VERMONT
DEPARTMENT OF HEALTH

Literature Review: Diabetes Prevention & Management Program Considerations for Vermont

April 2020

Introduction

The Vermont Department of Health has been charged with conducting a literature review on behalf of the Vermont Blueprint for Health and OneCare Vermont with the goal of identifying effective and scalable self-management or community-based programs to address the underlying health behaviors for prediabetes and diabetes.

The criteria for the review include:

(1) Strength of the evidence for self-management and/or community-based interventions for prediabetes and diabetes management;

(2) Size of the population reached by the intervention and impact on clinical outcomes;

(3) When possible, cost efficiency ratio (impact for investment) including scale of delivery model and administration of programs; and

(4) Findings that may inform feasibility to scale the intervention state-wide will be noted.

Context to Interpret Summary

It is important to note that this is a rapid review. Due to time constraints, not all articles selected for review were included in this summary and as such, this should not be considered a comprehensive literature review. Given the limited timeframe available to complete it, the primary foci were:

1. Systematic reviews and meta-analyses published between January 2000 and March 2020
2. Articles describing established, structured programs with a standardized curriculum or intervention protocol focused on preventing or managing hypertension or blood pressure reduction from January 2010 through January 2020.

It is critical to note that there is no uniform definition as to what constitutes a *program* or agreement on specific elements necessary to include in such an intervention for chronic disease self-management or prevention. Therefore, to establish consistency in this review, when the term program is used it will be to refer to an intervention that has a structured evidence-based curriculum or process that was used on a community scale. All other interventions will be referred to as a study trial or protocol used to prevent or manage the disease.

Article Selection

With few exceptions, the majority of peer-reviewed literature in this review were obtained from PubMed searches. It is possible that the inclusion of searches in other databases (e.g. the Chochran Library, Medline, etc.) may yield novel research that was not available through PubMed.

Search Terms

The terms in the table below contain the search terms used to identify records for consideration in PubMed. These terms were used as OR statements in their respective searches with medical subject headings (MeSH) terms to allow for synonyms of the provided terms to be included in the search. This provides for a wide net in returned results. Articles shared by subject matter experts were also considered for inclusion.

Prediabetes	**Diabetes Management**
Program evaluation	Program evaluation
Evaluation studies as topic	Evaluation studies as topic
Validation studies as topic	Validation studies as topic
Cost efficient	Community based care
Community based care	Self-management
Self-management	Diabetes mellitus
Self-manage	English
Self-care	Aged or middle aged or adult
Diabetes mellitus	Cost efficient
Prediabetic state	Self-care
English	Behavior change
Aged or middle aged or adult	Diabetes management
Behavior change	

Inclusion Criteria

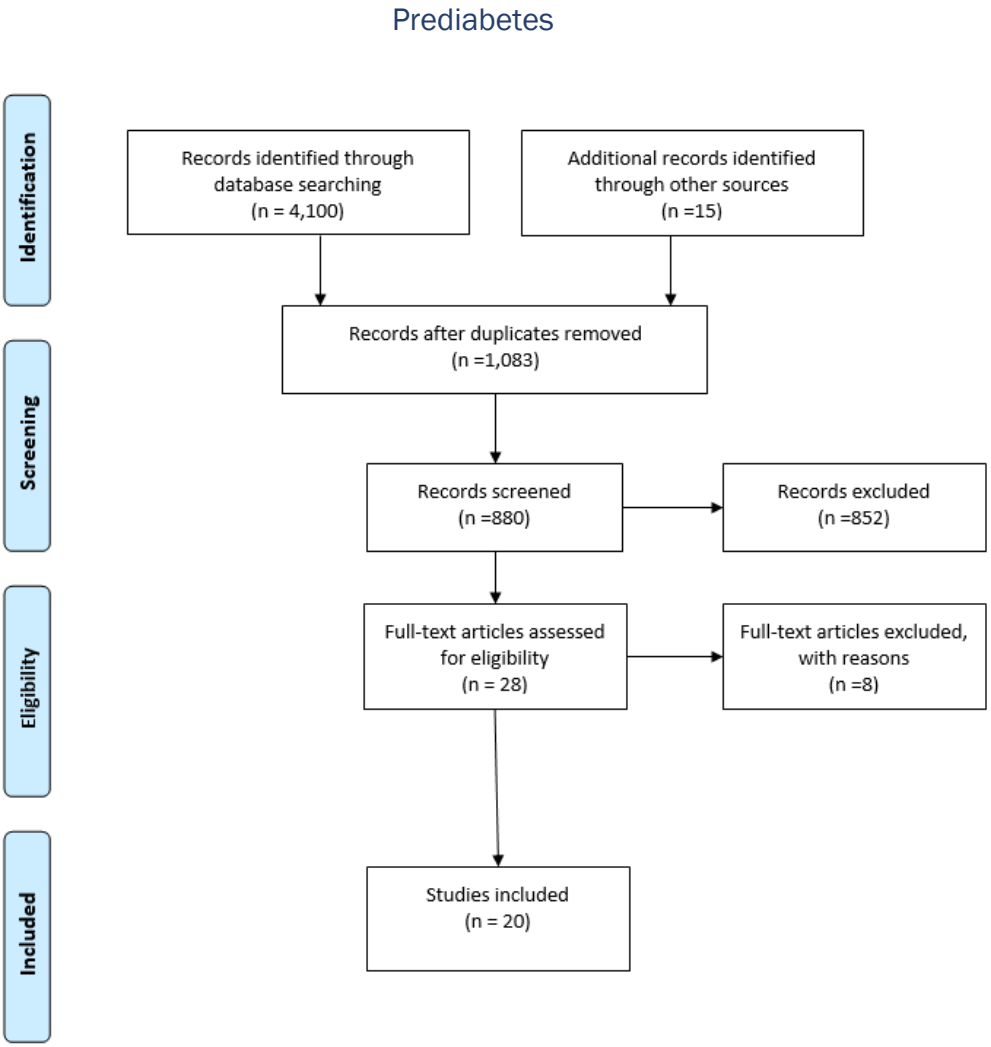
- Article published in English
- Study was conducted in the U.S.[1]
- Study sample was 50+ adults[2]
- Focus of study was prehypertension or hypertension
- Measured outcomes included blood pressure or established disease risk scores (e.g. Framingham cardiovascular disease risk score)
- Published 2000 and later (systematic reviews and meta-analyses) or 2010 and later (all other review articles)

Exclusion Criteria

- Population too specific to be scalable or generalizable
- Statistical power <80%, if reported
- Poor methodology
- Duplicate study

[1] The exception to this is the prediabetes review because several landmark studies occurred outside of the U.S.
[2] Flexibility was given for novel approaches.

Article Inclusion Flow Chart



Prediabetes

Introduction

Diabetes prevention programs in the United States stem primarily from research indicating that lifestyle interventions delay the onset of type 2 diabetes. These lifestyle interventions were composed of physical activity and diet with the goal of losing a modest amount of weight. Knowler et al.'s (2002) was a landmark clinical trial beginning in 1996. This trial compared the impact of lifestyle interventions to drug therapy, demonstrating that participants completing the lifestyle change intervention reduced their risk of type 2 diabetes by 58% (71% for people over 60). Two similar large clinical trials in Finland and China support increased physical activity and diet with the goal of weight loss as the main components of diabetes prevention (Gong et al., 2019; Lindstrom et al., 2006). Together, these studies make up the core literature supporting the development of diabetes prevention programs in both the United States and globally.

The success of Knowler's study spurred the United States Congress to authorize the Centers for Disease Control and Prevention (CDC) to create the National Diabetes Prevention Program (NDPP). Translations of the original program are managed under the CDC's Diabetes Prevention Recognition Program (DPRP), which accredits diabetes prevention programs across the United States and ensures fidelity to the evidence base. Ten years after Knowler's original trial, the impact of the intervention continues to have positive outcomes for participants including a lower incidence of diabetes compared to the metformin and control group (Knowler et al., 2009).

The NDPP, a CDC recognized lifestyle change program, is taught by a trained coach. The coach could be in the health field or a layperson. The program consists of 16, 1-hour core sessions and 6-9 additional 1-hour maintenance sessions. Translations of the NDPP require that curricula are based on science and the following guidelines from CDC Recognition Program Standards and Operating Procedures:

- *Emphasize the overarching goal of preventing type 2 diabetes*
- *Focus on making lasting lifestyle changes, rather than simply completing the curriculum*
- *Build up to moderate changes in diet and physical activity that lead to 5-7% weight loss in the first six months*
- *Discuss strategies for self-monitoring of diet and physical activity, building participants self-efficacy and social support to maintain lifestyle changes, and problem-solving to overcome common weight loss, physical activity, and healthy eating challenges*
- *Weigh participants at each session*
- *Provide participant materials to support program goals*

Methods for Successful Diabetes Prevention Programs (DPPs)

A review of successful DPP articles demonstrate that a variety of methods lead to positive results (Mayer et al., 2019; Kim et al., 2019; Sepah et al., 201; Vadheim et al., 2017; Bian et al., 2017; Aguiar et al., 2016; Balk et al., 2015; Ma et al., 2013). There is no one clear path for type 2 diabetes prevention. For example, program delivery ranged from exercise counselors to nurses, trained laypeople, community health workers and dieticians (Balk et al., 2015). Culturally tailoring the program is an effective approach, as well as simplifying content and supplementing the in-person program with digital tools such as mobile applications or websites. In all cases, the more program sessions attended, or logins, in the case of digital platforms, the greater the impact (Mayer et al., 2019).

Program delivery ranged from the standard 16 in-person core sessions and additional maintenance sessions described in the NDPP to telehealth versions where the participants and coach interact through videoconferencing. Mobile-based apps can also be used to log participant weight and physical activity minutes. Participants may watch learning modules independently and interact with other participants via written discussion boards. In a clinic-based prevention program, messages were sent using secure email from the patient's electronic medical record by the Lifestyle Coach. Emails included self-monitoring advice and standardized monthly motivational messages to increase patient participation and retention (Ma et al., 2013). These various intervention delivery

methods led to significant weight loss reductions and other important clinical outcomes such as hemoglobin A1C[3].

Clinical Outcomes of Lifestyle Change Programs

Our review, which includes a direct analysis or meta-analyses of roughly 80 diabetes prevention programs, found that programs integrating physical activity and improving diet yield positive biometric outcomes. In a meta-analysis conducted for the Community Preventive Services Task Force[4], a review of 66 studies promoting physical activity and diet led to 20% of participants reverting to normoglycemia at two years and 52% of participants reverting to normoglycemia at six years (Balk et al., 2015). Programs that used protocols based on the U.S. DPP or Finnish Diabetes Prevention Study (similar outcomes) led to participants losing 3% more weight compared with participants in programs not based on the U.S. NDPP or Finnish DPS (Balk et al., 2015).

A review of nine studies of lifestyle interventions showed that seven of the nine interventions were successful in reducing the risk of type 2 diabetes from the end of the study up to ten years after. Interventions included exercise, diet and one other component such as behavior modification or smoking cessation, Results also documented a positive reduction in body composition and other metabolic measures as well as physical activity and diet (Schellenberg et al., 2013).

Technology-assisted or Web-based Programs

The following are examples of successful Diabetes Prevention Program (DPP) translation programs and their associated results. Vadheim et al. (2017) compared a telehealth version of the DPP completed by 894 participants in rural Montana to in-personal standard DPP classes. They found that both groups achieved the program goal of losing 5% of their weight. Both groups had similar mean weight loss, participation level and physical activity rates. Telehealth delivery of the NDPP allows for greater participation in remote and rural areas and overcomes the transportation barrier that many people face in rural communities. This study demonstrates that telehealth is both feasible and leads to improved clinical outcomes.

A review of 15 technology-mediated DPPs indicate that interventions based on the NDPP resulted in marginally higher average weight loss than non-interventions (Bian et al., 2017). Technology-based interventions were effective at decreasing weight by an average of four kilograms (8.8 lbs). Further, of the five studies that reported baseline and post-intervention prediabetes prevalence measurements demonstrated a decrease in prevalence. Similarly, three years after completing the Omada online DPP, participant weight and hemoglobin A1c remained statistically significantly reduced from baseline. An increase in web logins and group participation was significantly associated with weight loss at 16 weeks and one year (Sepah et al., 2017).

The Real Appeal program is a free online behavioral weight loss program offered by an employer. Real Appeal engaged 50,000 participants across a variety of companies, 87% of which were considered at risk for prediabetes, diabetes or cardiovascular disease. Program completers, those

[3] The A1C or hemoglobin A1C/glycated hemoglobin test measures the amount of glucose in the bloodstream and is used to diagnose and manage type 2 diabetes. The measure reflects a three-moth average blood glucose and a normal A1C level is below 5.7%.

[4] The Community Preventative Services Task Force is an independent panel of public health and prevention experts established by the U.S. Department of Health and Human Services

who attended at least nine sessions, (27,164 people) lost an average of 4.3% body weight. Thirty-six percent of completers achieved 5% weight loss (Hortsman et al., 2018). As with the DPP, participants who attended at least nine sessions were nearly four times more likely to achieve 5% weight loss. To offset the cost to employers, companies paid only per session the participant attended and only when the participant was on track for 5% weight loss (Hortsman et al., 2018). This program has achieved full recognition from the Diabetes Prevention Recognition Program.

A randomized control trial measured the effectiveness of the "Prevention Using LifeStyle Education (PULSE)" program, which is a self-directed diabetes prevention program for men. The program provided participants with print and video resources on weight loss using the SHED-IT guidelines: Self-Help, Exercise and Diet using Internet Technology. After the intervention, the prevalence of prediabetes was reduced by 30% and weight loss was significant (5.5kg average or 12.1 lbs). The rate of HbA1c was reduced more compared to the DPP lifestyle group at six months. This study should be treated with caution as a long-term outcome study was not completed and physical activity outcomes were meager (Aguiar et al., 2016).

Weight-focused Programs

Weight is a significant factor in the development of Type 2 Diabetes. Programs that focus exclusively on weight loss may improve outcomes for people with prediabetes. Without focusing exclusively on people with prediabetes, weight loss programs have broad appeal and can impact people who are not aware they have prediabetes. However, weight reduction alone is not enough to guarantee long term risk reduction. These programs should have an added component of lifestyle change and/or diet to increase effectiveness. Below are a few examples of such programs that have demonstrated positive results.

A 2016 study of Weight Watchers® participants demonstrated that clinical outcomes were greater compared with participants who viewed diabetes self-management education & support (DSMES) literature with a health coach. DSMES includes guidance and recommendations on lifestyle change. The Weight Watcher intervention consisted of calorie restriction to promote weight loss and increasing physical activity. Specifically, at 6 and 12 months, the Weight Watcher group lost an average of 5% body weight. Both Weight Watchers and the NDPP held a similar number of group sessions (21.6) (Marrero et al., 2016).

Programs that focus exclusively on diet may lead to greater weight loss in a shorter amount of time compared to the NDPP. For example, an 8-week study based on a whole food plant-based lifestyle modification program showed average weight loss of 5.7% after 9 weeks. This program did not mandate exercise, but rather touched on physical activity and stress reduction and focused mainly on nutrition. The program was composed of sixteen classes, delivered twice weekly, with the goal of leading to adoption of a whole foods plant-based diet using live demonstrations of cooking and hands-on techniques. There was no calorie counting or portion control. At the end of the study, 99% of participants completed the program and clinical outcomes include a mean total cholesterol reduction of 25 points along with a 15-point reduction in HDL cholesterol. Final blood pressure also decreased and 27% of participants were able to decrease or stop at least one chronic medication (Campbell et al., 2019). A similar study on the impacts of a whole foods plant-based diet for participants with type 2 diabetes led to an average weight loss of 9% after three months and 12% after six months (Wright et al., 2017).

Program Barriers

Though the NDPP is the gold standard for lifestyle change programs geared towards people with prediabetes, it is not without barriers (Knowler et al., 2002). We know that one in three Americans have prediabetes, but only 10% know they have it (Centers for Disease Control and Prevention, 2020). A program focused exclusively on diabetes prevention may leave out a significant number of undiagnosed people who could benefit, but who lack an official diagnosis of prediabetes (Hortsman et al., 2018; Marrero et al., 2016). Alternatively, a health program that incorporates behavior change aimed at increasing physical activity and improving diet is recommended for several chronic diseases, not only prediabetes.

Additionally, the typical NDPP schedule, with a specific order of classes offered once to each cohort is difficult to meet. Programs with recurring sessions accessible at various times, or the "loop method" may lead to greater participation and program benefits (Marrero et al., 2016).

Economic Assessment of Diabetes Prevention Programs

Most diabetes prevention intervention trials did not include an economic assessment. However, a 2015 review of 28 diabetes prevention programs using physical activity and diet demonstrated cost effectiveness (Li et al., 2015). Further, program costs per participant were lower for group-based programs and for programs into community or primary care settings. The use of telehealth video conferencing for the DPP lifestyle intervention can also reduce the overall cost per participant compared to in-person classes (Vadheim et al., 2017). The cost of Weight Watchers compared favorably with the DPP, for example, $515 for an annual Weight Watchers membership compared with $429 for the YMCA DPP (could be less with sliding fee scale) (Marrero et al., 2016). When comparing the Veteran's Affairs Diabetes Prevention Program to the weight loss program MOVE!, authors concluded that inpatient, outpatient and total expenditures were similar between programs (Moin et al., 2017).

Conclusion

This review demonstrates that programs focused on physical activity and diet, oriented toward modest weight loss are effective in reducing the risk of type 2 diabetes. Successful programs followed the pattern of more weight loss during and directly after the intervention, followed by moderate weight regain. However, in most cases, type 2 diabetes risk reduction remained significant.

A gap exists in published studies focusing on DPPs targeting rural populations. One review of rural DPPs found that though individuals living in rural locations in North America experience a 17% higher prevalence of diabetes compared to urban dwellers, many existing programs did not yield significant clinical outcomes and methodologies lacked rigor (Rosputni et al., 2019). For example, only three of eight studies measuring body weight reported statistically significant reduction at follow-up.

Few articles cited family-based approaches to diabetes prevention, perhaps due to the adult-focus of this review. One article focused on a culturally tailored diabetes prevention program for Latino adolescents with some family involvement, however adult outcomes were not studied (Soltero et al., 2018). Family-based diabetes prevention programs may be an underexplored venue for type 2 diabetes prevention in the United States.

The sample size of programs assessed varied greatly, as did feasibility to scale. Further research on general wellness programs that incorporate diet and exercise may also be helpful, even if their outcomes are too early for peer-reviewed research. Varied settings, facilitator roles and modalities may lead to additional positive outcomes. Several technology-assisted programs meet or excel DPRP standards for clinical outcomes and participation and should be considered to address participation barriers such as transportation, childcare or limited mobility. Finally, given the prevalence of prediabetes, prevention efforts should focus on evidence-based practices such as physical activity and a healthy diet that contribute to chronic disease more generally. As the Finnish Diabetes Prevention Study suggested, "The high diabetes incidence even in the intervention group of our study suggests that preventive actions should probably be targeted to all high-risk individuals, even before impaired glucose tolerance is present" (Lindstrom et al., 2006, p. 1678).

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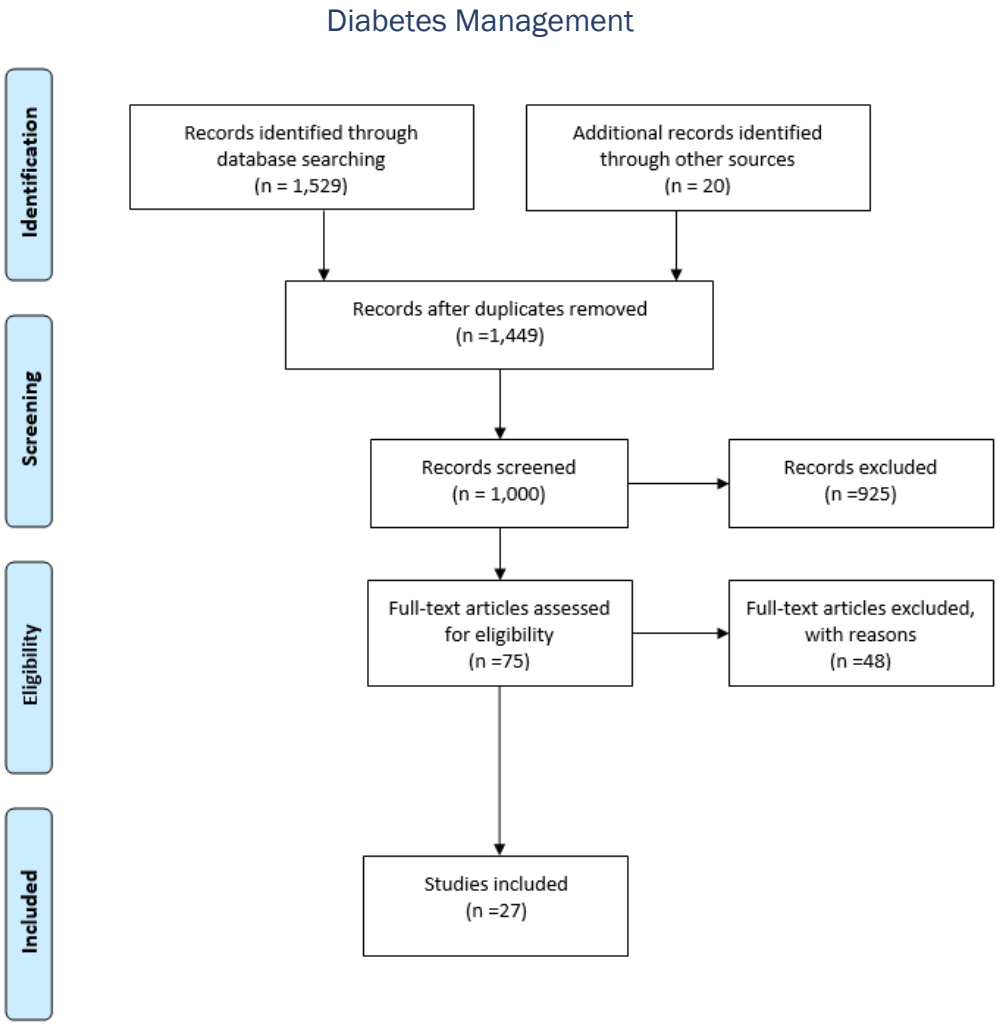
Article Inclusion Flow Chart



Diabetes Management

Introduction

Type 2 diabetes self-management education is formalized in the United States in order to receive accreditation or recognition, and in some cases is required for coverage under certain public health insurance plans. The Centers for Disease Control and Prevention (CDC) distinguishes between diabetes self-management education (DSME), diabetes self-management education and support (DSMES) and the diabetes self-management program (DSMP). These terms are reviewed below and provide context for the analysis of diabetes self-management programs and strategies.

The peer-reviewed research supporting self-management of type 2 diabetes is robust. A review of 118 DSME interventions engaging participants in self-management practices for type 2 diabetes showed that 62% of self-management interventions reported a statistically significant reduction in

Hemoglobin A1C (A1C)[5] values (Chrvala et al., 2015). DSMES services have also been shown to improve A1C values as much as many medications but without the side effects. For both DSME and DSMES, the more visits with a diabetes educator, the better their clinical outcomes compared with usual care (Beck et al., 2017; Chodosh et al., 2015).

Strong empirical evidence supports *diabetes self-management education* (DSME) as a best practice for individuals diagnosed with type 2 diabetes. According to a joint statement from the American Diabetes Association (ADA), the Association of Diabetes Care & Education Specialists (ADCES) and the Academy of Nutrition and Dietetics (AND), DSME is, "the active, ongoing process of facilitating the knowledge, skill, and ability necessary for diabetes self-care" (Powers et al., 2016, pg. 70). Recognized or accredited DSME programs are facilitated by a licensed health professional (nurse, dietitian, pharmacist, etc.) and focus on the medical management of type 2 diabetes using seven self-care behaviors: healthy eating, physical activity, monitoring, medication management, problem solving, reducing risks and healthy coping.

Diabetes self-management education and support (DSMES) encompasses DSME but covers additional services including nutritional counseling from a dietician, for example. DSMES is led by a diabetes educator such as a registered nurse, pharmacist or dietician[6]. The ADA, ADCES and AND defines DSMES as, "the ongoing process of facilitating the knowledge, skills, and ability necessary for diabetes self-care, as well as activities that assist a person in implementing and sustaining the behaviors needed to manage his or her condition on an ongoing basis, beyond or outside of formal self-management training" (Beck et al., 2017, pg. 450). In Vermont, a small handful of hospital and outpatient services offer full DSMES services.

The CDC recommends that individuals with type 2 diabetes utilize an accredited or recognized DSME or DSMES program. Individual entities design their own system for delivering DSME or DSMES and recognition or accreditation is awarded through one of two national organizations: ADA for recognition or ADCES for accreditation. In the United States, DSME or DSMES programs are based on the 2017 National Standards for Diabetes Self-Management and Support (Beck et al., 2017). All accredited or recognized programs must meet ten standards, including, for example:

- **Internal Structure.** The provider(s) of DSME or DSMES services will define and document a mission statement and goals. The DSMES services are incorporated within the organization—large or small, or independently operated.
- **Stakeholder Input**. The provider(s) of DSME or DSMES services will seek ongoing input from valued stakeholders and experts to promote quality and enhance participant utilization.
- **Curriculum.** A curriculum reflecting current evidence and practice guidelines, with criteria for evaluating outcomes, will serve as the framework for the provision of DSME or DSMES. The needs of the individual participant will determine which elements of the curriculum are required. The curriculum is based on seven behaviors[7].

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[5]The A1C/hemoglobin A1C/glycated hemoglobin test measures the amount of glucose in the bloodstream and is used to diagnose and manage type 2 diabetes. The measure reflects a three-moth average blood glucose; a normal A1C level is below 5.7%.

[6] In 2017, ADA and ADCES combined the terms DSME and DSMP into DSMES to create a more holistic representation of recognized and accredited approaches. The terms used in this review reflect the terms that were standard at the time of publication.

[7] These seven behaviors are also referred to as the AADE7 Self-Care Behaviors.

The CDC recommends the Diabetes Self-Management Program (DSMP), also known as Better Choices Better Health (or Stanford Self-Management Program), which can be a foundation for recognized or accredited DSMES programming. The DSMP is a six-week program for adults with type 2 diabetes and any family member or peer support member who would like to accompany them. The program focuses on action planning, problem solving, emotional and behavior change. The DSMP is facilitated by two lay leaders, one of whom has diabetes. The model has been scaled throughout the United States and Vermont currently offers the DSMP statewide as part of a suite of free self-management programs available at www.myhealthyvt.org. Multiple studies with trials engaging over 700 people with diabetes have demonstrated the effectiveness of this program on reducing A1C and implementing lifestyle changes to improve quality of life for people with type 2 diabetes (Lorig et al., 2016; Lorig, 2009).

Components of Successful Programs

Programs that integrate intensive lifestyle interventions through diet, physical activity and education for a period of at least six months with multiple sessions yield positive outcomes for people with type 2 diabetes (Huang et al., 2015). For example, in a meta-analysis of 17 studies on lifestyle interventions for people with type 2 diabetes, the authors noted that diet, physical activity and education yielded positive outcomes on BMI, however diet and physical activity programs lead to a greater reduction in A1C values. Programs that focus specifically on nutrition lead to slightly better outcomes for cholesterol, blood glucose and blood pressure measures (Huang et al., 2015).

Similarly, a review of 129 components of intervention programs demonstrated greater effectiveness when programs targeted both diet and physical activity together, and even greater efficacy when programs mobilize social support and use established behavior-change techniques (Greaves et al., 2011). Additionally, programs that utilize “self-regulatory” behaviors such as goal-setting or self-monitoring lead to better outcomes (Greaves et al., 2011).

A dissenting meta-analysis of lifestyle interventions for type 2 diabetes management, however, notes that at the ten-year follow-up, there was no difference between the intervention group (lifestyle interventions) and the control group for all-cause mortality (Schellenberg et al., 2013). The authors note this observation should be acknowledged with caution as it was formed using only two long-term studies.

Supplementing Diabetes Self-Management Education

Several studies have added components to standard diabetes self-management programs, like the Diabetes Management Program, to sustain and improve clinical outcomes. For example, one study utilized a pharmacist who was a certified diabetes educator to reach out individually to participants by phone *after* their DSME program ended (n=41). The pharmacist educator tailored their program to individual needs and addressed any concerns from the original class. At both 3- and 6-month intervention follow-ups, the mean reduction in A1C was statistically significant compared to a physician’s usual care (Moore et al., 2019).

Diabetes self-management programs have led to better clinical outcomes when healthy cooking demonstrations are incorporated. The Healthy Teaching Kitchen was a behavior intervention (n=155) that provided veterans with healthy cooking and eating skills to promote healthy and economical food choices. The curriculum focused on hands-on experience and nutrition concepts.

Participants were able to keep recipes for future use. Researchers found that greater attendance in Healthy Teaching Kitchen classes resulted in greater reduction in A1C (Byrne et al., 2017).

Diabetes self-management programs may also benefit from the inclusion of mindful eating approaches. In 2012, a randomized control trial compared the outcomes of participants in a three-month intervention of Smart Choices, a standard DSME program, or a Mindfulness-Based Eating Awareness Training (MB-EAT) (n=52). The MB-EAT training included lessons on making conscious food choices, developing awareness of physical versus psychological hunger, satiety cues and eating healthfully in response to those cues. At the end of the trial the MB-EAT participants reported a significant decrease in energy intake and documented moderate weight loss. Both groups lowered A1C levels and improved glycemic control (Miller et al., 2012).

Diet-focused Programs

Several studies have documented success in self-managing type 2 diabetes by adopting a vegetarian or plant-based diet. These studies support earlier claims in this review that nutrition is a key element of type 2 diabetes management and should be a component of any diabetes management program. Yokoyama et al. (2014) performed a systematic review of vegetarian diets and glycemic control in type 2 diabetes and found that the consumption of vegetarian diets for at least four weeks is associated with a statistically significant mean reduction in A1C compared with omnivorous diets.

Similarly, the BROAD study tracked participants for twelve weeks with half of the participants receiving normal care while the intervention group attended twice per week meetings and followed a non-energy (calorie) restricted, whole food, plant-based diet (no exercise component) (n=49). At six months, mean BMI reduction was greater in the intervention (plant-based diet) group, as was quality of life, nutritional self-efficacy and self-esteem. Total medication usage also decreased in the intervention group and increased in the control group. Reduction in A1C values for this study and Yokoyama et al.'s (2014) review lead to an effect roughly half of the diabetes drug, metformin, though without the side effects (Wright, et al., 2017).

Modes of Delivery

The National Standards for DSMES advocate developing alternative modes of delivery that maintain the fidelity of the program, such as evidence-based skills and interventions, while also meeting participant needs. Consequently, several adaptations including telehealth, distance-learning, and pharmacist-led programs have emerged. Alternative platforms for hosting the DSMP that have led to positive clinical outcomes include programs that are entirely web-based, programs using mobile-based applications (for example, Social Diabetes[8]), telephone-based programs and hybrid in-person/mobile programs (Kim, et al., 2019; Lorig et al., 2016; Moore et al., 2019; Pirbaglou et al., 2018). Mobile platforms may aid in self-management by monitoring and tracking self-management tasks, sending tips, and in some cases, communicating health outcomes and values to providers.

A review of six studies using mobile-based applications for communication to patients with type 2 diabetes found that most communication functions included automated feedback from healthcare personnel. Two studies in the review demonstrated a statistically significant decline in A1C

[8] https://www.socialdiabetes.com/

compared to the control group, two studies reported no change between groups and the remaining two did not report A1C levels. The authors noted that the goal of the applications was to change behavior, yet few of the developers discussed behavior change theory (Holmen et al., 2017).

The Community Preventive Services Task Force (CPSTF), an independent panel of public health and prevention experts reviewed the evidence for mobile-based applications to support diabetes management. They found that compared with usual care, mobile phone applications implemented in healthcare settings reduced A1C levels by a median of .4%, which was statistically significant (Fatehi et al., 2017; Hou et al., 2016). When healthcare professionals provided feedback through the app, the mean reduction in A1c levels were greater. Also, patients 55 years or younger showed a greater reduction in A1C by using the app, compared to patients over 55. Younger participants demonstrated a 1.03% mean reduction in A1C. This could be due to the higher use of and comfort with mobile-based technology among younger users (Fatehi et al., 2017; Hou et al., 2016).

Type 2 diabetes self-management guidance led by personal health coaches is another promising strategy for self-management. Personal health coaches assist patients in developing self-management goals, support self-efficacy and monitor adherence to the program. A review of personal health coaching as a self-management strategy for people with type 2 diabetes using multiple methods led to a statistically significant decline in the patient's A1C levels. The methods included telephone, remote patient monitoring, mobile-based applications or in person coaching, Health coaches used a variety of behavior-change theories and strategies, including motivational interviewing, cognitive-behavioral therapy, self-efficacy and social-cognitive theory (Pirbaglou et al., 2018).

Similar to the Diabetes Self-Management Program, the YMCA Diabetes Control Program is led by lay health coaches. The YMCA Diabetes Control Program engaged 312 participants in weekly tracking of food intake and physical activity. After the 12-week intervention, average participant A1C declined from 8.4% to 7.6% (though weight was unchanged). Depressive symptoms declined from 32% to 16% and the frequency of glucose monitoring significantly increased (Mezuk et al. 2018).

A meta-analysis of peer-led programs involving 2,352 participants, including the Diabetes Self-Management Program, demonstrated that the peer led programs reduced average participant A1C levels by .57% compared to usual care (nurse, dietician, provider, etc.). For those with poor glycemic control, peer support is even more effective (Qi et al., 2015). In this context, peer support is defined as, "support from a person who possesses experiential knowledge of a specific behavior or stressor and similar characteristics as the target population" (Qi, 2005, pg 1).

Several studies have studied the impact of community health workers (CHWs) to improve type 2 diabetes self-management. CHWs are frontline public health workers who serve as a bridge between underserved communities and healthcare systems. They typically are from or have a unique understanding of the community served (C3 Project, 2016). Diabetes management activities undertaken by CHWs may include patient education, coaching, and social support, through direct or group-based interactions. The CPSTF states there is strong evidence for diabetes management interventions that engage community health workers. Their findings indicate that CHW interventions for type 2 diabetes management lead to improved blood glucose control and reduced healthcare utilization. Improvements in lipid control and health behavior outcomes, such as physical activity and nutrition, were also improved (Nelson, 2010; Valentine et al., 2014). CHWs have also been found to be a cost-effective way of implementing diabetes self-management

education (Jacob et al., 2019). This recommendation has led the CDC to incorporate CHW-specific strategies into state cooperative agreements to address diabetes and cardiovascular disease nationwide.

Group medical visits to address diabetes self-management strategies had mixed outcomes. Group medical appointments or visits (also known as shared medical appointments) are consecutive medical consultations provided by a provider in a group setting, where integrated medical care and patient education are delivered in a single session (Menon et al., 2017, pg 1). A review of 17 studies (including retrospective, prospective and randomized control trials) analyzing the impacts of group medical visits found variable clinical results. In some cases, there was no difference between the intervention and control groups for weight and A1C, and in one case there was no change in dietary or exercise habits for participants enrolled in shared medical appointments. Studies with large sample sizes and more frequent meetings were able to demonstrate some cases of positive outcomes for diabetes knowledge and A1C. Due to the heterogeneity of studies, the effectiveness of shared medical appointments warrants further research (Menon et al., 2017).

Emerging Programs

Several emerging programs that support type 2 diabetes management behaviors demonstrate success but have limited or nonexistent peer-reviewed research. Some of these applications boost existing program retention and participation; others offer an entirely new model of behavior change. Such examples include:

Sidekick Health is a web or mobile-based application that uses gaming principles and behavioral economics to augment diabetes prevention and management programs. Platform users demonstrate increased retention and engagement in the programs. In a pilot of 153 individuals who were randomly assigned to the standard program or the standard program with support with the Side Kick mobile application. Early results show that the enhanced program led to higher adherence rate of participation and a 2.97-fold increase in the achievement of a 5% weight loss goal (Oddsson, 2017).

Open Source Wellness is a “behavioral pharmacy” program designed to provide experiential fulfillment of behavioral prescriptions to eat better, move more, strengthen social support and manage stress. Participants with a chronic disease and unfavorable social determinants of health engage in a community empowerment approach. They move together (30 mins), cook a plant-based meal together (15 mins), eat the meal together while engaging in small-group coaching (60 mins) and engage in a stress management exercise such as mindful meditation (5 minutes). The aim is to practice and learn healthy behaviors that play a direct role in chronic disease prevention and management. An initial study of 49 patients demonstrated a statistically significant reduction in BMI, systolic blood pressure, as well as an increase in fruit and vegetable consumption and exercise. There was not a significant reduction in acute care utilization or diastolic blood pressure (Emmert-Aronson et al., 2019).

Conclusion

A plethora of accredited or recognized self-management programs for type 2 diabetes have demonstrated success in improving clinical outcomes. Diabetes is a complicated disease. People with diabetes require the knowledge and skills to observe changes in health and make appropriate changes to avoid the severe risks associated with type 2 diabetes. This review confirms that programs targeting physical activity, diet, social support and established behavior change techniques have the best chance of improving outcomes (Greaves et al., 2011).

This review utilized peer-reviewed research to identify programs or protocols that improved clinical outcomes of diabetes such as A1C and weight. This review is not exhaustive; many programs may exist that are not specifically marketed to people with diabetes, or lack peer-reviewed research but include components of successful programs (physical activity and diet). Holistic wellness programs that utilize proven behavior change techniques and have been tested on a community level will have the best chance of engaging Vermonters with type 2 diabetes.

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