Diabetes Prevention Programs

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Overview

This report reviews the long-term effects of combined diet and physical activity focused lifestyle interventions on individuals with prediabetes or at high risk for diabetes. The lifestyle interventions evaluated in this report either used the protocol from the diet and physical activity arm of the original Diabetes Prevention Program (DPP) randomized controlled trial (RCT) (i.e., DPP intervention), or used a similar lifestyle intervention to the original DPP RCT diet and physical activity protocol (i.e., DPP-like intervention). This report also includes an evaluation of the long-term effectiveness of variations in program delivery or population subgroups for DPP or DPP-like interventions.

Background

Clinical Overview

Prediabetes is a common condition and is defined by the Centers for Disease Control and Prevention (CDC) as having blood glucose levels above a normal range, but not high enough to be diagnosed with diabetes mellitus (CDC, 2017). Glycemic measures consistent with prediabetes are fasting plasma glucose of 100 to 125 mg/dL, glycated hemoglobin (HbA1c) of 5.7% to 6.4%, or plasma glucose after an oral glucose tolerance test of 140 to 199 mg/dL. Glycemic indices above these levels are diagnostic for type 2 diabetes (T2DM). In the U.S., diabetes is the seventh leading cause of death, and one in 10 U.S. adults has diabetes (CDC, 2017).

Individuals at risk for prediabetes include those who are overweight (body mass index ≥24 kg/m2); are at least 45 years old; have immediate family members with T2DM; are physically active less than three times per week; have given birth to a baby that weighed over nine pounds; have had gestational diabetes while pregnant; or are African American, Hispanic/Latino American, American Indian or Pacific Islanders, and Asian Americans (CDC, 2017).

The initial U.S. DPP study was conducted between 1996 and 2001 as a three-arm RCT that compared metformin to a lifestyle intervention (focused on diet and physical activity) or a placebo with the aim of preventing progression to T2DM in individuals at high risk for diabetes. In the original DPP study, the diet and physical activity intervention was provided at an individual level, so the costs per participant were relatively high (Li et al., 2015). The RCT demonstrated sustained weight loss and improved glycemic markers for the lifestyle intervention compared to metformin and a placebo (Nathan et al., 2015).

The original DPP diet and physical activity intervention aimed to help participants reduce their weight by at least 7%; incorporate a low-calorie, low-fat diet; and increase their physical activity to 150 minutes per week of moderate-intensity activity (e.g., brisk walking). The original DPP trial included a diverse cohort of participants: 45.3% identified as African American, Hispanic,

American Indian, or Asian. Case managers delivered the diet and physical activity intervention in person and individually to participants in 16 sessions.

International studies on diabetes prevention (i.e., DPP-like) with long-term follow-up include the Finnish Diabetes Prevention Study (DPS) (started in 1993, with seven years of published follow-up data) and the Da Qing study from China (started in 1986, with 23 years of published follow-up data). Both studies included a diet and physical activity intervention arm and had similar goals to the DPP study (achieving weight loss and increasing physical activity).

Implementation and translational diabetes prevention studies in the U.S. have adapted the diet and physical activity component of the original DPP study through a multitude of changes in an attempt to lower costs while sustaining the benefits observed in the original DPP study (Balk et al., 2015; Li et al., 2015). These adaptions include focusing on particular components of the intervention (e.g., diet or physical activity but not both, no specific goals for weight loss), fewer sessions, group sessions, web-based or online programs, or layperson-led programs (Balk et al., 2015; Li et al., 2015).

The National Diabetes Prevention Program (NDPP) is a partnership between the CDC and private organizations working to reduce diabetes in the U.S. (CDC, 2017). In addition to providing extensive resources, the NDPP certifies programs providing diet and physical activity interventions based on the U.S. DPP study protocol (CDC, 2017). Certified programs are led by a trained lifestyle coach; are delivered in a yearlong period, with at least 16 sessions in the first half of the program, and at least six sessions in the second half of the program; are conducted in person or online; and use a CDC-approved curriculum (CDC, 2016). Certified programs must be able to report on attendance, weight loss, and physical activity every 12 months (CDC, 2016). Full details for CDC recognition are available at: https://www.cdc.gov/diabetes/prevention/pdf/dprp-standards.pdf

Authors of studies usually report on the statistical significance of findings, but it is not always clear how relevant a statistically significant finding is in clinical practice. Although HbA1c targeting has recently been called into question (Bejan-Angoulvant et al., 2015; Lipska & Krumholz, 2017), previous reports have demonstrated that a 1.0% increase in HbA1c is associated with a 20% to 30% increase in cardiovascular events and mortality (Khaw et al., 2004). Weight loss recommendations from the American Heart Association, American College of Cardiology, and The Obesity Society note that a 3% to 5% reduction in weight is likely to result in clinically meaningful improvements in blood glucose (Jensen et al., 2013). Although surrogate outcomes (e.g., glycemic indices, lipid profiles) were frequently reported in early publications on the DPP and DPP-like interventions, the length of follow-up is now more than five years for many studies; so clinical endpoints (e.g., development of diabetes, cardiovascular events) are available across studies.

The DPP and DPP-like interventions are reimbursable through a temporary Current Procedural Terminology (CPT) code (i.e., 0403T), or through CPT code 99412. Table 1 outlines the billing code descriptions.

Table 1. Billing Codes for DPP and DPP-like Interventions

CPT Code*	Description
0403T	Preventive behavior change, intensive program of prevention of diabetes using a standardized diabetes prevention program curriculum, provided to individuals in a group setting, minimum 60 minutes per day
99412	Preventive medicine counseling and/or risk factor reduction intervention(s) provided to individuals in a group setting (separate procedure)

*Abbreviations. CPT: Current Procedural Terminology. Notes. * 0488T (Preventive behavior change, online/electronic structured intensive program for prevention of diabetes using a standardized diabetes prevention program curriculum, provided to an individual, per 30 days) will be available starting January 1, 2018.*

Key Findings

- A single systematic review with meta-analysis on combined diet and physical activity promotion programs to prevent T2DM, conducted for the Community Preventive Services Task Force, provided the effectiveness evidence for this report. Nearly half (41%) of all identified studies were based on the U.S. DPP intervention or Finnish DPS.
- Limitations identified by the authors of the systematic review include high loss to follow-up, poor descriptions of population or intervention, and data interpretation issues within the original studies. The authors also stated that only 30% of studies reported on diagnosis of diabetes as an outcome despite focusing on diabetes prevention. This systematic review included estimates from U.S. and non-U.S. studies, but reported results in such a way to identify U.S.-based studies.
- Across all studies, with up to 23 years of follow up (10 years for U.S. studies), participants in a combined diet and physical activity promotion program demonstrated a reduction of nearly 50% in their risk of diabetes and were more likely to return to a normoglycemic state even though improvements in the surrogate outcomes of weight loss and HbA1c were small.
- More intense diet and physical activity interventions demonstrated a trend of greater reduction for diabetes risk, return to normoglycemia, and weight loss than less intense programs. More intense program interventions could include more sessions; targets for weight loss, diet, or physical activity similar to the original study; a maintenance period; and in-person sessions.

- There is a lack of long-term evidence of effectiveness for many newer DPP adaptations. Systematic reviews providing insights into these adaptations (e.g., eHealth, cultural adaptations) are summarized in the Other Considerations section of this report but are not within sections describing the evidence of effectiveness.
- Available economic estimates have consistently found DPP to be a cost-effective but not cost-saving intervention.
- Guidelines from the American Diabetes Association (ADA) and the Community Preventive Services Task Force recommend the use of combined diet and physical activity interventions by health care systems, communities, and other implementers for the prevention of diabetes. The ADA recommends that third-party payers cover DPP given its cost-effectiveness and has stated that technology might be useful for delivery of DPP services.
- The Centers for Medicare & Medicaid Services (CMS) recently expanded the pilot Medicare Diabetes Prevention Program (MDPP) in 2016 and has begun to develop beneficiary and supplier criteria for calendar years (CYs) 2017 and 2018. The proposed rule changes for CY 2018 include a pay-for-performance payment structure with large incentives for MDPP suppliers to have beneficiaries achieve a 5% weight loss or greater.
- DPP and DPP-like interventions are widely covered and promoted by the private payers identified in the policy search performed for this report. None of the state Medicaid agencies reviewed in this report include explicit coverage policies governing DPP services in their provider manuals. Oregon and Massachusetts reimburse for group prevention counseling (CPT code 99412), but do not provide additional coverage criteria in their provider manuals. California Medicaid will begin covering DPP for its recipients starting in July 2018, and a small number of other state Medicaid programs have established pathways for DPP coverage in recent years (e.g., Minnesota, Montana).

Prevalence

Prediabetes affects 84 million adults (greater than one out of three individuals) in the U.S. and 4.5 million people in New York (CDC, 2017; New York State, 2017). According to the CDC (2017), 90% of individuals are unaware that they have prediabetes. Within three to five years, 15% to 30% of individuals with prediabetes will develop T2DM if no intervention is undertaken (CDC, 2017; New York State, 2017). In addition, individuals with prediabetes are at increased risk for stroke and heart disease (CDC, 2017; New York State, 2017).

PICO

The following PICO guides this evidence review.

Population: Adults (over 18 years of age) in the United States meeting either of these criteria:

- CDC-recognized eligibility criteria for the NDPP: overweight (BMI ≥24, ≥22 if Asian), AND no prior diagnosis of type 1 or type 2 diabetes, AND findings of prediabetes (any of the following):
  - HbA1c: 5.7% to 6.4%
  - Fasting plasma glucose: 100–125 mg/dL
  - Two-hour plasma glucose (after 75 g load): 140–199 mg/dL
  - History of gestational diabetes
- Additional risk factors for diabetes considered were delivery of a macrosomic infant (i.e., greater than 9 lbs.), family history of T2DM, race/ethnicity, polycystic ovarian syndrome, and use of medication that impairs glucose tolerance (e.g., glucocorticoids)

Interventions: DPP; similar interventions based on the DPP protocol focusing on diet and exercise promotion

Comparators: Usual care (e.g., standard diet and exercise education), with or without pharmacological interventions

Outcomes: Incidence of diabetes; quality of life; morbidity; mortality; adverse effects; cost or cost-effectiveness (all outcomes at ≥5 years after initiation of the intervention)

Methods

Center for Evidence-based Policy (Center) researchers searched Center core evidence and guidelines sources and Ovid MEDLINE for systematic reviews (with or without meta-analysis), and technology assessments on the DPP or DPP-like interventions published within the last 10 years and clinical practice guidelines published within the last five years. Search dates for individual studies were determined by the last search dates of the included systematic reviews. Center researchers additionally searched the Ovid MEDLINE database for individual studies published between January 1, 2015 and September 27, 2017. Center researchers evaluated the methodological quality of systematic reviews, individual studies, and clinical practice guidelines eligible for this report using the methodology described in detail in Appendix A and quality assessment tools included with the New York State Department of Health dossier process (available on pages 14 to 33 of the *Dossier Submission Form* located on the New York State Department of Health website). Center researchers also searched Medicare, several state Medicaid programs, and private payers for coverage policies on DPP services for the prevention of diabetes. See Appendix A for a full list of payers searched.

Center researchers excluded systematic reviews if all of the included studies were also summarized by a more comprehensive systematic review, a systematic review of a higher

methodological quality, and/or a more recently published systematic review. Patient-important outcomes that have relevance for New York State Department of Health, provided in the PICO section above, were predetermined in the topic scope development, and studies reporting other outcomes were not included. Exclusion criteria were selected prior to review of the studies, and study methods were assessed before review of outcomes to eliminate bias. Given the available follow-up data from the original DPP study, systematic reviews were excluded if they did not stratify data by U.S. studies, and systematic reviews and individual studies were excluded if all outcomes had follow-up periods of less than five years or reported only on surrogate outcomes (except for HbA1c and weight loss). See Appendix A for a full description of methods.

Center researchers summarized the evidence as reported by the included systematic reviews. Center researchers did not review the individual studies included in the systematic reviews unless necessary for clarification of information reported in the systematic reviews.

Evidence Review

Findings

The Ovid MEDLINE database search identified 458 studies. Center researchers identified 23 studies in the Center's core sources. Figure 1 outlines the number of articles identified by each search and the total number of studies included in this evidence synthesis. The search strategies and list of studies reviewed in full with reasons for exclusion are in Appendices A and B, respectively.

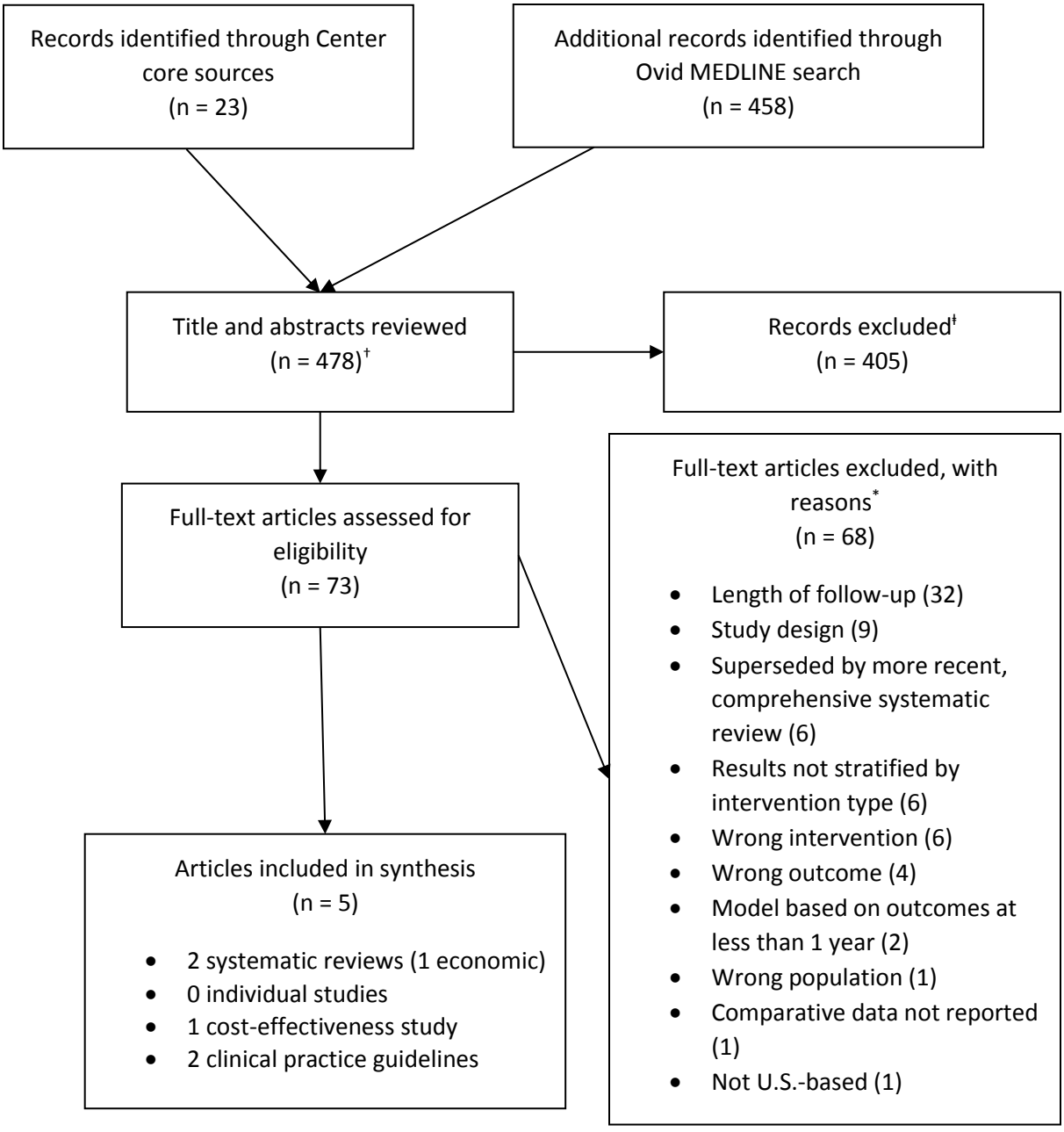
Overview of Evidence Sources

Center researchers identified one recent systematic review on effectiveness (Balk et al., 2015) that met full pre-specified inclusion criteria (notably outcomes of diabetes development, return to normoglycemia, and mortality at least five years post- intervention) and one systematic review on costs (Li et al., 2015) that met full pre-specified inclusion criteria. The included studies within the Balk et al. (2015) systematic review ranged from one to 23 years of follow-up and included 10 years of follow-up for the U.S.-based DPP study. Given the extensive follow-up data from the studies contained in the Balk et al. (2015) systematic review, individual studies published after Balk et al. (2015) systematic review's search date (February 2015) were only included if they provided at least five years of follow-up data.

In addition, Center researchers identified one individual study on cost and cost-effectiveness (Dall et al., 2015) that met inclusion criteria.

The Other Considerations section of this report covers systematic reviews that assessed modifications of the DPP, reported on different delivery routes (e.g., virtual or eHealth), or conducted subanalyses for racial or ethnic subgroups, but did not meet strict inclusion criteria, particularly at least five years of follow-up and relevant outcomes.

Figure 1. Search Results



† Some duplication of articles between Center core source search results and Ovid MEDLINE search results.

‡ Articles were excluded if they did not meet predetermined inclusion criteria (e.g., PICO, study design, English language, publication date) as described in Appendix A.

* Exclusion rationale provided in Appendix B.

Systematic Review of Effectiveness with Meta-analysis

Balk et al. (2015)

Balk et al. (2015) conducted a good methodological quality systematic review with meta-analysis on combined diet and physical activity promotion programs to prevent T2DM among individuals at high risk for diabetes. To be included in the systematic review, intervention programs needed to focus on diabetes prevention through both diet and increased physical activity and include at least two contact sessions (in-person or virtual) in a period of at least three months (Balk et al., 2015). Table 2 provides in depth details on eligible study designs, populations, interventions, and comparisons. The systematic review protocol specified U.S. and international studies on diabetes prevention with at least six months of follow-up (Balk et al., 2015). The authors identified 53 studies that reported outcomes up to 23 years post-intervention (total n = 23,607). The authors planned to investigate potential effect modifiers including program intensity, setting, and implementers. As available, the authors reported outcomes by study approach (e.g., DPP, DPS) (Balk et al., 2015).

This systematic review was undertaken to inform the Community Preventive Services Task Force guidance on diabetes prevention through diet and physical activity promotion programs. Table 3 summarizes the findings of this systematic review.

Systematic Review of Economic Evaluations

Li et al. (2015)

Li et al. (2015) conducted a good methodological quality systematic review of economic evaluations on cost, cost-effectiveness, and cost-benefit estimates of programs promoting diet and physical activity. The authors planned subgroup analyses to compare original studies of the DPP with programs conducted in real-word settings; group or individual intervention delivery; and type of study personnel delivering the program (Li et al., 2015). The authors considered two economic perspectives: health system (medical costs and benefits to health system considered); societal perspective (direct medical and indirect costs considered) (Li et al., 2015). The authors identified 28 studies, with all costs adjusted to 2013 U.S. dollars (Li et al., 2015).

This systematic review was undertaken to inform the Community Preventive Services Task Force guidance on diabetes prevention. Table 4 summarizes the economic evaluation findings.

Individual Economic Evaluations

Dall et al. (2015)

Dall et al. (2015) was a good methodological quality economic evaluation that used a Markov-based microsimulation model to estimate the long-term health and economic effects of a lifestyle intervention for the total U.S. population with prediabetes. The model used biometrics,

demographics, and HbA1c levels to simulate interactions with incidence of disease, adverse health events, and mortality in a 10-year follow-up period (Dall et al., 2015). Model scenarios based on findings from the DPP study were applied to a nationally reflective sample: the National Health and Nutrition Examination Survey (NHANES) 2003 to 2010 data set of 3,700 adults with prediabetes. The study also compared outcomes by different recommendations for screening for diabetes or prediabetes (2008 U.S. Preventive Services Task Force and ADA) (Dall et al., 2015).

Quality and Limitations

Center researchers assessed the methodological quality of the included systematic reviews and not the individual studies within them. The individual studies in the systematic reviews were assessed by the respective review authors. References to individual study quality are taken directly from the systematic reviews, and are not assessments made by Center researchers.

Center researchers rated the systematic review of effectiveness as having good methodological quality (Balk et al., 2015). The single systematic review on economic evaluations was also assessed as having good methodological quality (Li et al., 2015).

Center researchers assessed the methodological quality of the individual cost study not included in the systematic reviews using standard quality assessment methods (see Appendix A for details). Center researchers rated the single individual cost study as being of good methodological quality (Dall et al., 2015).

The Balk et al. (2015) systematic review reported on the outcome of new diabetes diagnosis (i.e., incident diabetes) in the follow-up period ranging from one to 23 years. Balk et al. (2015) noted that only 30% of studies, all focused on diabetes prevention, reported on incident diabetes in the follow-up period. In this same review, over half of studies reported attrition or loss to follow-up of greater than 20% (Balk et al., 2015). The review included U.S. studies (42%) and international studies (42% conducted in Western Europe/Australia). The report described the results from U.S.-based studies, but meta-analysis estimates that combine studies across regions might be less generalizable to the U.S. and to the Medicaid population.

Summary of the Evidence

Table 2 provides an overview of the methods of the Balk et al. (2015) systematic review. Table 3 provides the summary of findings by outcome as reported by the Balk et al. (2015) systematic review. Table 4 summarizes the economic evaluation findings from the Li et al. (2015) systematic review and the Dall et al. (2015) study.

Table 2. Methods of Included Systematic Review of Effectiveness

Citation, Study Details	Study Design, Population Inclusion and Exclusion	Intervention Inclusion and Exclusion	# of Studies (k) Population (n) *Individual Study Quality*	Outcomes, Subgroup Analyses, and Method Comments
Systematic Review with Meta-analysis				
Balk et al. (2015) Search Dates 1991 to February 27, 2015 SR undertaken as part of the Community Preventive Services Task Force guidance on diabetes prevention Methodological quality of the SR (assessed by Center researchers) Good	Eligible Study Designs RCTs, prospective comparative studies with at least 30 individuals in each group, prospective non-comparative studies with at least 100 individuals Eligible studies reported at least 6 months follow-up data No language restriction; not limited to only U.S. studies Population Included studies of adults or children at increased risk of T2DM including any of the following: • Prediabetes by glycemic indices or diabetes risk tools • Metabolic syndrome diagnosis • At risk of T2DM or CV disease Excluded studies of individuals with T2DM diagnosis, obesity alone, or only increased risk of CV disease without prediabetes risk explicitly stated	Included studies • Implied or explicit intent of program to prevent diabetes • ≥2 contact sessions (in-person or virtual) in at least 3 months • Physical activity and dietary components required • Any outpatient setting Excluded studies • Dietary arm limited to single food or supplements (e.g., fish oil) • Antidiabetic medication use Comparative group, if present, had to include usual care or lower-intensity diet and physical activity program	k = 53 studies (66 programs, 104 publications) total n = 23,607 *Methodological quality of included studies (assessed by the SR authors):* 33 good, 20 fair	Outcomes at 1 to 23 years (*see Table 3*) • Incident diabetes • Return to normoglycemia • Body weight • Glycemic measures • All–cause death • Diabetes-related clinical outcomes • Blood pressure • Lipid profile Subgroup analyses for incident diabetes and body weight Within and across studies by program type (e.g., DPP, DPS) for setting, number of sessions, duration, inclusion of weight-loss goal, individual or group diet or physical activity sessions, individual diet plans, or diet or physical activity counselors

Abbreviations. CV: cardiovascular disease; DPP: Diabetes Prevention Program; DPS: Finnish Diabetes Prevention Study; RCT: randomized controlled trial; SR: systematic review; T2DM: type 2 diabetes mellitus.

Table 3. Outcomes Reported by Included Systematic Review on Effectiveness

Outcome	Balk et al. (2015)	Comments
Incident Diabetes	Comparators *Diet and physical activity programs vs. usual care* Included Studies 16 studies (13 RCTs); see Figure 2 for forest plot from systematic review Follow-up 1 to 23 years Comparative Effectiveness Findings Summary RR, 0.59 (95% CI, 0.52 to 0.66); $I^2 = 0$; no heterogeneity *Across all studies* 0% (at 1 year) to 73% (at 23 years in China) of all program participants developed diabetes. Across all studies, program participants demonstrated decreased risk compared to control groups. *Median risk difference* -11% points (IQR, -16 to -5) *Subgroup Analyses* Funnel plot without different effects between larger and small studies (p = .27) "No significant differences [in incident diabetes] across studies were found by setting; number of sessions; program duration; whether the program was based on the DPP or DPS approach; or inclusion of a weight-loss goal; individual or group diet or exercise sessions; individually tailored diet plans; or diet or exercise counselors" (Balk et al., 2015, p. 441).	Usual care included no formal diet or exercise promotion program, or a program of lower-intensity. Limitations of included studies were poor descriptions of population or intervention, issues with data management or interpretation, high dropout rate (9 studies had dropout or loss to follow-up rates of >20%). New diagnosis of diabetes was only reported as an outcome in 30% of studies. Studies with more intense programs ranged in approach including more visits; goals for weight loss, diet, or exercise; maintenance phase; more intense diet or exercise plans; an exercise physiologist; individual sessions; or in-person session (vs. DVD).

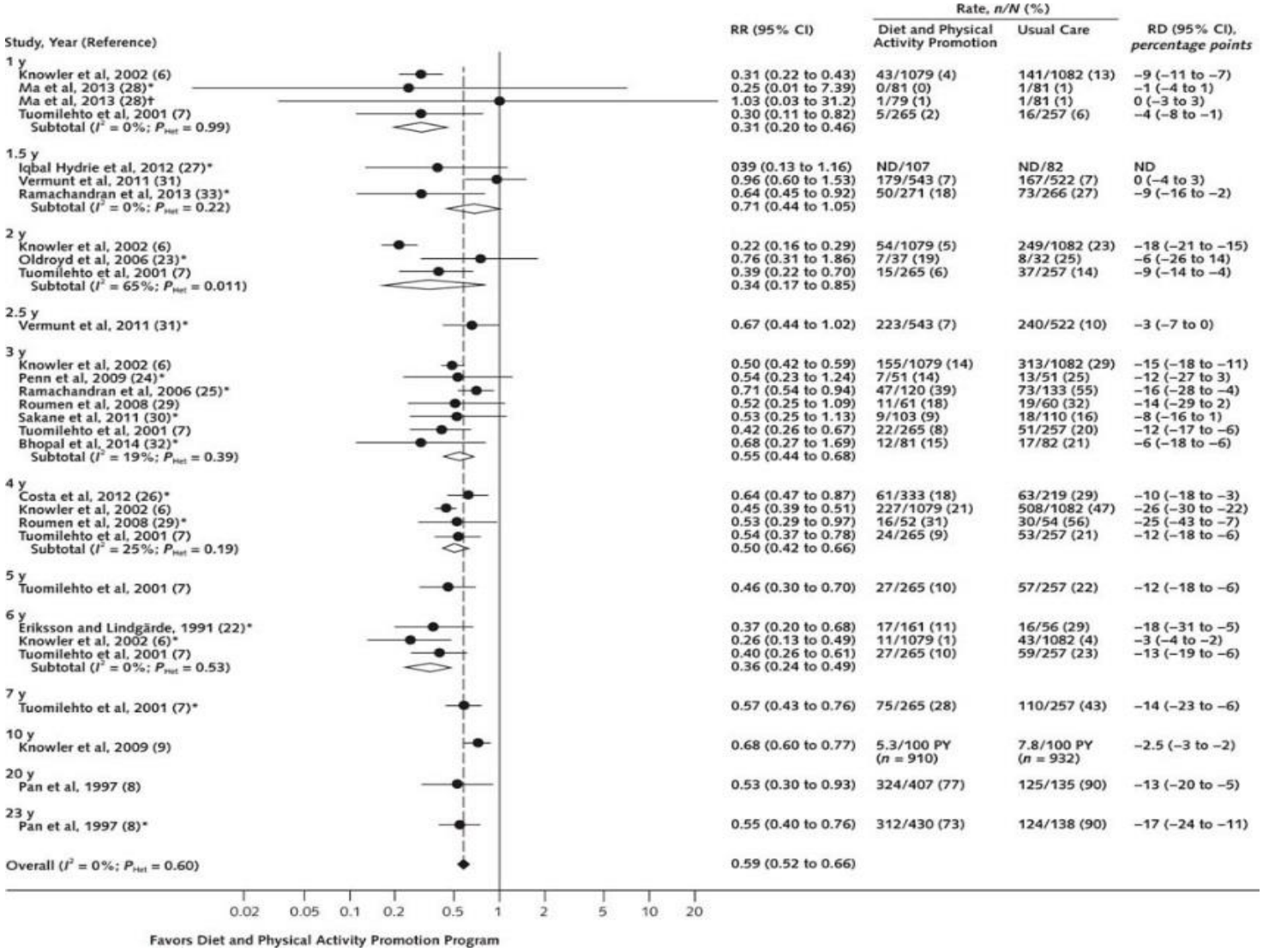
Outcome	Balk et al. (2015)	Comments
	Individually tailored exercise plans demonstrated small but not statistically significant improvement compared to non-individually tailored exercise plans (11 studies) RR, 0.53 (95% CI, 0.45 to 0.63) for interventions that included individually tailored plans vs. RR, 0.67 (95% CI, 0.55 to 0. 81) (p = .07) for interventions that did not include individually tailored exercise plans. *More intense programs demonstrated lower incidence of diabetes compared to lower intensity programs (*5 studies) Narrative results only. RR ranged from 0.28 to 0.56 compared to lower intensity programs; statistical significance demonstrated in 1 study.	
Return to Normoglycemia	Comparators *Diet and physical activity programs vs. usual care* Included Studies 6 studies (5 RCTs) Follow-up 2 to 6 years Comparative Effectiveness Findings Across all studies 20% (at 2 years) to 52% of program participants (at 6 years) regained normoglycemia *At 3 years (4 studies)* RR, 1.53 (95% CI, 1.26 to 1.71) *Median risk difference* 12% points (IQR, 6 to 14) No between-study subgroup differences found	Studies with more intense programs ranged in approach including more visits; goals for weight loss, diet, or exercise; maintenance phase; more intense diet or exercise plans; an exercise physiologist; individual sessions; or in-person session (vs. DVD).

Outcome	Balk et al. (2015)	Comments
	More intense programs demonstrated greater impact (3 studies, meta-analysis not performed) RR ranged from 1.58 to 2.11; 2 studies demonstrated statistical significance	
Body weight	Comparators *Diet and physical activity programs vs. usual care* Included Studies 24 studies Comparative Effectiveness Findings *Change in weight (range)* -0.2% to -10.5% *Net change across all studies* -2.2% (95% CI, -2.9% to -1.4%) with high heterogeneity (I^2 = 89%, p < .001) Subgroup Analyses Funnel plot without different effects between larger and smaller studies (p = .51) No study subgroup differences observed aside from: *DPP or DPS-based approach (net change)* -3.0% (95% CI, -4.1% to -1.9%) vs. -1.6% (95% CI, -2.5% to -0.6%) for other approaches *More intense programs* 6 of the 10 studies found statistically greater weight loss with more intense programs	Studies with more intense programs ranged in approach including more visits; goals for weight loss, diet, or exercise; maintenance phase; more intense diet or exercise plans; an exercise physiologist, individual sessions; or in-person session (vs. DVD).

Outcome	Balk et al. (2015)	Comments
All-cause mortality	Comparators *Diet and physical activity programs vs. usual care* Included Studies 3 studies, meta-analysis not performed, 2 studies outside the U.S. (China and Finland) No findings at five years or more post-intervention.	The U.S. DPP intervention provides this estimate at 3 years post intervention: Risk difference -0.6 per 1,000 person-years.
HbA1c	Comparators *Diet and physical activity programs vs. usual care* Included Studies 9 studies ranging from 0.5 to 10 years of follow-up *HbA1c net change (at longest follow-up)* -0.049% (95% CI, -0.087 to-0.008), no heterogeneity	
Cardiovascular death	*No data from U.S. studies for this outcome.*	
Diabetes Clinical Comorbidities	"Limited evidence suggested no significant effects…including cardiovascular events, nephropathy, and neuropathy, often due to lack of power" (Balk et al., 2015, p. 443).	Study's power to detect a change in these clinical outcomes limited by number of individuals planned for enrollment.
Quality of life	*Not reported*	

Abbreviations. CI: confidence interval; DPP: Diabetes Prevention Program; DPS: Finnish Diabetes Prevention Study; DVD: digital video disc; IQR: interquartile range; RCT: randomized controlled trial; RR: risk ratio.

Figure 2. Forest Plot of Incident-Diabetes by Year of Follow-up



Source. Balk et al. (2015, p. 411)

Table 4. Economic Outcomes

Study Citation, Study Designs	Included Studies	Outcomes	Comments
Systematic Reviews of Economic Evaluations			
Li et al. (2015) Search Dates January 1985 to April 7, 2015 Eligible Studies Cost, cost-benefit ratio, ICER Perspective Health system, societal Methodological Quality of the SR (assessed by Center researchers): Good	k = 28 studies 2013 U.S. dollars Inclusion criteria: must include actual program implementation cost data *The authors of this systematic review did not formally assess the quality of the included studies.*	*ICER* Cost-effectiveness estimates (22 studies): cost per QALY (17), cost per LYG (6), cost per DALY averted (2). Majority of models predicated on 10-year consequences Median ICER overall: $13,761 per QALY saved (IQI, $3,067 to $21,899) Study authors stated that "of the 16 studies that included cost per QALY saved from the health system perspective, all but 1 reported ICERs below the cost-effectiveness threshold of $50,000 per QALY saved. Three studies reported cost-savings" (Li et al., 2015, p. 455). *Median ICER for individual vs. group intervention delivery* $15,846 (IQI, $7,980 to $72,723) vs. $1,819 (IQI, -$5,027 to $16,443) per QALY *Median ICER per LYG (6 studies)* $2,684 (IQI, -$2,444 to $17,410) Study authors concluded "that diet and physical activity promotion programs are cost-effective and involve an efficient use of health care resources" (Li et al., 2015, p. 456).	ICER measured as dollars per life-year gained, QALY saved, or disability-adjusted life-year averted. Of 22 studies reporting cost-effectiveness, 8 were U.S. based. Authors noted that no studies included costs of recruitment to the DPP or DPP-like intervention; only two studies evaluated costs and cost-effectiveness of primary care or community-implemented programs. No cost-benefit studies identified. Lack of studies on costs related to programs delivered by laypersons compared to health professionals.

Study Citation, Study Designs	Included Studies	Outcomes	Comments
Individual Economic Evaluations			
Dall et al. (2015)	Markov model using DPP findings at 10 years applied to NHANES prediabetes population	*Over 10 years, entire U.S. prediabetes population* 11.4 million cases of diabetes averted $539 billion in medical costs avoided $992 billion in nonmedical benefits mostly through employment $30 million QALY gained	Evaluation uses outcomes from original DPP study at 10 years, which included individual-level diet and exercise counseling at a cost of $3,770 (2013 dollars). Formal cost-effectiveness estimation was outside the scope of this study.

Abbreviations. CDC: Centers for Disease Control and Prevention; DALY: disability-adjusted life-year; DPP: diabetes prevention program; HbA1c: glycated hemoglobin; ICER: incremental cost-effectiveness ratio; IQI: interquartile interval; LYG: life-year gained; NHANES: National Health and Nutrition Examination Survey; QALY: quality-adjusted life-year.

Effectiveness Outcome #1: Incident Diabetes

Systematic Reviews

Balk et al. (2015), a good methodological quality systematic review, included 16 studies that reported on the development of T2DM during the follow-up period. The authors reported reduced risk of incident diabetes across all follow-up time periods with a relative risk (RR) of 0.59 (95% CI, 0.52 to 0.66) (Balk et al., 2015). See Figure 2 for the forest plot with estimates grouped by duration of follow-up. The authors conducted additional individual analyses to assess if the estimate of effect varied by a specific characteristic (e.g. setting, number of sessions, duration).

Variations in Effectiveness

Older individuals experienced a greater risk reduction in the DPP intervention and DPP-like studies. Statistically significant improvements were observed across all age groups in the DPS study. Differences by sex were not observed in the DPP intervention or DPS approach (Balk et al., 2015). In the DPP intervention, there were no differences in the estimate of effect by racial or ethnic categories (Balk et al., 2015).

Balk et al. (2015) reported no significant differences in estimate of effect on incident diabetes cases in the following individual analyses: terms of setting, number of sessions, program duration, DPP or DPS approach, inclusion of specific weight-loss goal, individual or group diet or exercise sessions, individually tailored diet plans, or use of diet or exercise counselors.

Balk et al. (2015) reported a small improvement for individually tailored exercise plans (RR, 0.53; 95% CI, 0.45 to 0.63) versus programs without individual exercise tailoring (RR, 0.67; 95% CI, 0.55 to 0.81) that was not statistically significant (p = .070 for interaction).

Balk et al. (2015) performed pre-specified comparisons to evaluate for effect modification by intensity of program in studies directly comparing more and less intense programs. More intense programs might have some or all of the following attributes: more sessions; specific weight-loss, diet, or exercise goals; a maintenance phase; more intense diet or exercise plans; an exercise physiologist; individual contact sessions; or in-person sessions. In the narrative review, the authors reported lower diabetes incidence for more intense programs (RR, 0.28 to 0.56), but results only reached statistical significance in one of the five studies of greater intensity reporting this outcome (this single study also had the highest enrollment numbers [n = 641] compared with the other four studies [n range, 48 to 458]) (Balk et al., 2015).

Effectiveness Outcome #2: Return to Normoglycemia

Systematic Reviews

The proportion of patients returning to normoglycemia at follow-up was reported by a single systematic review of good methodological quality (Balk et al., 2015). The authors reported that

return to normoglycemia at three years of follow-up was greater for program participants than for those in control groups (RR, 1.53; 95% CI, 1.26 to 1.71) (Balk et al., 2015). The authors again conducted additional individual analyses to assess if the estimate of effect varied by a specific characteristic (e.g. setting, number of sessions, duration).

Variation in Effectiveness

Balk et al. (2015) reported no significant differences in estimate of effect on return to normoglycemia in terms of setting, number of sessions, program duration, DPP or DPS approach, inclusion of specific weight-loss goal, individual or group diet or exercise sessions, individually tailored diet or exercise plans, or diet or exercise counselors.

Balk et al. (2015) performed pre-specified comparisons to evaluate for effect modification by intensity of program in studies directly comparing more and less intense programs. (See Effectiveness Outcome #1 for description of intensity differences). In the narrative review, the authors reported greater point estimates for higher intensity programs (RR range from 1.58 to 2.11) across three studies, of which two demonstrated statistical significance (Balk et al., 2015).

Effectiveness Outcome #3: Body Weight

Systematic Reviews

Balk et al. (2015) reported on body weight change and included studies with up to nine years of follow up. Across all included studies, the overall net change in weight percentage was 2.19% less (95% CI, 2.94 to 1.45% lower than baseline). This estimate demonstrated heterogeneity (I^2 = 89%) (Balk et al., 2015).

Variation in Effectiveness

Balk et al. (2015) reported greater weight loss for DPP- or DPS-based approaches: net weight change was 3.0% lower than baseline (95% CI, 4.1% to 1.9%) versus 1.6% lower than baseline (95% CI, 2.5% to 0.6%) for other approaches. More intense programs demonstrated greater effect in six of the 10 studies reporting this outcome (narrative report, no details provided) (Balk et al., 2015). No other subgroup differences were noted (Balk et al., 2015).

Effectiveness Outcome #4: All-Cause Mortality

Systematic Reviews

A single good methodological quality systematic review reported on all-cause mortality (Balk et al., 2015). Findings from the sole U.S. study demonstrated a risk difference at three years (-0.6 per 1,000 person-years) that was not statistically significant (p-value not reported) (Balk et al., 2015).

Effectiveness Outcome #5: HbA1c

Systematic Reviews

The Balk et al. (2015) systematic review reported on change in HbA1c or other glycemic indices (Balk et al., 2015). The nine studies included in Balk et al. (2015) demonstrated a small change in HbA1c at the longest included follow-up period included in each study (ranging from 0.5 to 10 years) (-0.049%; 95% CI, -0.087 to -0.008).

Variation in Effectiveness

The Balk et al. (2015) systematic review did not evaluate the effect of variations on the effectiveness in HbA1c change.

Effectiveness Outcome #6: Quality of Life

Systematic Reviews

The Balk et al. (2015) systematic review did not include quality of life as an outcome.

Effectiveness Outcome #7: Cardiovascular Death

Systematic Reviews

The Balk et al. (2015) systematic review did not identify any U.S.-based estimates of cardiovascular death.

Effectiveness Outcome #8: Diabetes Clinical Comorbidities

Systematic Reviews

The Balk et al. (2015) systematic review provided a narrative summary of diabetes-related clinical comorbidities (e.g., nephropathy, neuropathy, retinal disease), which stated that there is "limited evidence" suggesting no significant effect because of lack of power in the included studies (p. 443).

Costs and Cost-Effectiveness Outcomes

Systematic Reviews

A single systematic review (Li et al., 2015) found that DPP or DPP-like diet and exercise promotion interventions are consistently cost-effective at the $50,000 per quality-adjusted-life-year (QALY) threshold. Although three of the 28 studies found the intervention to be cost saving, whereas the others did not, the authors noted that only one U.S. study observed this finding (Li et al., 2015). In that study, the DPP was delivered in a group format, and cost savings were observed 11 years after the intervention, demonstrating long-term but not short-term cost savings (specific short term costs not provided) (Li et al., 2015). The authors stated that few health interventions are cost saving and insurance typically covers services with greater cost per QALY (i.e., incremental cost effectiveness ratio) than observed in their review (Li et al., 2015).

Individual Studies

One individual study (Dall et al., 2015) estimated the costs and potential savings for Medicare using simulation models based on outcomes from the original DPP RCT. In the models, when the findings of the original DPP RCT are applied to the Medicare population, the potential clinical and economic effects are large including 11.4 million cases of diabetes averted, $539 billion in medical costs avoided, $992 billion in nonmedical benefits mostly through higher employment, and $30 million QALY gained (Dall et al., 2015).

Other Considerations

There is a lack of long-term evidence of effectiveness for many newer adaptations of the DPP. Systematic reviews providing insights into these adaptations (e.g., eHealth, cultural adaptations) are summarized below. Because these studies did not meet strict inclusion criteria, they were not formally assessed for methodological quality and are only provided to add context for possible future publications in this field.

Community-based Interventions

In their 2016 systematic review with meta-analysis, Mudaliar et al. (2016) reviewed the effectiveness of U.S. community-based adaptations of the DPP. Adaptations of the original DPP protocol included changing the number of core sessions; offering group sessions; changing guidance from a case manager to a dietician, health educator, exercise physiologist, or behavioral psychologist; or removing the maintenance component (Mudaliar et al., 2016). The authors identified 44 studies involving 8,995 individuals that had a maximum of three years of follow-up, however, the majority of studies had one year of follow-up (Mudaliar et al., 2016). The authors observed that the majority of the studies used pre-post comparisons and were nonrandomized translational or implementation studies with high attrition (23.5% across all studies) (Mudaliar et al., 2016).

Pooled outcomes across all studies, not stratified by duration, indicated a mean weight loss of 3.77 kg (95% CI, 4.55 to 2.99 lower than baseline) (Mudaliar et al., 2016). Unfortunately, weight-loss data were not provided as percentage weight reduction from baseline to allow comparison to the Balk et al. (2015) study. The authors observed that this mean weight loss was less than the original DPP (which observed 6.8 kg loss at 12 months) (Mudaliar et al., 2016). Changes in HbA1c were also smaller than those observed in the earlier studies (pre-post change -0.21% [95% CI, -0.29 to -0.13, I^2 = 82.72%]) (Mudaliar et al., 2016).

eHealth Approaches

In their 2017 systematic review, Joiner, Nam, and Whittemore (2017) summarized eHealth approaches to delivering DPP interventions. These approaches included web-based applications, social media, games, DVDs, mobile applications, and computer-based telehealth applications

(including interactive voice-response or video conferencing). The authors noted that compared to the original DPP cohort, eHealth studies tended to enroll a greater number of white individuals and participants had a higher education level (Joiner et al., 2017). Individuals in the eHealth interventions demonstrated a smaller change in mean percentage weight loss compared to individuals receiving behavioral support from an in-person counselor; -3.34% compared to -4.65% at 15 months after the intervention, with moderate heterogeneity observed.

Cultural Adaptations

In their subanalysis of a 2013 systematic review, Neamah, Sebert Kuhlmann, and Tabak (2016) categorized modifications to DPPs in terms of cultural adaption approaches and translational strategies. Outcomes were reported to 12 months and because Balk et al.'s (2015) subanalyses on similar translational approaches had longer follow-up periods, this review was excluded. However, Neamah et al. (2016) provided greater detail about the adaptations, which included modifications to the frequency or timeline of classes, the class format (individual vs. group), the implementation setting, and the staff members participating in implementation. Cultural adaptations included content modifications, culturally appropriate recipes, and cultural ideas related to diabetes risk. The authors found that programs with fewer modifications (at least two modifications) reported greater BMI and weight reductions, but that these results were only statistically significant for weight at 12 months. Additionally, programs with a maintenance phase showed statistically significant weight loss at 12 months.

McCurley, Gutierrez, and Gallo (2017) conducted a systematic review on cultural adaptations specifically for the Hispanic population. Examples included targeting, tailoring, or adapting (e.g., Hispanic food recipes, Spanish language delivery, literacy modification). The review identified 12 studies, of which five were RCTs, six were single group pre-post studies, and one study was a quasi-experimental community comparison (McCurley et al., 2017). Of the 12 studies, four included only women, and another four included ≥70% women (McCurley et al., 2017). Outcomes were presented at follow-up periods of 12 months or less, and thus this study was excluded from this report. The authors noted wide variation across studies in regard to modifications and interventions, with high loss to follow-up (McCurley et al., 2017). McCurley et al. (2017) reported weight loss in absolute amounts (i.e., pounds), not the percentage lost from baseline, limiting the ability to make comparisons to studies formally included in this report. Three studies found a statistically significant reduction in HbA1c in the intervention group compared to a control group; the authors noted small effect sizes for this reduction (effect size range 0.04 to 0.67) (McCurley et al., 2017). Changes in weight were also small (effect size 0.01 to 0.32) in the five studies making comparisons to a control group (McCurley et al., 2017).

Clinical Practice Guidelines

Center researchers identified two U.S.-based clinical practice guidelines that address the use of DPP or DPP-like interventions for the treatment of prediabetes (ADA, 2017; Pronk & Remington, 2015). Center researchers rated one guideline as having good methodological quality (Pronk & Remington, 2015) and one as having poor methodological quality (ADA, 2017).

Guidelines from the ADA and the Community Preventive Services Task Force strongly recommend the use of lifestyle interventions for individuals at increased risk for diabetes (ADA, 2017; Pronk & Remington, 2015). The recommendation from the Community Preventive Services Task Force is broad, recommending the use of "combined diet and physical activity promotion programs" (Pronk & Remington, 2015, p. 465); the ADA specifically recommended the use of "lifestyle intervention program[s] modeled on the [DPP]" (ADA, 2017, p. S44). In addition, the ADA recommended that third-party payers cover DPP-like lifestyle interventions as a cost-effective diabetes prevention model, and stated that the use of technology to assist in delivery of such interventions could be useful (American Diabetes Association, 2017). Table 5 describes the recommendations from each organization.

Although the ADA (2017) guideline authors stated that a systematic literature review was conducted for the development of the guideline, the authors did not provide any details of the literature search, how studies were selected for inclusion, characteristics of included studies, or the methodological quality of included studies. Although the recommendations from the guideline are clearly linked to an evidence rating, the lack of detail about the underlying evidence review makes it difficult to discern how the guideline authors developed recommendations. In contrast, the guideline from the Community Preventive Services Task Force (Pronk & Remington, 2015) was clearly developed based on the Balk et al. (2015) and Li et al. (2015) reviews described above.

Table 5. Clinical Practice Guidelines' Recommendations for DPP or DPP-like Interventions

Citation, Methodological Quality‡	Recommendation (Evidence Rating*)
ADA (2017) Poor	"Patients with prediabetes should be referred to an intensive behavioral lifestyle intervention program modeled on the Diabetes Prevention Program to achieve and maintain 7% loss of initial body weight and increase moderate intensity physical activity (such as brisk walking) to at least 150 min/week (Evidence Rating: A). Technology-assisted tools including Internet-based social networks, distance learning, DVD-based content, and mobile applications may be useful elements of effective lifestyle modification to prevent diabetes (Evidence Rating: B).

	Given the cost-effectiveness of diabetes prevention, such intervention programs should be covered by third-party payers (Evidence Rating: B)" (ADA, 2017, p. S44).
Pronk and Remington (2015) Good	"The [Community Preventive Services] Task Force recommends the use of combined diet and physical activity promotion programs by health care systems, communities, and other implementers to provide counseling and support to clients identified as being at increased risk for type 2 diabetes. Economic evidence indicates that these programs are cost-effective" (Pronk & Remington, 2015, p. 465).

*Notes. ǂ Determined by Center researchers. *Determined by guideline authors. Evidence rating descriptions: A indicates clear evidence from well-conducted, generalizable RCTs that are adequately powered; compelling nonexperimental evidence; or supportive evidence from well-conducted RCTs that are adequately powered. B indicates supportive evidence from well-conducted cohort studies. C indicates supportive evidence from poorly controlled or uncontrolled studies. [No D rating.] E indicates expert consensus or clinical experience (ADA, 2017, p. S2).*

Payer Policies

Center researchers searched for policies on DPP coverage from Aetna, Anthem, Blue Shield of Northeastern New York, Capital District Physicians' Health Plan, CMS, Cigna, EmblemHealth, Empire Blue Cross Blue Shield (BCBS), Excellus BCBS, Tufts Health Plan, UnitedHealthcare, and nine state Medicaid programs (CA, FL, MA, NJ, NY, OR, PA, TX, and WA).

Medicare

The Medicare Diabetes Prevention Program (MDPP) started as a pilot program funded under the CMS Health Care Innovation awards and was expanded in 2017 to create additional access to diabetes prevention services for Medicare beneficiaries (CMS, 2017a). The MDPP is designed to prevent T2DM and has a goal of 5% average weight loss for participants. The program uses a CDC-approved curriculum that is based on the DPP intervention (CMS, 2017a).

The expanded MDPP model incorporates new payment structures, supplier enrollment requirements, and supplier compliance standards, which are outlined in the recent release of the CY 2018 proposed rule (CMS, 2017b). The 2018 proposed rule builds on the previous year's criteria, including the following (CMS, 2017b):

- Development of diabetes while enrolled in the MDPP would not prevent an individual from participating in the program.
- Ongoing maintenance sessions are limited to two years; the total MDPP services period is limited to three years.

- Beneficiaries are required to attend three sessions and maintain 5% weight loss at least once in the previous maintenance session to be eligible for continued program participation.
- Payment structure links performance goals with payment (see Table 6).
- Beneficiaries who change MDPP providers receive a one-time $25 supplier bridge payment.
- MDPP suppliers are required to achieve CMS interim preliminary recognition, CDC preliminary recognition, or CDC full recognition.
- MDPP supplier standards must be established to mitigate fraud, waste, and abuse and to ensure fidelity to the MDPP expanded model.
- MDPP suppliers revalidating their enrollment will be screened at the moderate-risk level (i.e., finger printing and background checks not required, as with high-risk-level classification for newly enrolling MDPP suppliers). Revalidation would be required every three years.
- MDPP suppliers can choose to offer in-kind patient engagement incentives for beneficiaries to participate in MDPP.
- In-person MDPP suppliers will be allowed to offer a limited number of virtual make-up sessions for beneficiaries who miss a session. CMS will develop a separate virtual MDPP model.

Center researchers did not identify any Medicare national or local coverage determinations for DPP or DPP-like interventions.

Table 6. MDPP CY 2018 Proposed Payment Structure

Performance Goal	Proposed Performance Payment per Beneficiary (with ≥5% weight loss)	Proposed Performance Payment per Beneficiary (without ≥5% weight loss)
First core session attended	$25	
4 total core sessions attended	$30	
9 total core sessions attended	$50	
3 sessions attended in first core maintenance session interval (months 7 to 9 of the MDPP core services period)	$60*	$10
3 sessions attended in second core maintenance session interval (months 10 to 12 of the MDPP core services period)	$60*	$10
5% weight loss achieved	$160	$0

9% weight loss achieved	$25	$0
3 sessions attended in ongoing maintenance session interval (8 consecutive 3-month intervals over months 13 to 36 of the MDPP ongoing services period)	$50* for each 3-month maintenance session, maximum payment amount: $400	$0
Total performance payment	$810	$125

*Abbreviations. MDPP: Medicare Diabetes Prevention Program. Notes. ± The core services period is the first 12 month of services. There are 16 core sessions that are offered at least a week apart during Months 1 through 6. Core maintenance sessions, available to an individual after they have completed the initial 16 core sessions, are offered once a month during Months 7 through 12. * The required minimum weight loss from baseline must be achieved or maintained during the core maintenance session 3-month interval or maintained during the ongoing maintenance session 3-month interval. Source. Adapted from CMS (2017b).*

Private Payers

All of the private payers searched, with the exception of Empire BCBS (no policy or program identified), offer DPP-like services to their members. Some payers, such as Capital District Physicians' Health Plan, Excellus BCBS, and UnitedHealthcare have established criteria that members must meet to be eligible for DPP participation.

State Medicaid Agencies

Center researchers did not identify any coverage policies or DPP services offered by the nine state Medicaid agencies searched. Two states agencies (Massachusetts, Oregon) reimburse for CPT code 99412, but do not specify coverage criteria. The remaining states either do not list the applicable CPT codes or explicitly do not cover CPT codes 0403Tand 99412. However, some states offer DPP interventions outside of state Medicaid agencies. Washington, for example, offers a DPP intervention to all public employees who are at least 18 years old, have a BMI greater than or equal to 25 (or greater than or equal to 22 if Asian), have no previous diagnosis of type 1 or type 2 diabetes, and either score a nine or higher on the diabetes prevention risk quiz, have been previously diagnosed with gestational diabetes, or have a blood sugar test result in the prediabetes range within the last year (Washington State Health Care Authority, 2017).

Although none of the state Medicaid agency provider manuals searched for this report include a DPP coverage policy (see Table 7), the DPP is starting to gain state coverage. The National Association of Chronic Disease Directors (2017) recently released an online toolkit as a resource for payers interested in implementing the NDPP from the CDC. The toolkit authors noted that a few state Medicaid agencies had successfully set up reimbursement mechanisms for the NDPP

(National Association of Chronic Disease Directors, 2017). Montana Medicaid reimburses $21.88 per weekly class in the first six months ($350.00 for the 16-session class) and $25 per monthly class for the second six months ($150 for completion of the six classes) (National Association of Chronic Disease Directors, 2017). Minnesota Medicaid reimburses $13.62 for each class in a 12-month period ($300 for 22 classes) (National Association of Chronic Disease Directors, 2017).

Table 7 provides a comparison of identified coverage criteria for all payers searched.

Table 7. Payer Coverage of DPP or DPP-like Interventions

Payer	Coverage Criteria
Medicare	
See MDPP description above for program description and proposed value-based payment structure. CPT 0403T is contractor priced. CPT 99412 not included in physician fee schedule.	
Private Payers	
Aetna *(last review 7/2017)*	CPT 0403T is covered.
Anthem	Anthem contracts with Solera to provide access to virtual and in-person community health and wellness programs (Anthem, 2016).
Blue Shield of Northeastern New York	Wellness classes and seminars provided to members free of charge (includes diabetes classes). Members allowed two free fitness-related classes/seminars per year, and one free non-fitness-related class/seminar per topic each year (BlueShield of Northeastern New York, 2017).
Capital District Physicians' Health Plan	Members reimbursed up to $500 per subscriber (family), per plan year, upon completion of a diabetes prevention program. Program eligibility criteria include: • Prediabetes diagnosis or history of gestational diabetes • At least 18 years old • BMI ≥24 or BMI ≥22 if Asian • No previous diagnosis of type 1 or 2 diabetes • Cannot be pregnant (Capital District Physicians' Health Plan, 2017)
Cigna *(last review 1/2017)*	Coverage of 0403T allowed with any diagnosis. The 0403T code is listed under preventive care screenings and interventions associated with "abnormal blood glucose and type 2 diabetes screening and counseling: Adults, age 40-70 who are overweight or obese."
EmblemHealth	DPP program covered. EmblemHealth was the first insurer in the nation to receive full recognition from the CDC for its DPP (EmblemHealth, 2016).
Empire BCBS	*No information identified.*

Payer	Coverage Criteria
Excellus BCBS (*last review 8/2017*)	Intensive/high-intensity lifestyle counseling programs considered medically appropriate when the following criteria are met: • The patient has a known coronary artery disease or diabetes; OR • The patient has a BMI ≥25 kg/m^2 and at least one coronary artery disease risk factor, such as: ▪ Prediabetes ▪ Hypertension ▪ Hyperlipidemia, dyslipidemia (*see policy for definition*) ▪ Metabolic syndrome (*see policy for definition*) ▪ Is a current smoker; AND ▪ The patient is able to tolerate a healthy diet and does not require a controlled/specialized diet (e.g., kidney disease); and ▪ The patient is able to tolerate physical activity and does not have specific physical activity limitations for health reasons (e.g., cardiac or physiotherapy rehabilitation patients); and ▪ The patient is competent and alert and exhibits motivation and a readiness for change in their lifestyle. Readiness for change is measured utilizing standard instruments.
Tufts Health Plan (*effective 9/2017*)	0403T and 99412 are covered for adults with hyperlipidemia and other risk factors for cardiovascular disease and diet-related chronic illness.
UnitedHealthcare	UnitedHealthcare partners with the YMCA to deliver the UnitedHealthcare DPP. The UnitedHealthcare DPP is also available online. The program is available to individuals with a BMI ≥25 and who are prediabetic or at risk for developing diabetes based on a quiz (*quiz not publicly available*) (UnitedHealthcare, 2016).
State Medicaid	
California	*No coverage policy or program identified. However, the California legislature recently approved funding for California Medicaid (Medi-Cal) recipients to enroll in diabetes prevention programs starting in July 2018. Program participants will have to meet the following criteria to enroll in a diabetes prevention program (Welfare and Institutions Code, Division 9, Part 3, Chapter 7, Article 4.11):* • *18 years or older* • *BMI ≥25, or ≥23 if self-identified as Asian* • *One of the following within the 12-month period prior to the provider recommendation [of DPP participation]* o *HbA1c 5.7% to 6.4%* o *Fasting plasma glucose of 110 to 125 mg/dL* o *Two-hour plasma glucose of 140 to 199 mg/dL* • *No previous diagnosis of type 1 or type 2 diabetes, with the exception of gestational diabetes*

Payer	Coverage Criteria
	• *No end-stage renal disease* *Providers offering DPP will be required to use a CDC-approved lifestyle change curriculum that emphasizes self-monitoring, self-efficacy, and problem solving; provides for coach feedback; include participant materials to support program goals; and requires participant weigh-ins to track and achieve program goals.* Reimbursement: *0403T, 99412 not listed in fee schedule.*
Florida	*No coverage policy or program identified.* Reimbursement: *0403T, 99412 not listed in fee schedule.*
Massachusetts	*No coverage policy or program identified.* Reimbursement: 99412: $12.42 (non-facility), $5.68 (facility). *0403T is not listed in fee schedule.*
New Jersey	*No coverage policy or program identified.* Reimbursement: *0403T, 99412 not listed in fee schedule.*
New York	*No coverage policy or program identified.* Reimbursement: *0403T, 99412 not listed in fee schedule.*
Oregon	*No coverage policy or program identified.* Reimbursement: 99412 (Oregon's primary care rate): $16.38 (non-facility), $9.87 (facility). 99412: $15.00 (non-facility), $9.04 (facility). *0403T not listed in fee schedule.*
Pennsylvania	*No coverage policy or program identified.* Reimbursement: *0403T, 99412 not listed in fee schedule.*
Texas	*No coverage policy or program identified.* Reimbursement: 0403T and 99412 are not covered.
Washington	*No coverage policy or program identified.* Reimbursement: 99412 not covered. *0403T not listed in fee schedule.*

Abbreviations. BCBS: Blue Cross Blue Shield; BMI: body mass index; CDC: Centers for Disease Control and Prevention; CPT: current procedural terminology; DPP: diabetes prevention program; HbA1c: glycated hemoglobin; MDPP: Medicare Diabetes Prevention program.

Discussion

Long-term evidence on the effectiveness of the DPP or DPP-like interventions on the subsequent development of diabetes demonstrated a nearly 50% reduction compared to usual care in addition to a greater return to a normoglycemic state. Yet, the authors of the included systematic review noted that relevant clinical endpoints (e.g., development of diabetes) are rarely reported in the available literature (Balk et al., 2015).

Since the publication of the original DPP data, subsequent modifications have attempted to address the high costs of the individual sessions in the original DPP intervention. In subgroup analyses, no differences were observed for setting, session number, duration, specific weight-loss goal, or individual diet or exercise plans. However, greater effectiveness was observed for

more intense programs compared to less intense ones. Cultural modifications, use of technology, and community-based delivery in the U.S. demonstrated smaller but promising changes in weight or glycemic indices, but most follow-up occurred at one year.

Diabetes prevention programs are consistently cost-effective and might be cost saving on a long-term horizon (over 10 years after the intervention). There is a lack of data on costs of providing the program in a community setting or by laypersons.

DPPs are recommended by the ADA (2017) and Community Preventive Services Taskforce (Pronk & Remington, 2015) as effective interventions for individuals with prediabetes or who are at increased risk for type 2 diabetes. In addition, the ADA recommended coverage of DPP programs by third-party payers, and stated that the use of technology could be useful in DPP implementation (ADA, 2017).

CMS developed the MDPP based on the DPP and as an expansion to the MDPP, CMS officials are proposing a performance-based payment structure for MDPP services for CY 2018, along with other program modifications from the CY 2017 program structure (CMS, 2017b). All of the private payers searched (with the exception of no program identified for Excellus BCBS) offer DPP-like services to their members. None of the state Medicaid agencies searched have coverage policies on DPP services. Oregon and Massachusetts Medicaid programs cover CPT 99412, but do not offer any coverage criteria of the code. California Medicaid will begin covering DPP for its recipients starting in July 2018, and a small number of other state Medicaid programs have established pathways for DPP coverage. A temporary CPT code (0403T) was released specific to DPP-like services in 2016. If a permanent code is assigned to DPP-like services, there might be a greater uptake of DPP coverage by state Medicaid agencies after there is a clear mechanism to reimburse for services.

Strength of Evidence

The Center uses the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) Working Group approach to enhance consistency in grading the strength of evidence. RCTs are initially categorized as having high strength of evidence and observational studies are categorized as having low strength of evidence. The strength rating is downgraded depending on the severity of the bias, based on limitations including study risk of bias; inconsistency (i.e., differences between study findings indicated by statistical or clinical heterogeneity); indirectness (i.e., limited generalizability of the findings from the study sample to another population); imprecision (i.e., wide confidence intervals); and high probability of reporting bias, also known as publication bias. The rating can be increased from low for evidence from observational studies if

there is a strong association,[1] a very strong association,[2] or a dose-response gradient. The rating is also increased if all plausible confounders have reduced the estimate (Schünemann, Brozek, Guyatt, & Oxman, 2014). Table 8 provides an overview of the strength of evidence by population, outcome, and associated rationale for the strength of evidence rating.

Table 8. Strength of Evidence for DPP and DPP-like Interventions: Effectiveness, Harms, and Cost-Effectiveness

Outcome	Strength of Evidence Assessment	Rationale
Effectiveness (Compared to Usual Care)		
Incident Diabetes	High	Based on a good methodological quality SR, DPP appears to decrease diabetes risk compared to usual care, with sustained effect several years out from the intervention. The lack of heterogeneity in the estimate of effect, despite modifications to the intervention, is a strength. A greater effect is seen for programs with more intensity.
Return to Normoglycemia	High	Based on a good methodological quality SR, DPP appears to increase likelihood of returning to normoglycemia compared to usual care, with sustained effect several years out from the intervention. The lack of heterogeneity in the estimate of effect, despite modifications to the intervention, is a strength. A greater effect is seen for programs with more intensity.
Weight change	Moderate	Based on a good methodological quality SR, DPP appears to lead to a decrease in weight compared to usual care. • Downgraded for heterogeneity in estimate
HbA1c	Moderate	Based on a good methodological quality SR, DPP appears to decrease hemoglobin A1c compared to usual care. • Downgraded for indirectness (follow up ranged from 0.5 to 10 years)
All-Cause Mortality	Unknown	*No long-term estimates on this outcome.*

[1] Significant relative risk of >2 or <0.5 with no plausible confounders in two or more observational studies.
[2] Significant relative risk of >5 or <0.2 based on direct evidence with no major threats to validity.

Outcome	Strength of Evidence Assessment	Rationale
CV Mortality	Unknown	*No U.S.-based estimates of this outcome.*
Quality of Life	Unknown	*Current search did not identify studies reporting this outcome.*
Diabetes-Related Clinical Outcomes	Low	Single SR identified small number of studies without observed change in outcome. Note that identified studies were not powered to detect a difference in these outcomes. • Downgraded two levels for imprecision based on authors' assessment of lack of power in original studies
Cost-Effectiveness (Compared to Usual Care)		
ICER	Moderate	Based on a good methodological SR of cost studies, DPP is cost-effective. Majority of models based on outcomes from 3 years of follow-up. Although this might exacerbate the potential benefit in cost-effectiveness, evidence exists to support benefit of program after three years. • Downgraded for indirectness.

Abbreviations. HbA1c: glycated hemoglobin. Notes. Programs with greater intensity included some but not all of the following: more sessions; goals for weight loss, diet, or exercise; maintenance phase; more intense diet or exercise plans; an exercise physiologist; individual sessions; or in-person session (vs. DVD).

References

Adams, R., Hebert, C. J., McVey, L., & Williams, R. (2016). Implementation of the YMCA diabetes prevention program throughout an integrated health system: A translational study. *Permanente Journal, 20*(4), 82-86. doi: https://dx.doi.org/10.7812/TPP/15-241

Ali, M. K., Echouffo-Tcheugui, J., & Williamson, D. F. (2012). How effective were lifestyle interventions in real-world settings that were modeled on the Diabetes Prevention Program? *Health Affairs, 31*(1), 67-75. doi: 10.1377/hlthaff.2011.1009

Allende-Vigo, M. Z. (2015). Diabetes mellitus prevention. *American Journal of Therapeutics, 22*(1), 68-72. doi: https://dx.doi.org/10.1097/MJT.0b013e3182211bae

Alva, M. L., Hoerger, T. J., Jeyaraman, R., Amico, P., & Rojas-Smith, L. (2017). Impact of the YMCA of the USA Diabetes Prevention Program on Medicare spending and utilization. *Health Affairs, 36*(3), 417-424. doi: https://dx.doi.org/10.1377/hlthaff.2016.1307

American Diabetes Association. (2017). Standards of Medical Care in Diabetes--2017. *Diabetes Care, 40*(Suppl 1), S1-S135. doi: 10.2337/dc17-S008

Anonymous. (2015). YMCA Diabetes Prevention Program. *Tennessee Nurse, 78*(3), 19.

Anthem. (2016). *Anthem Blue Cross partners with community organizations to help prevent diabetes*. Retrieved from https://www.anthem.com/press/california/anthem-blue-cross-partners-with-community-organizations-to-help-prevent-diabetes/

AuYoung, M., Damschroder, L. J., Kinsinger, L., Moin, T., & Richardson, C. R. (2017). Practical partnered research to improve weight loss among overweight/obese veterans: Lessons from the trenches. *BMC Medical Research Methodology, 17*(1), 50. doi: https://dx.doi.org/10.1186/s12874-017-0321-9

Azar, K. M., Koliwad, S., Poon, T., Xiao, L., Lv, N., Griggs, R., & Ma, J. (2016). The Electronic CardioMetabolic Program (eCMP) for patients with cardiometabolic risk: A randomized controlled trial. *Journal of Medical Internet Research, 18*(5), e134. doi: https://dx.doi.org/10.2196/jmir.5143

Aziz, Z., Absetz, P., Oldroyd, J., Pronk, N. P., & Oldenburg, B. (2015). A systematic review of real-world diabetes prevention programs: Learnings from the last 15 years. *Implementation Science, 10*, 172. doi: 10.1186/s13012-015-0354-6

Baker, M. K., Simpson, K., Lloyd, B., Bauman, A. E., & Singh, M. A. (2011). Behavioral strategies in diabetes prevention programs: A systematic review of randomized controlled trials. *Diabetes Research and Clinical Practice, 91*(1), 1-12. doi: 10.1016/j.diabres.2010.06.030

Balk, E. M., Earley, A., Raman, G., Avendano, E. A., Pittas, A. G., & Remington, P. L. (2015). Combined diet and physical activity promotion programs to prevent type 2 diabetes among persons at increased risk: A systematic review for the community preventive services task force. *Annals of Internal Medicine, 163*(6), 437-451. doi: 10.7326/M15-0452

Bansal, N. (2015). Prediabetes diagnosis and treatment: A review. *World Journal of Diabetes, 6*(2), 296-303. doi: https://dx.doi.org/10.4239/wjd.v6.i2.296

Barry, E., Roberts, S., Oke, J., Vijayaraghavan, S., Normansell, R., & Greenhalgh, T. (2017). Efficacy and effectiveness of screen and treat policies in prevention of type 2 diabetes: Systematic review and meta-analysis of screening tests and interventions. *BMJ, 356*, i6538. doi: https://dx.doi.org/10.1136/bmj.i6538

Bejan-Angoulvant, T., Cornu, C., Archambault, P., Tudrej, B., Audier, P., Brabant, Y., . . . Boussageon, R. (2015). Is HbA1c a valid surrogate for macrovascular and microvascular complications in type 2 diabetes? *Diabetes & Metabolism, 41*(3), 195-201. doi: 10.1016/j.diabet.2015.04.001

Bian, R. R., Piatt, G. A., Sen, A., Plegue, M. A., De Michele, M. L., Hafez, D., . . . Richardson, C. R. (2017). The effect of technology-mediated diabetes prevention interventions on weight: A meta-analysis. *Journal of Medical Internet Research, 19*(3), e76. doi: 10.2196/jmir.4709

Block, G., Azar, K. M., Romanelli, R. J., Block, T. J., Hopkins, D., Carpenter, H. A., . . . Block, C. H. (2015). Diabetes prevention and weight loss with a fully automated behavioral intervention by email, web, and mobile phone: A randomized controlled trial among persons with prediabetes. *Journal of Medical Internet Research, 17*(10), e240. doi: https://dx.doi.org/10.2196/jmir.4897

BlueShield of Northeastern New York. (2017). *Wellness and prevention*. Retrieved from https://www.bsneny.com/content/NENYmember/health-wellness/wellness_seminars_and_prevention.html

Brouwers, M. C., Kho, M. E., Browman, G. P., Burgers, J. S., Cluzeau, F., Feder, G., . . . Zitzelsberger, L. (2010). AGREE II: Advancing guideline development, reporting and evaluation in health care. *Canadian Medical Association Journal, 182*(18), E839-E842. doi: 10.1503/cmaj.090449

Brown, S. A., Garcia, A. A., Orlander, P. R., & Hanis, C. L. (2017). A randomized clinical trial of diabetes self-management for Mexican Americans: Are there serendipitous health benefits for supporters of study participants? *SAGE Open Medicine, 5*, 2050312116682125. doi: https://dx.doi.org/10.1177/2050312116682125

Brunisholz, K. D., Joy, E. A., Hashibe, M., Gren, L. H., Savitz, L. A., Hamilton, S., . . . Kim, J. (2017a). Stepping back to move forward: Evaluating the effectiveness of a diabetes prevention program within a large integrated healthcare delivery system. *Journal for Healthcare Quality, 39*(5), 278-293. doi: https://dx.doi.org/10.1097/JHQ.0000000000000103

Brunisholz, K. D., Kim, J., Savitz, L. A., Hashibe, M., Gren, L. H., Hamilton, S., . . . Joy, E. A. (2017b). A formative evaluation of a diabetes prevention program using the RE-AIM framework in a learning health care system, Utah, 2013-2015. *Preventing Chronic Disease, 14*, E58. doi: https://dx.doi.org/10.5888/pcd14.160556

Campbell Collaboration. (2015). Campbell Collaboration systematic reviews: Policies and guidelines. *Campbell Systematic Reviews, Supplement 1*. doi: 10.4073/csrs.2015.1

Capital District Physicians' Health Plan. (2017). *Diabetes Prevention Program*. Retrieved from https://www.cdphp.com/diabetes/for-adults/diabetes-prevention/diabetes-prevention-program

Centers for Disease Control and Prevention. (2016). *National Diabetes Prevention Program: Requirements for CDC recognition*. Retrieved from https://www.cdc.gov/diabetes/prevention/lifestyle-program/requirements.html

Centers for Disease Control and Prevention. (2017). *National Diabetes Prevention Program*. Retrieved from https://www.cdc.gov/diabetes/prevention/index.html

Centers for Medicare & Medicaid Services. (2017a). *Medicare Diabetes Prevention Program (MDPP) expanded model*. Retrieved from https://innovation.cms.gov/initiatives/medicare-diabetes-prevention-program/

Centers for Medicare & Medicaid Services. (2017b). *Proposed policies for the Medicare Diabetes Prevention Program expanded model in the calendar year 2018 physician fee schedule proposed rule*. Retrieved from https://www.cms.gov/Newsroom/MediaReleaseDatabase/Fact-sheets/2017-Fact-Sheet-items/2017-07-13-3.html

Chen, F., Su, W., Becker, S. H., Payne, M., Castro Sweet, C. M., Peters, A. L., & Dall, T. M. (2016). Clinical and economic impact of a digital, remotely-delivered intensive behavioral counseling program on Medicare beneficiaries at risk for diabetes and cardiovascular

disease. *PLoS ONE, 11*(10), e0163627. doi: https://dx.doi.org/10.1371/journal.pone.0163627

Chesla, C. A., Chun, K. M., Kwong, Y., Gay, C. L., Chi, H. L., Gu, Y., . . . Ma, J. (2016). Cultural adaptation of the group lifestyle balance program for Chinese Americans. *Diabetes Educator, 42*(6), 686-696. doi: https://dx.doi.org/10.1177/0145721716666679

Clark, B., Boghani, S., Grullon, C., & Batista, M. (2017). The impact of a worksite-based diabetes prevention intervention: A pilot study. *Population Health Management, 20*(3), 233-238. doi: https://dx.doi.org/10.1089/pop.2016.0055

Dall, T. M., Storm, M. V., Semilla, A. P., Wintfeld, N., O'Grady, M., & Narayan, K. M. (2015). Value of lifestyle intervention to prevent diabetes and sequelae. *American Journal of Preventive Medicine, 48*(3), 271-280. doi: https://dx.doi.org/10.1016/j.amepre.2014.10.003

Damschroder, L. J., Reardon, C. M., AuYoung, M., Moin, T., Datta, S. K., Sparks, J. B., . . . Richardson, C. R. (2017). Implementation findings from a hybrid III implementation-effectiveness trial of the Diabetes Prevention Program (DPP) in the Veterans Health Administration (VHA). *Implementation Science, 12*(1), 94. doi: https://dx.doi.org/10.1186/s13012-017-0619-3

Desai, J., Taylor, G., Vazquez-Benitez, G., Vine, S., Anderson, J., Garrett, J. E., . . . O'Connor, P. J. (2017). Financial incentives for diabetes prevention in a Medicaid population: Study design and baseline characteristics. *Contemporary Clinical Trials, 53*, 1-10. doi: https://dx.doi.org/10.1016/j.cct.2016.11.007

Eaglehouse, Y. L., Kramer, M. K., Rockette-Wagner, B., Arena, V. C., & Kriska, A. M. (2015). Evaluation of physical activity reporting in community Diabetes Prevention Program lifestyle intervention efforts: A systematic review. *Preventive Medicine, 77*, 191-199. doi: 10.1016/j.ypmed.2015.05.023

Eaglehouse, Y. L., Schafer, G. L., Arena, V. C., Kramer, M. K., Miller, R. G., & Kriska, A. M. (2016). Impact of a community-based lifestyle intervention program on health-related quality of life. *Quality of Life Research, 25*(8), 1903-1912. doi: https://dx.doi.org/10.1007/s11136-016-1240-7

EmblemHealth. (2016). *EmblemHealth--First US insurer to receive full CDC recognition for its diabetes prevention program*. Retrieved from https://www.emblemhealth.com/eblast/brokers/2016/jp30326_Broker_DDP_Aug2016_post.html

Fischer, H. H., Fischer, I. P., Pereira, R. I., Furniss, A. L., Rozwadowski, J. M., Moore, S. L., . . . Havranek, E. P. (2016). Text message support for weight loss in patients with prediabetes: A randomized clinical trial. *Diabetes Care, 39*(8), 1364-1370. doi: https://dx.doi.org/10.2337/dc15-2137

Glechner, A., Harreiter, J., Gartlehner, G., Rohleder, S., Kautzky, A., Tuomilehto, J., . . . Kautzky-Willer, A. (2015). Sex-specific differences in diabetes prevention: A systematic review and meta-analysis. *Diabetologia, 58*(2), 242-254. doi: https://dx.doi.org/10.1007/s00125-014-3439-x

Goldberg, R. B., Aroda, V. R., Bluemke, D. A., Barrett-Connor, E., Budoff, M., Crandall, J. P., . . . Diabetes Prevention Program Research, G. (2017). Effect of long-term metformin and lifestyle in the Diabetes Prevention Program and its outcome study on coronary artery calcium. *Circulation, 136*(1), 52-64. doi: https://dx.doi.org/10.1161/CIRCULATIONAHA.116.025483

Golden, S. H., Maruthur, N., Mathioudakis, N., Spanakis, E., Rubin, D., Zilbermint, M., & Hill-Briggs, F. (2017). The case for diabetes population health improvement: Evidence-based programming for population outcomes in diabetes. *Current Diabetes Reports, 17*(7), 51. doi: https://dx.doi.org/10.1007/s11892-017-0875-2

Guo, J., Chen, J. L., Whittemore, R., & Whitaker, E. (2016). Postpartum lifestyle interventions to prevent type 2 diabetes among women with history of gestational diabetes: A systematic review of randomized clinical trials. *Journal of Women's Health, 25*(1), 38-49. doi: 10.1089/jwh.2015.5262

Hafez, D., De Michele, M., & Sachdev, N. (2016). Frontline account: Resident-led implementation of the National Diabetes Prevention Program within primary care clinics of a large, academic medical center. *Journal of General Internal Medicine, 31*(5), 573-575. doi: https://dx.doi.org/10.1007/s11606-016-3613-6

Higgins, J. P. T., & Green, S. (Eds.). (2011). *Cochrane handbook for systematic reviews of interventions*. http://handbook.cochrane.org/.

Hu, R., Li, Y., Lv, Q., Wu, T., & Tong, N. (2015). Acarbose monotherapy and type 2 diabetes prevention in Eastern and Western prediabetes: An ethnicity-specific meta-analysis. *Clinical Therapeutics, 37*(8), 1798-1812. doi: https://dx.doi.org/10.1016/j.clinthera.2015.05.504

Jensen, M. D., Ryan, D. H., Apovian, C. M., Ard, J. D., Comuzzie, A. G., Donato, K. A., . . . Yanovski, S. Z. (2013). 2013 AHA/ACC/TOS guideline for the management of overweight and

obesity in adults. *Circulation, 129*(25 Suppl 2), S102-138. doi: 10.1161/01.cir.0000437739.71477.ee

Johnson, M., Jones, R., Freeman, C., Woods, H. B., Gillett, M., Goyder, E., & Payne, N. (2013). Can diabetes prevention programmes be translated effectively into real-world settings and still deliver improved outcomes? A synthesis of evidence. *Diabetic Medicine, 30*(1), 3-15. doi: 10.1111/dme.12018

Joiner, K. L., Nam, S., & Whittemore, R. (2017). Lifestyle interventions based on the diabetes prevention program delivered via eHealth: A systematic review and meta-analysis. *Preventive Medicine, 100*, 194-207. doi: 10.1016/j.ypmed.2017.04.033

Kerrison, G., Gillis, R. B., Jiwani, S. I., Alzahrani, Q., Kok, S., Harding, S. E., . . . Adams, G. G. (2017). The effectiveness of lifestyle adaptation for the prevention of prediabetes in adults: A systematic review. *Journal of Diabetes Research, 2017*, 8493145. doi: https://dx.doi.org/10.1155/2017/8493145

Khaw, K. T., Wareham, N., Bingham, S., Luben, R., Welch, A., & Day, N. (2004). Association of hemoglobin A1c with cardiovascular disease and mortality in adults: the European prospective investigation into cancer in Norfolk. *Annals of Internal Medicine, 141*(6), 413-420.

Li, R., Qu, S., Zhang, P., Chattopadhyay, S., Gregg, E. W., Albright, A., . . . Pronk, N. P. (2015). Economic evaluation of combined diet and physical activity promotion programs to prevent type 2 diabetes among persons at increased risk: A systematic review for the Community Preventive Services Task Force. *Annals of Internal Medicine, 163*(6), 452-460. doi: 10.7326/m15-0469

Li, R., Zhang, P., Barker, L. E., Chowdhury, F. M., & Zhang, X. (2010). Cost-effectiveness of interventions to prevent and control diabetes mellitus: A systematic review. *Diabetes Care, 33*(8), 1872-1894. doi: 10.2337/dc10-0843

Lipska, K. J., & Krumholz, H. M. (2017). Is hemoglobin A1c the right outcome for studies of diabetes? *JAMA, 317*(10), 1017-1018. doi: 10.1001/jama.2017.0029

Marrero, D. G., Ma, Y., de Groot, M., Horton, E. S., Price, D. W., Barrett-Connor, E., . . . Knowler, W. C. (2015). Depressive symptoms, antidepressant medication use, and new onset of diabetes in participants of the diabetes prevention program and the diabetes prevention program outcomes study. *Psychosomatic Medicine, 77*(3), 303-310. doi: https://dx.doi.org/10.1097/PSY.0000000000000156

Marrero, D. G., Palmer, K. N., Phillips, E. O., Miller-Kovach, K., Foster, G. D., & Saha, C. K. (2016). Comparison of commercial and self-initiated weight loss programs in people with prediabetes: A randomized control trial. *American Journal of Public Health, 106*(5), 949-956. doi: https://dx.doi.org/10.2105/AJPH.2015.303035

McCurley, J. L., Gutierrez, A. P., & Gallo, L. C. (2017). Diabetes prevention in U.S. Hispanic adults: A systematic review of culturally tailored interventions. *American Journal of Preventive Medicine, 52*(4), 519-529. doi: https://dx.doi.org/10.1016/j.amepre.2016.10.028

Michaelides, A., Raby, C., Wood, M., Farr, K., & Toro-Ramos, T. (2016). Weight loss efficacy of a novel mobile Diabetes Prevention Program delivery platform with human coaching. *BMJ Open Diabetes Research & Care, 4*(1), e000264. doi: https://dx.doi.org/10.1136/bmjdrc-2016-000264

Miller, C. K., Nagaraja, H. N., & Weinhold, K. R. (2015). Early weight-loss success identifies nonresponders after a lifestyle intervention in a worksite diabetes prevention trial. *Journal of the Academy of Nutrition & Dietetics, 115*(9), 1464-1471. doi: https://dx.doi.org/10.1016/j.jand.2015.04.022

Miller, C. K., Weinhold, K. R., & Nagaraja, H. N. (2016). Impact of a worksite diabetes prevention intervention on diet quality and social cognitive influences of health behavior: A randomized controlled trial. *Journal of Nutrition Education & Behavior, 48*(3), 160-169.e161. doi: https://dx.doi.org/10.1016/j.jneb.2015.12.002

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine, 6*(7), e1000097. doi: 10.1371/journal.pmed.1000097

Moin, T., Damschroder, L. J., AuYoung, M., Maciejewski, M. L., Datta, S. K., Weinreb, J. E., . . . Richardson, C. R. (2017). Diabetes Prevention Program translation in the Veterans Health Administration. *American Journal of Preventive Medicine, 53*(1), 70-77. doi: https://dx.doi.org/10.1016/j.amepre.2016.11.009

Mudaliar, U., Zabetian, A., Goodman, M., Echouffo-Tcheugui, J. B., Albright, A. L., Gregg, E. W., & Ali, M. K. (2016). Cardiometabolic risk factor changes observed in diabetes prevention programs in US settings: A systematic review and meta-analysis. *PLoS Medicine, 13*(7), e1002095. doi: 10.1371/journal.pmed.1002095

Naci, H., & Ioannidis, J. P. (2013). Comparative effectiveness of exercise and drug interventions on mortality outcomes: Metaepidemiological study. *BMJ, 347*, f5577. doi: https://dx.doi.org/10.1136/bmj.f5577

Naci, H., & Ioannidis, J. P. (2015). Comparative effectiveness of exercise and drug interventions on mortality outcomes: Metaepidemiological study. *British Journal of Sports Medicine, 49*(21), 1414-1422. doi: https://dx.doi.org/10.1136/bjsports-2015-f5577rep

Nathan, D. M., Barrett-Connor, E., Crandall, J. P., Edelstein, S. L., Goldberg, R. B., Horton, E. S., . . . Temprosa, M. (2015). Long-term effects of lifestyle intervention or metformin on diabetes development and microvascular complications: The DPP Outcomes Study. *The Lancet, 3*(11), 866-875. doi: 10.1016/S2213-8587(15)00291-0

National Association of Chronic Disease Directors. (2017). *National Diabetes Prevention Program coverage toolkit*. Retrieved from http://www.nationaldppcoveragetoolkit.org/

National Institute for Health and Care Excellence. (2014). *Developing NICE guidelines: The manual*. Retrieved from https://www.nice.org.uk/media/default/about/what-we-do/our-programmes/developing-nice-guidelines-the-manual.pdf

National Institute for Health and Care Excellence. (2017). *Type 2 diabetes: Prevention in people at high risk*. Retrieved from https://www.nice.org.uk/guidance/ph38.

Neamah, H. H., Sebert Kuhlmann, A. K., & Tabak, R. G. (2016). Effectiveness of program modification strategies of the Diabetes Prevention Program: A systematic review. *Diabetes Educator, 42*(2), 153-165. doi: 10.1177/0145721716630386

New York State. (2017). *Prediabetes*. Retrieved from https://www.health.ny.gov/diseases/conditions/diabetes/prediabetes/

O'Brien, M. J., Perez, A., Alos, V. A., Whitaker, R. C., Ciolino, J. D., Mohr, D. C., & Ackermann, R. T. (2015). The feasibility, acceptability, and preliminary effectiveness of a Promotora-Led Diabetes Prevention Program (PL-DPP) in Latinas: A pilot study. *Diabetes Educator, 41*(4), 485-494. doi: https://dx.doi.org/10.1177/0145721715586576

O'Brien, M. J., Perez, A., Scanlan, A. B., Alos, V. A., Whitaker, R. C., Foster, G. D., . . . Homko, C. (2017). PREVENT-DM comparative effectiveness trial of lifestyle intervention and metformin. *American Journal of Preventive Medicine, 52*(6), 788-797. doi: https://dx.doi.org/10.1016/j.amepre.2017.01.008

O'Dea, A., Tierney, M., McGuire, B. E., Newell, J., Glynn, L. G., Gibson, I., . . . Dunne, F. P. (2015). Can the onset of type 2 diabetes be delayed by a group-based lifestyle intervention in women with prediabetes following gestational diabetes mellitus (GDM)? Findings from a randomized control mixed methods trial. *Journal of Diabetes Research, 2015*, 798460. doi: https://dx.doi.org/10.1155/2015/798460

Perez, A., Alos, V. A., Scanlan, A., Maia, C. M., Davey, A., Whitaker, R. C., . . . O'Brien, M. J. (2015). The rationale, design, and baseline characteristics of PREVENT-DM: A community-based comparative effectiveness trial of lifestyle intervention and metformin among Latinas with prediabetes. *Contemporary Clinical Trials, 45*(Pt B), 320-327. doi: https://dx.doi.org/10.1016/j.cct.2015.10.011

Pillay, J., Armstrong, M. J., Butalia, S., & et al. (2015). Behavioral programs for type 2 diabetes mellitus: A systematic review and network meta-analysis. *Annals of Internal Medicine, 163*(11), 848-860. doi: 10.7326/M15-1400

Pronk, N. P., & Remington, P. L. (2015). Combined diet and physical activity promotion programs for prevention of diabetes: Community Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine, 163*(6), 465-468. doi: 10.7326/m15-1029

Public Health England. (2015). *A systematic review and meta-analysis assessing the effectiveness of pragmatic lifestyle interventions for the prevention of type 2 diabetes mellitus in routine practice*. London: Public Health England. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/456147/PHE_Evidence_Review_of_diabetes_prevention_programmes-_FINAL.pdf.

Salimi, Y., Fotouhi, A., Mohammad, K., Mansournia, N., & Mansournia, M. A. (2017). Causal effects of intensive lifestyle and metformin interventions on cardiovascular disease risk factors in pre-diabetic people: An application of G-estimation. *Archives of Iranian Medicine, 20*(1), 55-59. doi: https://dx.doi.org/0172001/AIM.0012

Schellenberg, E., Dryden, D. M., Vandermeer, B., Ha, C., & Korownyk, C. (2013). Lifestyle interventions for patients with and at risk for type 2 diabetes: A systematic review and meta-analysis. *Annals of Internal Medicine, 159*(8), 543-551. doi: 10.7326/0003-4819-159-8-201310150-00007

Schünemann, H., Brozek, J., Guyatt, G., & Oxman, A. (2014). *GRADE handbook for grading quality of evidence and strength of recommendations. Updated October 2013. The GRADE Working Group, 2013*. Retrieved from http://gdt.guidelinedevelopment.org/app/handbook/handbook.html

Scottish Intercollegiate Guidelines Network. (2015a). *Methodology checklist 1: Systematic reviews and meta-analyses*. Retrieved from http://www.sign.ac.uk/checklists-and-notes.html

Scottish Intercollegiate Guidelines Network. (2015b). *Methodology checklist 2: Randomised controlled trials*. Retrieved from http://www.sign.ac.uk/checklists-and-notes.html

Sepah, S. C., Jiang, L., & Peters, A. L. (2015). Long-term outcomes of a web-based diabetes prevention program: 2-year results of a single-arm longitudinal study. *Journal of Medical Internet Research, 17*(4), e92. doi: https://dx.doi.org/10.2196/jmir.4052

Slentz, C. A., Bateman, L. A., Willis, L. H., Granville, E. O., Piner, L. W., Samsa, G. P., . . . Kraus, W. E. (2016). Effects of exercise training alone vs a combined exercise and nutritional lifestyle intervention on glucose homeostasis in prediabetic individuals: A randomised controlled trial. *Diabetologia, 59*(10), 2088-2098. doi: https://dx.doi.org/10.1007/s00125-016-4051-z

Su, W., Chen, F., Dall, T. M., Iacobucci, W., & Perreault, L. (2016). Return on investment for digital behavioral counseling in patients with prediabetes and cardiovascular disease. *Preventing Chronic Disease, 13*, E13. doi: https://dx.doi.org/10.5888/pcd13.150357

Sun, Y., You, W., Almeida, F., Estabrooks, P., & Davy, B. (2017). The effectiveness and cost of lifestyle interventions including nutrition education for diabetes prevention: A systematic review and meta-analysis. *Journal of the Academy of Nutrition and Dietetics, 117*(3), 404-421.e436. doi: 10.1016/j.jand.2016.11.016

Thomas, G. N., Jiang, C. Q., Taheri, S., Xiao, Z. H., Tomlinson, B., Cheung, B. M., . . . Cheng, K. K. (2010). A systematic review of lifestyle modification and glucose intolerance in the prevention of type 2 diabetes. *Current Diabetes Reviews, 6*(6), 378-387.

Umpierrez, G. E., & Pasquel, F. J. (2014). Primary prevention of type 2 diabetes by lifestyle intervention in primary care setting. *Revista Clinica Espanola, 214*(2), 79-82. doi: https://dx.doi.org/10.1016/j.rce.2013.11.004

UnitedHealthcare. (2016). *Managing diabetes through prevention and care*. Retrieved from https://www.stage-app.uhc.com/health-and-wellness/health-topics/diabetes/managing-diabetes

Vadheim, L. M., Patch, K., Brokaw, S. M., Carpenedo, D., Butcher, M. K., Helgerson, S. D., & Harwell, T. S. (2017). Telehealth delivery of the Diabetes Prevention Program to rural communities. *Translational Behavioral Medicine, 7*(2), 286-291. doi: https://dx.doi.org/10.1007/s13142-017-0496-y

Van Name, M. A., Camp, A. W., Magenheimer, E. A., Li, F., Dziura, J. D., Montosa, A., . . . Tamborlane, W. V. (2016). Effective translation of an intensive lifestyle intervention for Hispanic women with prediabetes in a community health center setting. *Diabetes Care, 39*(4), 525-531. doi: https://dx.doi.org/10.2337/dc15-1899

Vitolins, M. Z., Isom, S. P., Blackwell, C. S., Kernodle, D., Sydell, J. M., Pedley, C. F., . . . Goff, D. C., Jr. (2017). The Healthy Living Partnerships to Prevent Diabetes and the Diabetes

Prevention Program: A comparison of year 1 and 2 intervention results. *Translational Behavioral Medicine, 7*(2), 371-378. doi: https://dx.doi.org/10.1007/s13142-016-0447-z

Washington State Health Care Authority. (2017). *Diabetes prevention*. Retrieved from https://www.hca.wa.gov/public-employee-benefits/diabetes-prevention

Weinhold, K. R., Miller, C. K., Marrero, D. G., Nagaraja, H. N., Focht, B. C., & Gascon, G. M. (2015). A randomized controlled trial translating the Diabetes Prevention Program to a university worksite, Ohio, 2012-2014. *Preventing Chronic Disease, 12*, E210. doi: https://dx.doi.org/10.5888/pcd12.150301

Whittemore, R. (2011). A systematic review of the translational research on the Diabetes Prevention Program. *Translational Behavioral Medicine, 1*(3), 480. doi: 10.1007/s13142-011-0062-y

Yeh, M. C., Heo, M., Suchday, S., Wong, A., Poon, E., Liu, G., & Wylie-Rosett, J. (2016). Translation of the Diabetes Prevention Program for diabetes risk reduction in Chinese immigrants in New York City. *Diabetic Medicine, 33*(4), 547-551. doi: https://dx.doi.org/10.1111/dme.12848

Yuen, A., Sugeng, Y., Weiland, T. J., & Jelinek, G. A. (2010). Lifestyle and medication interventions for the prevention or delay of type 2 diabetes mellitus in prediabetes: A systematic review of randomised controlled trials. *Australian & New Zealand Journal of Public Health, 34*(2), 172-178. doi: https://dx.doi.org/10.1111/j.1753-6405.2010.00503.x

Zheng, L., Wu, J., Wang, G., Persuitte, G., Ma, Y., Zou, L., . . . Li, J. (2016). Comparison of control fasting plasma glucose of exercise-only versus exercise-diet among a pre-diabetic population: A meta-analysis. *European Journal of Clinical Nutrition, 70*(4), 424-430. doi: https://dx.doi.org/10.1038/ejcn.2015.128

Appendix A. Methods

Search Strategies

Evidence

A full search of the Center's core clinical evidence primary sources was conducted to identify systematic reviews, meta-analyses, and technology assessments using the search terms *diabetes prevention*. Searches of core sources were limited to citations published after 2006. Center researchers also searched the Ovid MEDLINE database for relevant systematic reviews and meta-analyses, technology assessments, and cost-effectiveness studies published after 2006, and for individual studies reporting on effectiveness and/or harms outcomes published after 2014.

The core sources searched included the following:

Agency for Healthcare Research and Quality (AHRQ)

BMJ – Clinical Evidence

Cochrane Library (Wiley Interscience)

National Institute for Health and Care Excellence (NICE)

PubMed Health

Tufts Cost-Effectiveness Analysis Registry

Veterans Administration Evidence-based Synthesis Program (ESP)

Washington State Health Technology Assessment Program

Clinical Practice Guidelines

Center researchers conducted a full search of Center clinical practice guidelines primary sources to identify clinical practice guidelines using the term *diabetes prevention*. Searches were limited to citations published within the last five years. Center researchers included guidelines from governmental bodies and professional associations; guidelines from single clinical institutions (e.g., a single hospital or clinic) were not included.

The guideline sources included the following:

Australian Government National Health and Medical Research Council (NHMRC)

National Guidelines Clearinghouse

National Institute for Health and Care Excellence (NICE)

New Zealand Guidelines Group

Scottish Intercollegiate Guidelines Network (SIGN)

Veterans Administration/Department of Defense (VA/DOD)

World Health Organization (WHO)

Center researchers searched Google 10 pages deep using the terms *diabetes prevention* and *guideline or position or statement or policy or recommendation*.

Coverage Policies

Center researchers searched for policies on the coverage of the DPP or DPP-like interventions from Aetna, Anthem, Blue Shield of Northeastern New York, Capital District Physicians' Health Plan, CMS, Cigna, Emblem Health, Empire BCBS, Excellus BCBS, Tufts Health Plan, UnitedHealthcare, and nine state Medicaid programs (CA, FL, MA, NJ, NY, OR, PA, TX, and WA).

Ovid MEDLINE

The Ovid MEDLINE search strategy was developed for broad inclusion of relevant systematic reviews and individual studies. Individual studies published after the search dates of the included systematic review or studies that were eligible and not included in the systematic review were included to update the systematic review.

Database: Ovid MEDLINE <1946 to September Week 2 2017>, Ovid MEDLINE In-Process & Other Non-Indexed Citations <September 25, 2017>
Search Strategy:

1 exp Diabetes Mellitus/
2 diabetes.mp
3 1 or 2
4 exp primary prevention/ or exp secondary prevention/ or exp tertiary prevention/
5 prevention.mp
6 4 or 5
7 exp Life Style/
8 ((life and style) or life style or lifestyle).mp
9 (program$ or intervention$).mp
10 7 or 8 or 9
11 exp Prediabetic State/
12 ((prediabetic and state) or prediabetic state or prediabetes).mp
13 11 or 12
14 3 and 6 and 10 and 13
15 limit 14 to english language
16 limit 15 to yr="2007 -Current"
17 remove duplicates from 16

Study Inclusion/Exclusion Criteria

Two Center researchers independently reviewed the results from the Center core sources and Ovid MEDLINE database searches at each stage of review (e.g., title and abstract, full text). Any

study that was identified by at least one researcher as potentially meeting inclusion criteria was advanced to the next review level. All excluded studies were determined by two Center researchers as not meeting the predetermined inclusion criteria. Any disagreement between study reviewers regarding the inclusion of a study was arbitrated by a third Center researcher. Center researchers excluded studies that were not systematic reviews, meta-analyses, technology assessments, or individual studies (as applicable by topic); that were published before 2007; were published in a language other than English; or did not meet the specific inclusion/exclusion criteria outlined below.

Inclusion Criteria

Population: Adults (over 18 years of age) in the United States meeting either of these criteria:

- CDC-recognized eligibility criteria for the NDPP: overweight (BMI ≥24, ≥22 if Asian), AND no prior diagnosis of type 1 or type 2 diabetes, AND findings of prediabetes (any of the following):
  - HbA1c: 5.7% to 6.4%
  - Fasting plasma glucose: 100–125 mg/dL
  - Two-hour plasma glucose (after 75 g load): 140–199 mg/dL
  - History of gestational diabetes
- Additional risk factors for diabetes considered were delivery of a macrosomic infant (i.e., greater than 9 lbs.), family history of type 2 diabetes, race/ethnicity, polycystic ovarian syndrome, use of medication that impairs glucose tolerance (e.g., glucocorticoids)

Interventions: DPP; similar interventions based on the DPP protocol focusing on diet and exercise promotion

Comparators: Usual care (e.g., standard diet and exercise education), with or without pharmacological interventions

Outcomes: Incidence of diabetes; quality of life; morbidity; mortality; adverse effects, cost or cost-effectiveness (all outcomes at ≥5 years after initiation of the intervention)

Exclusion Criteria

Study exclusion criteria included the following:

- Studies conducted outside of the U.S.
- Studies that reported less than five years follow-up data only
- Studies that did not stratify results by intervention type and/or country
- Studies that reported on surrogate outcomes, with the exception of HbA1c and weight loss
- Case reports, letters, editorials, comments

- Duplicate information from a research study published in more than one source (only the highest quality, most recent publication with outcome of interest was included)
- Systematic reviews that included only studies that were summarized by more comprehensive systematic reviews or systematic reviews of higher quality and/or that were more recently published
- Studies identified that were included in a summarized systematic review or technology assessment

Quality Assessment

Center researchers assessed the methodological quality of the included studies using standard instruments developed and adapted by the Center that are modifications of the systems in use by the Campbell Collaboration, Cochrane, the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA), the National Institute for Health and Care Excellence (NICE), and the Scottish Intercollegiate Guidelines Network (SIGN) (Brouwers et al., 2010; Campbell Collaboration, 2015; Higgins & Green, 2011; Moher, Liberati, Tetzlaff, & Altman, 2009; National Institute for Health and Care Excellence, 2014; Scottish Intercollegiate Guidelines Network, 2015a, 2015b). Two Center researchers independently rated all studies. In cases where there was not agreement about the quality of a study, consensus was reached through discussion.

Each rater assigned the study a rating of good, fair, or poor, based on its adherence to recommended methods and potential for biases. In brief, good-quality systematic reviews include a clearly focused question, a literature search sufficiently rigorous to identify all relevant studies, criteria used to select studies for inclusion (e.g., RCTs) and assess study quality, and assessments of heterogeneity to determine whether a meta-analysis would be appropriate. Good-quality RCTs include a clear description of the population, setting, intervention, and comparison groups; a random and concealed allocation of patients to study groups; low dropout rates; and intention-to-treat analyses. Good-quality systematic reviews and RCTs also have low potential for bias from conflicts of interest and funding source(s). Fair-quality systematic reviews and RCTs have incomplete information about methods that might mask important limitations. Poor-quality systematic reviews and RCTs have clear flaws that could introduce significant bias.

Appendix B. Articles Selected for Full-Text Review Inclusion/Exclusion Rationale

Citation	Inclusion/Exclusion Rationale
Adams, Hebert, McVey, and Williams (2016)	Exclude: Length of follow-up (<5 years)
Ali, Echouffo-Tcheugui, and Williamson (2012)	Exclude: Superseded by more recent, comprehensive systematic reviews
Allende-Vigo (2015)	Exclude: Study design (narrative review)
Alva, Hoerger, Jeyaraman, Amico, and Rojas-Smith (2017)	Exclude: Length of follow-up (<5 years)
American Diabetes Association (2017)	Include
Anonymous (2015)	Exclude: Study design (program description, outcomes not reported)
AuYoung, Damschroder, Kinsinger, Moin, and Richardson (2017)	Exclude: Study design (program description, outcomes not reported)
Azar et al. (2016)	Exclude: Length of follow-up (<5 years)
Aziz, Absetz, Oldroyd, Pronk, and Oldenburg (2015)	Exclude: Outcomes (reported on Penetration, Implementation, Participation, Effectiveness [PIPE] impact metric)
Baker, Simpson, Lloyd, Bauman, and Singh (2011)	Exclude: Superseded by more recent, comprehensive systematic reviews
Balk et al. (2015)	Include
Bansal (2015)	Exclude: Study design (narrative review)
Barry et al. (2017)	Exclude: Intervention (unable to determine whether included studies are DPP or DPP-like)
Bian et al. (2017)	Exclude: Comparator (comparative data from included studies not reported)
Block et al. (2015)	Exclude: Length of follow-up (<5 years)
Brown, Garcia, Orlander, and Hanis (2017)	Exclude: Length of follow-up (<5 years)
Brunisholz et al. (2017a)	Exclude: Length of follow-up (<5 years)
Brunisholz et al. (2017b)	Exclude: Length of follow-up (<5 years)
Chen et al. (2016)	Exclude: Model based on outcomes at less than 1 year follow-up
Chesla et al. (2016)	Exclude: Length of follow-up (<5 years)
Clark, Boghani, Grullon, and Batista (2017)	Exclude: Length of follow-up (<5 years)
Dall et al. (2015)	Include

Citation	Inclusion/Exclusion Rationale
Damschroder et al. (2017)	Exclude: Length of follow-up (<5 years)
Desai et al. (2017)	Exclude: Length of follow-up (<5 years)
Eaglehouse, Kramer, Rockette-Wagner, Arena, and Kriska (2015)	Exclude: Outcome (main outcome is rate of physical activity reporting in DPP lifestyle interventions)
Eaglehouse et al. (2016)	Exclude: Length of follow-up (<5 years)
Fischer et al. (2016)	Exclude: Length of follow-up (<5 years)
Glechner et al. (2015)	Exclude: Intervention (results not stratified by intervention type)
Goldberg et al. (2017)	Exclude: Outcome (calcium scoring)
Golden et al. (2017)	Exclude: Study design (narrative review)
Guo, Chen, Whittemore, and Whitaker (2016)	Exclude: Intervention (results not stratified by intervention type)
Hafez, De Michele, and Sachdev (2016)	Exclude: Study design (program description, outcomes not reported)
Hu, Li, Lv, Wu, and Tong (2015)	Exclude: Intervention (acarbose monotherapy)
Johnson et al. (2013)	Exclude: Superseded by more recent, comprehensive systematic reviews
Joiner et al. (2017)	Exclude: Length of follow-up (all included studies <5 years)
Kerrison et al. (2017)	Exclude: Intervention (results not stratified by intervention type)
Li et al. (2015)	Include
Li, Zhang, Barker, Chowdhury, and Zhang (2010)	Exclude: Superseded by more recent, comprehensive systematic reviews
Marrero et al. (2015)	Exclude: Population (individuals with diabetes)
Marrero et al. (2016)	Exclude: Length of follow-up (<5 years)
McCurley et al. (2017)	Exclude: Length of follow-up (all included studies reported <5 years)
Michaelides, Raby, Wood, Farr, and Toro-Ramos (2016)	Exclude: Length of follow-up (<5 years)
Miller, Nagaraja, and Weinhold (2015)	Exclude: Length of follow-up (<5 years)
Miller, Weinhold, and Nagaraja (2016)	Exclude: Length of follow-up (<5 years)
Moin et al. (2017)	Exclude: Length of follow-up (<5 years)
Mudaliar et al. (2016)	Exclude: Length of follow-up (only reported on outcomes at 1 year from included studies)
Naci and Ioannidis (2013)	Exclude: Intervention (exercise-only interventions)

Citation	Inclusion/Exclusion Rationale
Naci and Ioannidis (2015)	Exclude: Intervention (exercise-only interventions)
NICE (2017)	Exclude: Not U.S.-based
Neamah et al. (2016)	Exclude: Outcome (impact of DPP intervention modifications)
O'Brien et al. (2015)	Exclude: Length of follow-up (<5 years)
O'Brien et al. (2017)	Exclude: Length of follow-up (<5 years)
O'Dea et al. (2015)	Exclude: Length of follow-up (<5 years)
Perez et al. (2015)	Exclude: Study design (trial protocol)
Pillay, Armstrong, Butalia, and et al. (2015)	Exclude: Intervention (results not stratified by intervention type)
Pronk and Remington (2015)	Include
Public Health England (2015)	Exclude: Intervention (results not stratified by intervention type)
Salimi, Fotouhi, Mohammad, Mansournia, and Mansournia (2017)	Exclude: Length of follow-up (<5 years)
Schellenberg, Dryden, Vandermeer, Ha, and Korownyk (2013)	Exclude: Intervention (majority of studies are not DPP-like)
Sepah, Jiang, and Peters (2015)	Exclude: Length of follow-up (<5 years)
Slentz et al. (2016)	Exclude: Length of follow-up (<5 years)
Su, Chen, Dall, Iacobucci, and Perreault (2016)	Exclude: Model based on outcomes at less than 1 year follow-up
Sun, You, Almeida, Estabrooks, and Davy (2017)	Exclude: Intervention (results not stratified by intervention type)
Thomas et al. (2010)	Exclude: Study design (narrative review)
Umpierrez and Pasquel (2014)	Exclude: Study design (editorial)
Vadheim et al. (2017)	Exclude: Length of follow-up (<5 years)
Van Name et al. (2016)	Exclude: Length of follow-up (<5 years)
Vitolins et al. (2017)	Exclude: Length of follow-up (<5 years)
Weinhold et al. (2015)	Exclude: Length of follow-up (<5 years)
Whittemore (2011)	Exclude: Superseded by more recent, comprehensive systematic reviews
Yeh et al. (2016)	Exclude: Length of follow-up (<5 years)
Yuen, Sugeng, Weiland, and Jelinek (2010)	Exclude: Superseded by more recent, comprehensive systematic reviews

Citation	Inclusion/Exclusion Rationale
Zheng et al. (2016)	Exclude: Intervention (unable to determine whether included studies are DPP-like)

Abbreviations. DPP: Diabetes Prevention Program.

Appendix C. List of Trials Registered on Clinicaltrials.gov

Trial Name ClinicalTrials.gov Identifier	Status	Notes
A Pharmacist-Coordinated Implementation of the Diabetes Prevention Program NCT02384109	Recruiting	Behavioral: Shared decision making with pharmacists Behavioral: Standard care from primary care providers Completion Date: June 2019
A Mixed Methods Pilot Study of a Low-Carbohydrate Diabetes Prevention Program Among Individuals With Prediabetes NCT03258918	Recruiting	Behavioral: Low-carbohydrate diabetes prevention program Completion Date: December 2018
Filipinos Fit and Trim Weight Loss for Diabetes Prevention Program NCT02278939	Active, not recruiting	Behavioral: Filipinos Fit and Trim Weight Loss Program Completion Date: January 2017
Translational Diabetes Prevention in GDM NCT01489163	Active, not recruiting	Behavioral: Lifestyle counseling Completion Date: December 2017
Evaluation of an Online Diabetes Prevention Program Adapted for Safety Net Users NCT02664064	Active, not recruiting	Behavioral: Prevent (online prevention program) Completion Date: May 2018
Culturally-adapted Diabetes Prevention Lifestyle Intervention for Latinos in Primary Care (E-LITE Latinos) NCT02459691	Active, not recruiting	Behavioral: Vida Sana [culturally adapted diabetes prevention lifestyle intervention, translated to English means *Healthy Life*] Other: Usual care only Completion Date: August 2019
Chinese Diabetes Prevention Program: An Implementation and Dissemination Study NCT02277509	Recruitment suspended	Behavioral: Chinese diabetes prevention program Behavioral: Minimal intervention control Completion Date: December 2019
Diabetes Prevention Program NCT00004992	Completed	Behavioral: Intensive lifestyle interventions Completion Date: April 2001

Trial Name ClinicalTrials.gov Identifier	Status	Notes
Effectiveness of Automated Telephone Intervention on Behavioral and Weight Outcomes for Patients With Pre-Diabetes NCT00384488	Completed	Behavioral: Interactive voice response system Completion Date: May 2006
Feasibility of a Partnered Approach to Prevent Diabetes NCT00302055	Completed	Behavioral: Clinician referral to diabetes prevention lifestyle Behavioral: Clinician referral to group diabetes prevention lifestyle Completion Date: July 2007
Translating the DPP Into the Community NCT00302042	Completed	Behavioral: Brief counseling plus group diabetes prevention in community Behavioral: Brief counseling for prediabetes alone Completion Date: August 2007
Screening, Training, Education and Prevention Service of the University of Pittsburgh, Phase 2 NCT00480779	Completed	Behavioral: Group lifestyle balance group Behavioral: Group lifestyle balance DVD Completion Date: May 2009
Virtual Translation of Diabetes Prevention to Primary Care: A Pilot Study NCT00729079	Completed	Behavioral: Diabetes prevention program Completion Date: October 2009
A Culturally Tailored Lifestyle Intervention to Prevent Diabetes in South Asians NCT01084928	Completed	Behavioral: Lifestyle intervention classes Completion Date: July 2012
Comparative Effectiveness of Practice-Based Diabetes Prevention Programs—A Pilot Study NCT01409889	Completed	Behavioral: Diabetes prevention program Behavioral: Healthy living program Completion Date: August 2012
Collaborations for Health Improvement in East Harlem—Project HEED NCT01004848	Completed	Behavioral: Peer-led lifestyle education on weight loss Completion Date: September 2012

Trial Name ClinicalTrials.gov Identifier	Status	Notes
mDPP Pilot RCT of a Motivational Mobile Diabetes Prevention Program (mDPP) NCT01579292	Completed	Behavioral: Mobile phone-based physical activity with intervention Behavioral: Pedometer only Completion Date: July 2013
Evaluation of a Lifestyle Intervention for Employees With Prediabetes NCT01682954	Completed	Behavioral: Lifestyle counseling Completion Date: May 2014
Translating Research Into the Prevention of Diabetes Mellitus (TRIP DM) NCT00631345	Completed	Behavioral: Group-based lifestyle intervention Behavioral: Individual education program Behavioral: Self-directed maintenance Behavioral: Extended group maintenance Completion Date: May 2015
Primary Prevention of Diabetes in Children and Mothers at Increased Risk: Encourage Healthy Families NCT01823367	Completed	Behavioral: Diabetes prevention program Completion Date: April 2016
Latinos Combatiendo la Diabetes (Latinos Combating Diabetes) NCT01831921	Completed	Behavioral: Lifestyle weight loss Behavioral: Counseling Completion Date: June 2017
Diabetes Prevention Program Outcomes Study NCT00038727	Unknown*	Behavioral: Group Lifestyle Drug: Metformin Behavioral: Boost Lifestyle Completion Date: January 2015

*Note: *As stated on clinicaltrials.gov. The trial record in clinicaltrials.gov has not been updated recently.*

About the Center for Evidence-based Policy

The Center for Evidence-based Policy (Center) is recognized as a national leader in evidence-based decision making and policy design. The Center understands the needs of policymakers and supports public organizations by providing reliable information to guide decisions, maximize existing resources, improve health outcomes, and reduce unnecessary costs. The Center specializes in ensuring diverse and relevant perspectives are considered, and appropriate resources are leveraged to strategically address complex policy issues with high-quality evidence and collaboration. The Center is based at Oregon Health & Science University in Portland, Oregon. Further information about the Center is available at http://centerforevidencebasedpolicy.org/.

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