary care	Adults (154)	Controlled before-after design/controlled cohort	I/E	No
McTigue et al., 2009 [82]	Online (thru primary care clinic)	Adults (50)	Pilot	I/E	No
NY Academy of Medicine, 2012 [83]	YMCA	Adults (254)	Mixed methods pre-post evaluation	I/E	No
Ockene et al., 2012 [84]	Senior center	Spanish-speaking Latinos (312)	Randomized controlled trial (randomized block design)	I/E	Yes
Pagoto et al., 2008 [85]	Hospital-based weight loss clinic	Mostly white adults (118)	Single group prospective intervention study	I/E	No
Perez Siwik et al., 2012 [86]	Primary Care Clinic	Adults (35 % Hispanic) (58)	Single group prospective intervention study	I/E	Yes
Piatt et al., 2012 [87]	Community sites	Adults (105)	Single group prospective intervention study	I/E	No
Rosal et al., 2011 [88]	Community sites	Postpartum women in WIC (27)	Single group prospective intervention study	I/E	Yes
Ruggiero et al., 2011 [89]	Community sites	Latinos (69)	Single group prospective intervention study	I/E	Yes
Schneider et al., 2011 [90]	Mental Health Organization	Severely mentally ill patients (adult) (14)	Pilot	I/E	No
Seidel et al., 2008 [91]	Community sites	Adults (88)	Single group prospective intervention study	I/E	No
Simkin-Silverman et al., 2011 [92]	Online (thru primary care clinic)	Adults (NA)	Pilot	I	No
Smith-Ray et al., 2009 [93]	Managed Care Organization	Adults (292)	Single group prospective intervention study	I/E	No
Vadheim et al., 2010 [94]	Community health care facility	Adults (101)	Single group prospective intervention study	I/E	No
West et al., 2011 [95]	Senior centers	Older adults (228)	Randomized controlled trial	I/E	No
Whittemore et al., 2009 [96]	Primary Care Clinic	Diverse adults (58)	2 phases: 1—modify intv; 2—prospective clinical trial pilot study w/ clusterrandomization	I/E	No
William et al., 2013 [97]	Church	African-Americans (604)	Randomized controlled trial	I	Yes
Yank et al., 2013 [98]	Primary Care Clinic	Adults (241)	3-group randomized trial	I/E	No
Yeary et al., 2011 [99]	Church	African-Americans (26)	Single group prospective intervention study	I/E	Yes

I implementation, evaluates implementation strategy or other factors related to implementation; *E* effectiveness, assesses the impact of the intervention on a health-related outcome

effectiveness of the program but had minimal implementation evaluation. Thus, 38 studies were coded as implementation studies. Less than half of the 44 studies (n=15) were coded as describing a cultural adaptation of the DPP.

Translation strategies

Adaptations of the DPP are summarized in Table 2. There was large variability in the number of studies reporting each type of intervention adaptation. Many articles reported modifying the words of their program to incorporate cultural competence or sensitivity, to be understandable to low-literacy audiences, or to be in the language of the target population. Another adaptation was changing the program administration, including reducing the timeline (often to 12 weeks) and frequency of meetings. Nearly all (n=42) of the articles reported a group-based intervention. The characteristics of individuals selected to lead the intervention varied, with many (n=18) using lay health workers. In health care settings, medical staff were typically enlisted as facilitators of the DPP. The ethnicity of the medical staff was often matched to the target population. The length (from 1 h to 2 days) and source (e.g., self-study materials, individuals previously trained to deliver the DPP) of training for program implementers varied across studies.

Cultural adaptation

Only five of the 15 studies that described cultural adaptation (Table 2) included a framework. The framework for all five was community-based participatory research (CBPR). These 15 studies tended to focus on the components of persons and content, with less emphasis on the other categories explored. The most commonly reported adaptation (13 of 15 articles) was content. The adaptation of DPP materials included targeting a cultural group. When this was described, it centered on modifying recipes or discussing cultural ideas about diabetes. Modification in the persons category involved delivery of the program by community members/peer educators and community health workers. Ten studies (67 %) reported matching the ethnicity of the implementation staff to that of the participants and training community members to deliver the DPP. This was described as going beyond language to include selection of community health workers from the target population. Studies targeting specific populations, such as through African-American churches, were the most likely to include cultural adaptation.

Implementation

To evaluate implementation, most studies (n=22, 58 %) used pre/post designs with no control group (Table 1); only nine were randomized controlled trials. In total, 11 studies reported an implementation framework (Table 3).

At the individual level, the most frequently assessed implementation outcome was adoption, which was typically reported as the number of individuals who participated from a pool of potential participants. Of the six studies that mentioned a program fee, most reported the fee was a barrier to adoption. Twenty-nine studies reported on feasibility at the individual level. Feasibility was explored in a number of ways, including attendance rates, dropout rates, and difficulty with parts of the program (most commonly, completing the diet and activity tracking and transportation to attend program sessions). At the level of the organization, feasibility was most commonly reported; studies often mentioned cost, staffing, and space. Interestingly, among articles that reported program acceptability and/or feasibility at the organizational level in the abstract, discussion, and/or conclusion, most did not describe how this was determined. There was a considerable overlap between the studies reporting organization-level outcomes related to sustainability and those reporting outcomes related to penetration; if a study reported on one, they tended to report on the other. Sustainability involved the extent to which the DPP is maintained or institutionalized within a setting's ongoing, stable operations strategies, and penetration is defined as the integration of a practice within a service setting and its subsystems.

DISCUSSION

The 44 studies in this review provide evidence that the DPP is being tested or evaluated in a variety of settings and populations, using numerous translation strategies and cultural adaptations. Since the DPP represents a milestone in lifestyle interventions for diabetes prevention [17, 18], significant effort has gone into translating the program to diverse populations and to those of disadvantaged socioeconomic backgrounds to reach those most at risk. This has required translation and implementation into settings, which require adaptations to the intervention to enhance the feasibility of program delivery and participant engagement [43].

Other review articles reported translations of the DPP in settings similar to those identified in the current review and noted adaptations were necessary for program fit [44, 45]. For example, while relatively less information was available about program adaptation at the time of an earlier review by Whittemore et al. [45], implementation of the DPP has increased. Twenty-three of the studies in the current review were published after the date for inclusion in the Whittemore et al. review and thus were not included in that earlier review. With efforts to implement DPP widely, the number of studies and implementations of the intervention has increased, enhancing the need to synthesize implementation efforts, particularly using the growing toolbox from the maturing field of implementation science. We found several common adaptations across the 44 studies reviewed, such as delivering the program in groups, offering the program over 12 sessions, and program delivery by existing staff from the implementing organization (to enhance feasibility and appropriateness) or by trained community members

Table 2 | Translational strategies and cultural adaptations of the Diabetes Prevention Program, 2005–2013

Translational strategies (n=44)			
Translational category	Description of strategy	Number reporting, N (%)	Study reference
Visuals	• Visuals reflecting study population, foods, and activities included in print materials	2 (4 %)	[84, 88]
Language and reading level	• Cultural sensitivity in wording • Literacy sensitive • Translation (tribal and Spanish)	11 (25 %)	[69, 79, 84–86, 88–90, 92, 96, 99]
Inclusion criteria	• Variation in age limit (18–25) • Variation in inclusion criteria based on health (type of screening or actual condition—e.g., some included metabolic syndrome vs risk for DM vs those with DM vs varying number of risk factors for DM); medical exclusion criteria (e.g., need clearance by physician)	22 (50 %)	[57, 69, 73–76, 78, 80, 81, 84–87, 89–92, 95, 96, 98, 99]
Incentives	• Small gifts (e.g., t-shirt) or money for data collection • (Refundable) commitment fees • Money/gift cards/raffle • Variation on the "toolkit" (e.g., pedometers, printed materials, money for food during class, gym membership, behavioral tracking materials)	21 (48 %)	[56–58, 61, 62, 64, 67, 72, 80, 81, 84, 85, 87–91, 94, 95, 97, 99]
Added activities	• Churches: prayer/time with God • Native community studies: talking circles, indigenous food Group exercise activities during/before/after class • Taste testing • Education on low-cost healthy eating • Communicating with your provider • Metabolic syndrome/CVD (blood lipids, etc.) • Requiring a support person • Technology (e.g., DVD, online resources)	34 (77 %)	[56–60, 62–71, 76–82, 86–92, 94–98]
Exclusion of DPP core components	• Selected only most relevant top to target population • Deleted toolbox due to funds • Removed sections due to staffing	7 (16 %)	[60, 63, 85, 88, 93, 95, 96]
Frequency and timing of DPP classes	• Changes to meeting frequency (e.g., weekly, bi-weekly, over a certain number of months) • Most commonly condensed to 12, 8, or 6 weeks • Variety in number and length of post-core sessions • Time of sessions varied from 30 min–2.5 h	24 (54 %)	[56, 60, 63, 65, 66, 72–75, 77, 79–81, 84–88, 91, 93, 95–98]
Class format	• Group • Web-based • DVD • Telephone-delivered classes • Self-study • Mix of individual and group classes • Family/support person groups (size 3–35)	42 (95 %)	All except [61, 96]

Implementation staff	• Dieticians • Nurses, other clinical staff • Other health professionals/medical background (e.g., exercise physiologist, psychologist) • Lay/Community health workers • Bilingual • Variations in amount, but nearly all describe training/certification/oversight	42 (95 %)	All except [61, 68]
Cultural adaptations (n=15)			
Category of cultural adaptation	Description of adaptation	Number reporting, N (%)	Study reference
Language	• Spanish • Tribal	4 (40 %)	[69, 79, 84, 89]
Implementation staff	• Bilingual individuals • Community or tribal members	10 (67 %)	[61, 65, 66, 70, 71, 74, 79, 84, 89, 99]
Metaphors	• Linking faith and health, i.e., encourage participants to draw strength from their faith to make positive health changes; included Scripture in lessons	1 (7 %)	[99]
Content	• Described culturally appropriate/traditional recipes and physical activities • Talked about cultural ideas related to diabetes risk • General description that the program was adapted to the cultural needs of the community	13 (73 %)	[59, 60, 63, 65, 66, 69, 74, 84, 86, 88, 89, 97, 99]
Concepts	• Targeting cultural beliefs (e.g., soap opera/novella) • Resiliency skills (recognize the link between stressful events and beliefs, emotional responses based on these beliefs, and subsequent behaviors)	3 (20 %)	[61, 84, 86, 99]
Goals	• Specifically culturally relevant goals	1 (7 %)	[86]
Methods	• Faith Task Force explored methods (e.g., lay health advisor model, group-based format) and incorporated culturally appropriate components for their community to produce The WORD • Talking circles in Native American communities	1 (7 %)	[99]
Framework	• Community-based participatory research	5 (27 %)	[60, 65, 66, 89, 99]

Table 3 | Implementation studies (n=38)

	Description	Number reporting, N (%)	Study reference
Implementation research studies			
Implementation framework	• 5—Community-based participatory research • 1—"Translation model" (also used CBPR) • 1—Intervention translation framework • 3—Diffusion of innovation • 2—RE-AIM	11 (29 %)	[60, 65, 66, 85, 88–90, 93, 96, 98, 99]
Individual outcome			
Acceptability	• Usually based on a survey or FGD • Participant satisfaction/enjoyment; sometimes specific components	16 (42 %)	[57, 62, 64, 65, 74, 79, 80, 83–85, 88, 90, 91, 93, 95, 99]
Adoption	• Few with fees mentioned that limitation • Most just mentioned total possible participants and number who decided to participate • Community screenings tended to have lower trend to adopt vs physician referral seemed to be higher	30 (79 %)	[57–60, 62, 63, 66, 67, 69, 72–74, 77, 79–83, 85–91, 94, 96–99]
Feasibility	• Many studies reported attendance rates and/or dropouts • Several studies reported participant difficulty getting to class sessions (e.g., transportation) • Several studies reported difficulty with maintaining food records • Some with phone sessions reported difficulty with completion of those	29 (76 %)	[57, 58, 63, 64, 66–73, 77, 79, 80, 82, 84–91, 93–96, 99]
Maintenance	• Most had 6-, 12-, or 24-month post intervention follow-up assessments or surveys • Most studies that mentioned outcomes described a decrease in effect over time on weight, but some behaviors were maintained	23 (61 %)	[57–60, 63, 64, 67, 69–73, 78, 80–84, 87, 89–91, 93]
Organizational outcome			
Acceptability	• Many studies mentioned acceptability by the community partner/program delivery agency in the discussion/conclusion, but few reported how this was determined	14 (37 %)	[59, 61–65, 69, 79, 82, 83, 88, 90, 93, 97]
Adoption	• Few studies reported the number of partners approached, and only reported on those choosing to implement • Reported on the organizational decision process regarding adoption in those that participated • Reported keeping track of the initial number of agencies and the number implementing	14 (37 %)	[60–62, 65, 69, 85, 88, 90, 93, 95–99]
Appropriateness	• Describe community or partner involvement in adapting the program to fit • Describe how the program fits in the agency workflow/expertise	20 (53 %)	[59–61, 63–67, 78–80, 83, 85, 88, 90, 93, 96–99]

	• Describe how the program fits with the agency mission		
Feasibility	• Mentioned acceptability by the community partner/program delivery agency in the discussion/conclusion, without details on how this was determined • Mentioned cost and/or specifically measured cost (e.g., mentioned decreases in health care premiums because of the program) • Several mentioned issues around staffing and/or space • Described feasibility from program deliverer's perspective (i.e., staff or LHE)	32 (84 %)	[56–60, 62–64, 66, 69–73, 75, 76, 81–86, 88–90, 93–99]
Fidelity	• Observations of sessions • Program deliverers of self-report provision of material • Saying program delivered but no additional description • Talked about extra resources for deliverers to get help with the program	13 (34 %)	[66, 67, 70–72, 83, 88–90, 95–97, 99]
Penetration	• Discussed looking into expanding/continuing the program • Actually doing or have done an expansion of the program to other settings/more sites	9 (24 %)	[60, 63, 80, 83, 85, 88, 90, 98, 99]
Sustainability	• Described how the cost was offset (either by the way the program was designed, new insurance policy, or acquisition of a community grant) to integrate the program into usual care • Donated intervention materials so program could continue • Had maintenance group spontaneously form • Integrated/hired staff to continue the program • Discussed how involving the partner in development/adaptation enhanced the ability of the agency to continue offering (and 1 was still offering)	15 (39 %)	[60, 62, 63, 82, 83, 85, 86, 88, 90–93, 97–99]
Other	• Unintended increase in Bible study attendance because after group meetings • Discovered a need for tailoring to populations with higher prevalence of mental illness/eating disorders • Discovered health issues with the peer wellness coaches and created a group for them	4 (11 %)	[63, 85, 90, 99]

(to enhance implementation and cultural adaptation). Further, researchers, program developers, and practitioners are employing a number of strategies to enhance translation of the program and reduce costs (e.g., reducing the frequency of classes, trimming the toolkit).

Of the few studies that focused on cultural adaptation of the DPP, we found several involved adaptation of program materials to target a cultural group. Many culturally adapted interventions increased ethnic matching between facilitators and participants, which was reported to facilitate cultural tailoring of the material [46]. Modification in the persons category were also common. Health interventions involving community health workers have emerged as an important approach to health promotion. Community health workers are typically respected and trusted community members, responsive to the needs of others [47], and are able to serve as "bridges" [48] and "culture brokers" [46] between community residents and the health care delivery system. There is clear evidence that interventions using community health workers can result in changes in knowledge and health practices [49–51].

Cultural adaptation of DPP content was another form of adaptation among a subset of the programs reviewed. Content adaptation has been shown to increase relevance of programs for participants [52–54]. Many cultural adaptations involved working within the community through CBPR, which appeared to facilitate community buy-in. For example, several studies adapted program content to include discussion of local foods and materials to provide information on how to prepare these items in healthier ways. Other adaptations encouraged participating in local and/or traditional physical activities and discussed cultural, social, and environmental forces that influence obesity and diabetes.

Cultural adaption may not be part of translation efforts for several reasons. The study team may not have experience with culturally adapting an evidence-based program and/or may lack the funding to support the additional work (e.g., formative evaluation, changing the visuals in DPP materials) required to adapt the DPP. If a particular translation is not designed to be implemented in a population with a specific cultural background, cultural adaptation may not be indicated; many of translation efforts explored were aimed at different settings, such as primary care. Adaptation may also be taking place, but go unreported, at least in the scientific literature.

While program adaptation can facilitate successful implementation, modifying an evidence-based program has the potential to alter program impact and must be tested and evaluated carefully during the implementation process [31, 43]. Our study was not a systematic review of the relationship between the degree of intervention adaptation, implementation efforts, cultural adaptation, and program impact (i.e., behavioral or physiologic outcomes). However, of the articles included in our analysis, 36 contain physiologic or behavioral outcomes (i.e., weight, glucose, insulin, lipids, blood pressure, diet, or physical activity), and of these, all had favorable results for at least one outcome. The heterogeneity in all three factors and outcomes selected for measurement make further analysis difficult. Thus, whether and/or to what extent program adaptation alters program impact remains an important question for future research.

Standard approaches to documenting translation and adaptation would facilitate the identification of that adaptation's enhanced implementation and effectiveness. This includes documenting changes to intervention materials and how decisions regarding these changes were made. Greater standardization in outcome reporting would also facilitate this process; however, a number of studies reported selecting outcome measures based on challenges related to implementation of data collection (e.g., capacity to obtain fasting blood samples). Despite the lack of standardization and difficulty determining the impact of program changes on outcomes, the adaptations described in the current literature may guide future efforts to translate the DPP.

Authors documented a number of ways in which they assessed and reported implementation outcomes for their translation efforts. Overall, 38 studies reported implementation evaluations with a variety of study designs; most were pre-post evaluations without a control group. However, there were nine randomized controlled trials. Designing translation efforts and evaluations based on an implementation framework can greatly enhance such efforts; however, only 11 studies used an implementation framework. The plan for data collection and analysis may be related to the initial aim of program development, i.e., whether the implementation was designed as a research study or an evaluation of a program implemented in a practice setting. In our review, we found that 27 studies were research, 11 were evaluation, and 6 had components of both research and evaluation. It is encouraging that many studies reported individual- and organizational-level implementation outcomes, incorporating measures such as feasibility and acceptability through processes put in place during the intervention. In some studies, process evaluations were conducted after implementation using qualitative and quantitative data collection with participants and implementers. These data can contribute to future translation efforts. However, most studies lack reporting on important implementation outcomes such as costs [55], which may be a major detriment to putting the DPP into practice through insurance reimbursement and providing access to the majority of the population for whom access is currently lacking. Also lacking was a robust discussion on program sustainability with only 13 studies (and only six cultural adaptation studies) assessing this important implementation outcome. Future studies incorporating assessment of cost and sustainability can greatly benefit continued efforts to increase uptake of the DPP.

This review has limitations. Although many studies included varying adaptations, some adaptations were not described and therefore could not be included in our analysis. Second, we restricted our search to the DPP. While there may be other effective programs to prevent diabetes, the DPP has shown efficacy and effectiveness in previous trials and has been disseminated widely. There are likely unpublished studies and programs that included cultural adaptation of the DPP. Further, though we looked for cited studies that might provide more detail about cultural adaptation from other papers, it is possible we missed ancillary articles with additional detail. Additionally, due to the heterogeneity of adaptations and outcomes reported, we could not summarize the impact of adaptation on program effectiveness.

IMPLICATIONS

In addition to the many studies testing DPP implementation efforts, major national initiatives (e.g., the YMCA program, the CDC's National DPP) are implementing the DPP. The current literature synthesis can inform these implementation efforts and guide evaluation of these initiatives. Practitioners should consider translational strategies and cultural adaptation to increase program relevance, satisfaction, and participation [43]. Support from policymakers is important as translational challenges are multilevel and multifactorial, reflecting the diverse nature of individuals, health systems, and communities [21]. When researchers provide detailed reporting of adaptations and lessons learned during translation it can help the DPP be effectively adapted for populations that experience a disproportionate burden of obesity and diabetes.

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