3. Prevention or Delay of Type 2 Diabetes: *Standards of Medical Care in Diabetes—2020*

American Diabetes Association

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The American Diabetes Association (ADA) "Standards of Medical Care in Diabetes" includes the ADA's current clinical practice recommendations and is intended to provide the components of diabetes care, general treatment goals and guidelines, and tools to evaluate quality of care. Members of the ADA Professional Practice Committee, a multidisciplinary expert committee (https://doi.org/10.2337/dc20-SPPC), are responsible for updating the Standards of Care annually, or more frequently as warranted. For a detailed description of ADA standards, statements, and reports, as well as the evidence-grading system for ADA's clinical practice recommendations, please refer to the Standards of Care Introduction (https://doi.org/10.2337/dc20-SINT). Readers who wish to comment on the Standards of Care are invited to do so at professional.diabetes.org/SOC.

For guidelines related to screening for increased risk for type 2 diabetes (prediabetes), please refer to Section 2 "Classification and Diagnosis of Diabetes" (https://doi.org/10.2337/dc20-S002).

Recommendation

3.1 At least annual monitoring for the development of type 2 diabetes in those with prediabetes is suggested. **E**

Screening for prediabetes and type 2 diabetes risk through an informal assessment of risk factors (**Table 2.3**) or with an assessment tool, such as the American Diabetes Association risk test (**Fig. 2.1**), is recommended to guide providers on whether performing a diagnostic test for prediabetes (**Table 2.5**) and previously undiagnosed type 2 diabetes (**Table 2.2**) is appropriate (see Section 2 "Classification and Diagnosis of Diabetes," https://doi.org/10.2337/dc20-S002). Those who are determined to be at high risk for type 2 diabetes, including people with A1C 5.7–6.4% (39–47 mmol/mol), impaired glucose tolerance, or impaired fasting glucose, are ideal candidates for diabetes prevention efforts. Using A1C to screen for prediabetes may be problematic in the presence of certain hemoglobinopathies or conditions that affect red blood cell turnover. See Section 2 "Classification and Diagnosis of Diabetes" (https://doi.org/10.2337/dc20-S002) and Section 6 "Glycemic Targets" (https://doi.org/10.2337/dc20-S006) for additional details on the appropriate use of the A1C test.

LIFESTYLE INTERVENTIONS

Recommendations

3.2 Refer patients with prediabetes to an intensive behavioral lifestyle intervention program modeled on the Diabetes Prevention Program (DPP) 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. **A**

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3.3 A variety of eating patterns are acceptable for persons with prediabetes. **B**

3.4 Based on patient preference, technology-assisted diabetes prevention interventions may be effective in preventing type 2 diabetes and should be considered. **B**

3.5 Given the cost-effectiveness of diabetes prevention, such intervention programs should be covered by third-party payers. **B**

The Diabetes Prevention Program

Several major randomized controlled trials, including the Diabetes Prevention Program (DPP) (1), the Finnish Diabetes Prevention Study (DPS) (2), and the Da Qing Diabetes Prevention Study (Da Qing study) (3), demonstrate that lifestyle/behavioral therapy featuring an individualized reduced calorie meal plan is highly effective in preventing type 2 diabetes and improving other cardiometabolic markers (such as blood pressure, lipids, and inflammation) (4). The strongest evidence for diabetes prevention in the U.S. comes from the DPP trial (1). The DPP demonstrated that an intensive lifestyle intervention could reduce the incidence of type 2 diabetes by 58% over 3 years. Follow-up of three large studies of lifestyle intervention for diabetes prevention has shown sustained reduction in the rate of conversion to type 2 diabetes: 39% reduction at 30 years in the Da Qing study (5), 43% reduction at 7 years in the Finnish DPS (2), and 34% reduction at 10 years (6) and 27% reduction at 15 years (7) in the U.S. Diabetes Prevention Program Outcomes Study (DPPOS). Notably, in the 30-year follow-up for the Da Qing study, reductions in all-cause mortality, cardiovascular disease–related mortality, and microvascular complications were observed for the lifestyle intervention groups compared with the control group (5).

The two major goals of the DPP intensive, behavioral lifestyle intervention were to achieve and maintain a minimum of 7% weight loss and 150 min of physical activity similar in intensity to brisk walking per week. The DPP lifestyle intervention was a goal-based intervention: all participants were given the same weight loss and physical activity goals, but individualization was permitted in the specific methods used to achieve the goals (8).

The 7% weight loss goal was selected because it was feasible to achieve and maintain and likely to lessen the risk of developing diabetes. Participants were encouraged to achieve the 7% weight loss during the first 6 months of the intervention. However, longer-term (4-year) data reveal maximal prevention of diabetes observed at about 7–10% weight loss (9). The recommended pace of weight loss was 1–2 lb/week. Calorie goals were calculated by estimating the daily calories needed to maintain the participant's initial weight and subtracting 500–1,000 calories/day (depending on initial body weight). The initial focus was on reducing total dietary fat. After several weeks, the concept of calorie balance and the need to restrict calories as well as fat was introduced (8).

The goal for physical activity was selected to approximate at least 700 kcal/week expenditure from physical activity. For ease of translation, this goal was described as at least 150 min of moderate-intensity physical activity per week similar in intensity to brisk walking. Participants were encouraged to distribute their activity throughout the week with a minimum frequency of three times per week and at least 10 min per session. A maximum of 75 min of strength training could be applied toward the total 150 min/week physical activity goal (8).

To implement the weight loss and physical activity goals, the DPP used an individual model of treatment rather than a group-based approach. This choice was based on a desire to intervene before participants had the possibility of developing diabetes or losing interest in the program. The individual approach also allowed for tailoring of interventions to reflect the diversity of the population (8).

The DPP intervention was administered as a structured core curriculum followed by a more flexible maintenance program of individual sessions, group classes, motivational campaigns, and restart opportunities. The 16-session core curriculum was completed within the first 24 weeks of the program and included sections on lowering calories, increasing physical activity, self-monitoring, maintaining healthy lifestyle behaviors, and psychological, social, and motivational challenges. For further details on the core curriculum sessions, refer to ref. 8.

Nutrition

Structured behavioral weight loss therapy, including a reduced calorie meal plan and physical activity, is of paramount importance for those at high risk for developing type 2 diabetes who have overweight or obesity (1,9). Because weight loss through lifestyle changes alone can be difficult to maintain long term (6), people being treated with weight loss therapy should have access to ongoing support and additional therapeutic options (such as pharmacotherapy) if needed. Based on intervention trials, a variety of eating patterns may be appropriate for patients with prediabetes (10), including Mediterranean (11–13) and low-calorie, low-fat eating patterns (8). An eating pattern represents the totality of all foods and beverages consumed (14). In addition, evidence suggests that the overall quality of food consumed (as measured by the Healthy Eating Index, Alternative Healthy Eating Index, and Dietary Approaches to Stop Hypertension [DASH] score), with an emphasis on whole grains, legumes, nuts, fruits and vegetables and minimal refined and processed foods, is also important (15–18).

As is the case for those with diabetes, individualized medical nutrition therapy (see Section 5 "Facilitating Behavior Change and Well-being to Improve Health Outcomes," https://doi.org/10.2337/dc20-S005, for more detailed information) is effective in lowering A1C in individuals diagnosed with prediabetes (19).

Physical Activity

Just as 150 min/week of moderate-intensity physical activity, such as brisk walking, showed beneficial effects in those with prediabetes (1), moderate-intensity physical activity has been shown to improve insulin sensitivity and reduce abdominal fat in children and young adults (20,21). On the basis of these findings, providers are encouraged to promote a DPP-style program, including its focus on physical activity, to all individuals who have been identified to be at an increased risk of type 2 diabetes. In addition to aerobic activity, an exercise regimen designed to prevent diabetes may include resistance training (8,22,23). Breaking up prolonged sedentary time may also be encouraged,

as it is associated with moderately lower postprandial glucose levels (24,25). The preventive effects of exercise appear to extend to the prevention of gestational diabetes mellitus (GDM) (26).

Tobacco Use

Smoking may increase the risk of type 2 diabetes (27); therefore, evaluation for tobacco use and referral for tobacco cessation, if indicated, should be part of routine care for those at risk for diabetes. Of note, the years immediately following smoking cessation may represent a time of increased risk for diabetes (27–29) and patients should be monitored for diabetes development and receive evidence-based interventions for diabetes prevention as described in this section. See Section 5 "Facilitating Behavior Change and Well-being to Improve Health Outcomes" (https://doi.org/10.2337/dc20-S005) for more detailed information.

Technology-Assisted Interventions to Deliver Lifestyle Interventions

Technology-assisted interventions may effectively deliver the DPP lifestyle intervention, reducing weight and, therefore, diabetes risk (30–35). Such technology-assisted interventions may deliver content through smartphone and web-based applications and telehealth (30). The Centers for Disease Control and Prevention (CDC) Diabetes Prevention Recognition Program (DPRP) (www.cdc.gov/diabetes/prevention/requirements-recognition.htm) certifies technology-assisted modalities as effective vehicles for DPP-based interventions; such programs must use an approved curriculum, include interaction with a coach, and attain the DPRP outcomes of participation, physical activity reporting, and weight loss. The selection of an in-person or virtual program should be based on patient preference.

Cost-effectiveness

A cost-effectiveness model suggested that the lifestyle intervention used in the DPP was cost-effective (36,37). Actual cost data from the DPP and DPPOS confirmed this (38). Group delivery of DPP content in community or primary care settings has the potential to reduce overall program costs while still producing weight loss and diabetes risk reduction (39–42). The use of community health workers to support DPP efforts has been shown to be effective with cost savings (43,44) (see Section 1 "Improving Care and Promoting Health in Populations," https://doi.org/10.2337/dc20-S001, for more information). Given the cost-effectiveness of diabetes prevention, such intervention programs should be covered by third-party payers.

The CDC coordinates the National Diabetes Prevention Program (National DPP), a resource designed to bring evidence-based lifestyle change programs for preventing type 2 diabetes to communities (www.cdc.gov/diabetes/prevention/index.htm). This online resource includes locations of CDC-recognized diabetes prevention lifestyle change programs (available at nccd.cdc.gov/DDT_DPRP/Programs.aspx). To be eligible for this program, patients must have a BMI in the overweight range and be at risk for diabetes based on laboratory testing or a positive risk test (available at www.cdc.gov/prediabetes/takethetest/). Results from the CDC's National DPP during the first 4 years of implementation are promising (45). The CDC has also developed the Diabetes Prevention Impact Tool Kit (available at nccd.cdc.gov/toolkit/diabetesimpact) to help organizations assess the economics of providing or covering the National DPP lifestyle change program (46).

National Policy

In an effort to expand preventive services using a cost-effective model that began in April 2018, the Centers for Medicare & Medicaid Services expanded Medicare reimbursement coverage for the National DPP lifestyle intervention to organizations recognized by the CDC that become Medicare suppliers for this service (online at innovation.cms.gov/initiatives/medicare-diabetes-prevention-program/). The locations of Medicare DPPs are available online at innovation.cms.gov/initiatives/medicare-diabetes-prevention-program/mdpp-map.html. To qualify for Medicare coverage, patients must have a BMI in the overweight range and laboratory testing consistent with prediabetes in the last year. Medicaid coverage of the DPP lifestyle intervention is also expanding on a state-by-state basis.

PHARMACOLOGIC INTERVENTIONS

Recommendations

3.6 Metformin therapy for prevention of type 2 diabetes should be considered in those with prediabetes, especially for those with BMI $\geq$35 kg/m^2, those aged $<$60 years, and women with prior gestational diabetes mellitus. **A**

3.7 Long-term use of metformin may be associated with biochemical vitamin B12 deficiency, and periodic measurement of vitamin B12 levels should be considered in metformin-treated patients, especially in those with anemia or peripheral neuropathy. **B**

Pharmacologic agents including metformin, α-glucosidase inhibitors, glucagon-like peptide 1 receptor agonists, thiazolidinediones, and several agents approved for weight loss have been shown in research studies to decrease the incidence of diabetes to various degrees in those with prediabetes (1,47–53), though none are approved by the U.S. Food and Drug Administration specifically for diabetes prevention. The risk versus benefit of each medication must be weighed. Metformin has the strongest evidence base (54) and demonstrated long-term safety as pharmacologic therapy for diabetes prevention (52). For other drugs, cost, side effects, and durable efficacy require consideration.

Metformin was overall less effective than lifestyle modification in the DPP, though group differences declined over time in the DPPOS (7), and metformin may be cost-saving over a 10-year period (38). During initial follow up in the DPP, metformin was as effective as lifestyle modification in participants with BMI $\geq$35 kg/m^2 but not significantly better than placebo in those over 60 years of age (1). In the DPP, for women with a history of GDM, metformin and intensive lifestyle modification led to an equivalent 50% reduction in diabetes risk (55), and both interventions remained highly effective during a 10-year follow-up period (56). By the time of the 15-year follow-up (DPPOS), exploratory analyses demonstrated that participants with a higher baseline fasting glucose

(≥110 mg/dL vs. 95–109 mg/dL) and women with a history of GDM (vs. women without a history of GDM) experienced higher risk reductions with metformin (compared with the placebo arm) (57). In the Indian Diabetes Prevention Program (IDPP-1), metformin and the lifestyle intervention reduced diabetes risk similarly at 30 months; of note, the lifestyle intervention in IDPP-1 was less intensive than that in the DPP (58). Based on findings from the DPP, metformin should be recommended as an option for high-risk individuals (e.g., those with a history of GDM or those with BMI ≥35 kg/m^2). Consider monitoring vitamin B12 levels in those taking metformin chronically to check for possible deficiency (56) (see Section 9 "Pharmacologic Approaches to Glycemic Treatment," https://doi.org/10.2337/dc20-S009, for more details).

PREVENTION OF CARDIOVASCULAR DISEASE

Recommendation

3.8 Prediabetes is associated with heightened cardiovascular risk; therefore, screening for and treatment of modifiable risk factors for cardiovascular disease are suggested. **B**

People with prediabetes often have other cardiovascular risk factors, including hypertension and dyslipidemia (59), and are at increased risk for cardiovascular disease (60,61). Although treatment goals for people with prediabetes are the same as for the general population (62), increased vigilance is warranted to identify and treat these and other cardiovascular risk factors (e.g., smoking).

DIABETES SELF-MANAGEMENT EDUCATION AND SUPPORT

Recommendation

3.9 Diabetes self-management education and support programs may be appropriate venues for people with prediabetes to receive education and support to develop and maintain behaviors that can prevent or delay the development of type 2 diabetes. **B**

As for those with established diabetes, the standards for diabetes self-management education and support (see Section 5 "Facilitating Behavior Change and Well-being to Improve Health Outcomes," https://doi.org/10.2337/dc20-S005) can also apply to people with prediabetes. Currently, there are significant barriers to the provision of education and support to those with prediabetes. However, the strategies for supporting successful behavior change and the healthy behaviors recommended for people with prediabetes are comparable to those for people with diabetes. Although reimbursement remains a barrier, studies show that providers of diabetes self-management education and support are particularly well equipped to assist people with prediabetes in developing and maintaining behaviors that can prevent or delay the development of diabetes (19,63).

References

1. Knowler WC, Barrett-Connor E, Fowler SE, et al.; Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393–403
2. Lindström J, Ilanne-Parikka P, Peltonen M, et al.; Finnish Diabetes Prevention Study Group. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. Lancet 2006;368:1673–1679
3. Li G, Zhang P, Wang J, et al. Cardiovascular mortality, all-cause mortality, and diabetes incidence after lifestyle intervention for people with impaired glucose tolerance in the Da Qing Diabetes Prevention Study: a 23-year follow-up study. Lancet Diabetes Endocrinol 2014;2:474–480
4. Nathan DM, Bennett PH, Crandall JP, et al.; DPP Research Group. Does diabetes prevention translate into reduced long-term vascular complications of diabetes? Diabetologia 2019;62:1319–1328
5. Gong Q, Zhang P, Wang J, et al.; Da Qing Diabetes Prevention Study Group. Morbidity and mortality after lifestyle intervention for people with impaired glucose tolerance: 30-year results of the Da Qing Diabetes Prevention Outcome Study. Lancet Diabetes Endocrinol 2019;7:452–461
6. Knowler WC, Fowler SE, Hamman RF, et al.; Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. Lancet 2009;374:1677–1686
7. Nathan DM, Barrett-Connor E, Crandall JP, et al.; Diabetes Prevention Program Research Group. Long-term effects of lifestyle intervention or metformin on diabetes development and microvascular complications: the DPP Outcomes Study. Lancet Diabetes Endocrinol 2015;3:866–875
8. Diabetes Prevention Program (DPP) Research Group. The Diabetes Prevention Program (DPP): description of lifestyle intervention. Diabetes Care 2002;25:2165–2171
9. Hamman RF, Wing RR, Edelstein SL, et al. Effect of weight loss with lifestyle intervention on risk of diabetes. Diabetes Care 2006;29:2102–2107
10. Evert AB, Dennison M, Gardner CD, et al. Nutrition therapy for adults with diabetes or prediabetes: a consensus report. Diabetes Care 2019;42:731–754
11. Salas-Salvadó J, Guasch-Ferré M, Lee C-H, Estruch R, Clish CB, Ros E. Protective effects of the Mediterranean diet on type 2 diabetes and metabolic syndrome. J Nutr 2016;146:920S–927S
12. Bloomfield HE, Koeller E, Greer N, MacDonald R, Kane R, Wilt TJ. Effects on health outcomes of a Mediterranean diet with no restriction on fat intake: a systematic review and meta-analysis. Ann Intern Med 2016;165:491–500
13. Estruch R, Ros E, Salas-Salvadó J, et al.; PREDIMED Study Investigators. Primary prevention of cardiovascular disease with a Mediterranean diet supplemented with extra-virgin olive oil or nuts. N Engl J Med 2018;378:e34
14. Department of Health and Human Services and Department of Agriculture. Dietary Guidelines for Americans 2015–2020, Eighth Edition. Accessed 31 October 2019. Available from https://health.gov/dietaryguidelines/2015/guidelines/
15. Ley SH, Hamdy O, Mohan V, Hu FB. Prevention and management of type 2 diabetes: dietary components and nutritional strategies. Lancet 2014;383:1999–2007
16. Jacobs S, Harmon BE, Boushey CJ, et al. A priori-defined diet quality indexes and risk of type 2 diabetes: the Multiethnic Cohort. Diabetologia 2015;58:98–112
17. Chiuve SE, Fung TT, Rimm EB, et al. Alternative dietary indices both strongly predict risk of chronic disease. J Nutr 2012;142:1009–1018
18. Schwingshackl L, Bogensberger B, Hoffmann G. Diet quality as assessed by the Healthy Eating Index, Alternate Healthy Eating Index, Dietary Approaches to Stop Hypertension score, and health outcomes: an updated systematic review and meta-analysis of cohort studies. J Acad Nutr Diet 2018;118:74–100.e11
19. Parker AR, Byham-Gray L, Denmark R, Winkle PJ. The effect of medical nutrition therapy by a registered dietitian nutritionist in patients with prediabetes participating in a randomized controlled clinical research trial. J Acad Nutr Diet 2014;114:1739–1748
20. Fedewa MV, Gist NH, Evans EM, Dishman RK. Exercise and insulin resistance in youth: a meta-analysis. Pediatrics 2014;133:e163–e174
21. Davis CL, Pollock NK, Waller JL, et al. Exercise dose and diabetes risk in overweight and obese children: a randomized controlled trial. JAMA 2012;308:1103–1112
22. Sigal RJ, Alberga AS, Goldfield GS, et al. Effects of aerobic training, resistance training, or both on percentage body fat and cardiometabolic risk markers in obese adolescents: the Healthy Eating Aerobic and Resistance Training in Youth randomized clinical trial. JAMA Pediatr 2014;168:1006–1014
23. Dai X, Zhai L, Chen Q, et al. Two-year-supervised resistance training prevented diabetes incidence in people with prediabetes: a randomised control trial. Diabetes Metab Res Rev 2019;35:e3143

24. Thorp AA, Kingwell BA, Sethi P, Hammond L, Owen N, Dunstan DW. Alternating bouts of sitting and standing attenuate postprandial glucose responses. Med Sci Sports Exerc 2014;46:2053–2061
25. Healy GN, Dunstan DW, Salmon J, et al. Breaks in sedentary time: beneficial associations with metabolic risk. Diabetes Care 2008;31:661–666
26. Russo LM, Nobles C, Ertel KA, Chasan-Taber L, Whitcomb BW. Physical activity interventions in pregnancy and risk of gestational diabetes mellitus: a systematic review and meta-analysis. Obstet Gynecol 2015;125:576–582
27. Yeh H-C, Duncan BB, Schmidt MI, Wang N-Y, Brancati FL. Smoking, smoking cessation, and risk for type 2 diabetes mellitus: a cohort study. Ann Intern Med 2010;152:10–17
28. Oba S, Noda M, Waki K, et al.; Japan Public Health Center-based Prospective Study Group. Smoking cessation increases short-term risk of type 2 diabetes irrespective of weight gain: the Japan Public Health Center-based Prospective Study [published correction appears in PLoS One 2013;8:10.1371/annotation/23aa7c42-9a4d-42a7-8f50-9d0ac4b85396]. PLoS One 2012;7:e17061
29. Hu Y, Zong G, Liu G, et al. Smoking cessation, weight change, type 2 diabetes, and mortality. N Engl J Med 2018;379:623–632
30. Grock S, Ku J-H, Kim J, Moin T. A review of technology-assisted interventions for diabetes prevention. Curr Diab Rep 2017;17:107
31. Sepah SC, Jiang L, Peters AL. Translating the Diabetes Prevention Program into an online social network: validation against CDC standards. Diabetes Educ 2014;40:435–443
32. Bian RR, Piatt GA, Sen A, et al. The effect of technology-mediated diabetes prevention interventions on weight: a meta-analysis. J Med Internet Res 2017;19:e76
33. Sepah SC, Jiang L, Peters AL. Long-term outcomes of a Web-based diabetes prevention program: 2-year results of a single-arm longitudinal study. J Med Internet Res 2015;17:e92
34. Moin T, Damschroder LJ, AuYoung M, et al. Results from a trial of an online diabetes prevention program intervention. Am J Prev Med 2018;55:583–591
35. Michaelides A, Major J, Pienkosz E Jr, Wood M, Kim Y, Toro-Ramos T. Usefulness of a novel mobile Diabetes Prevention Program delivery platform with human coaching: 65-week observational follow-up. JMIR Mhealth Uhealth 2018;6:e93
36. Herman WH, Hoerger TJ, Brandle M, et al.; Diabetes Prevention Program Research Group. The cost-effectiveness of lifestyle modification or metformin in preventing type 2 diabetes in adults with impaired glucose tolerance. Ann Intern Med 2005;142:323–332
37. Chen F, Su W, Becker SH, et al. 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 2016;11:e0163627
38. Diabetes Prevention Program Research Group. The 10-year cost-effectiveness of lifestyle intervention or metformin for diabetes prevention: an intent-to-treat analysis of the DPP/DPPOS [published correction appears in Diabetes Care 2013;36:4172–4175]. Diabetes Care 2012;35:723–730
39. Ackermann RT, Finch EA, Brizendine E, Zhou H, Marrero DG. Translating the Diabetes Prevention Program into the community. The DEPLOY pilot study. Am J Prev Med 2008;35:357–363
40. Balk EM, Earley A, Raman G, Avendano EA, Pittas AG, Remington PL. 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. Ann Intern Med 2015;163:437–451
41. Li R, Qu S, Zhang P, et al. 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. Ann Intern Med 2015;163:452–460
42. Gilmer T, O'Connor PJ, Schiff JS, et al. Cost-effectiveness of a community-based Diabetes Prevention Program with participation incentives for Medicaid beneficiaries. Health Serv Res 2018;53:4704–4724
43. The Community Guide. Diabetes prevention: interventions engaging community health workers, 2016. Accessed 31 October 2019. Available from https://www.thecommunityguide.org/findings/diabetes-prevention-interventions-engaging-community-health-workers
44. Jacob V, Chattopadhyay SK, Hopkins DP, et al. Economics of community health workers for chronic disease: findings from Community Guide systematic reviews. Am J Prev Med 2019;56:e95–e106
45. Ely EK, Gruss SM, Luman ET, et al. A national effort to prevent type 2 diabetes: participant-level evaluation of CDC's National Diabetes Prevention Program. Diabetes Care 2017;40:1331–1341
46. Lanza A, Soler R, Smith B, Hoerger T, Neuwahl S, Zhang P. The Diabetes Prevention Impact Tool Kit: an online tool kit to assess the cost-effectiveness of preventing type 2 diabetes. J Public Health Manag Pract 2019;25:E1–E5
47. Chiasson J-L, Josse RG, Gomis R, Hanefeld M, Karasik A, Laakso M; STOP-NIDDM Trail Research Group. Acarbose for prevention of type 2 diabetes mellitus: the STOP-NIDDM randomised trial. Lancet 2002;359:2072–2077
48. Torgerson JS, Hauptman J, Boldrin MN, Sjöström L. XENical in the prevention of diabetes in obese subjects (XENDOS) study: a randomized study of orlistat as an adjunct to lifestyle changes for the prevention of type 2 diabetes in obese patients. Diabetes Care 2004;27:155–161
49. le Roux CW, Astrup A, Fujioka K, et al.; SCALE Obesity Prediabetes NN8022-1839 Study Group. 3 years of liraglutide versus placebo for type 2 diabetes risk reduction and weight management in individuals with prediabetes: a randomised, double-blind trial. Lancet 2017;389:1399–1409
50. Gerstein HC, Yusuf S, Bosch J, et al.; DREAM (Diabetes REduction Assessment with ramipril and rosiglitazone Medication) Trial Investigators. Effect of rosiglitazone on the frequency of diabetes in patients with impaired glucose tolerance or impaired fasting glucose: a randomised controlled trial. Lancet 2006;368:1096–1105
51. DeFronzo RA, Tripathy D, Schwenke DC, et al.; ACT NOW Study. Pioglitazone for diabetes prevention in impaired glucose tolerance. N Engl J Med 2011;364:1104–1115
52. Diabetes Prevention Program Research Group. Long-term safety, tolerability, and weight loss associated with metformin in the Diabetes Prevention Program Outcomes Study. Diabetes Care 2012;35:731–737
53. Garvey WT, Ryan DH, Henry R, et al. Prevention of type 2 diabetes in subjects with prediabetes and metabolic syndrome treated with phentermine and topiramate extended release. Diabetes Care 2014;37:912–921
54. Moin T, Schmittdiel JA, Flory JH, et al. Review of metformin use for type 2 diabetes prevention. Am J Prev Med 2018;55:565–574
55. Ratner RE, Christophi CA, Metzger BE, et al.; Diabetes Prevention Program Research Group. Prevention of diabetes in women with a history of gestational diabetes: effects of metformin and lifestyle interventions. J Clin Endocrinol Metab 2008;93:4774–4779
56. Aroda VR, Christophi CA, Edelstein SL, et al.; Diabetes Prevention Program Research Group. The effect of lifestyle intervention and metformin on preventing or delaying diabetes among women with and without gestational diabetes: the Diabetes Prevention Program outcomes study 10-year follow-up. J Clin Endocrinol Metab 2015;100:1646–1653
57. Diabetes Prevention Program Research Group. Long-term effects of metformin on diabetes prevention: identification of subgroups that benefited most in the Diabetes Prevention Program and Diabetes Prevention Program Outcomes Study. Diabetes Care 2019;42:601–608
58. Ramachandran A, Snehalatha C, Mary S, Mukesh B, Bhaskar AD, Vijay V; Indian Diabetes Prevention Programme (IDPP). The Indian Diabetes Prevention Programme shows that lifestyle modification and metformin prevent type 2 diabetes in Asian Indian subjects with impaired glucose tolerance (IDPP-1). Diabetologia 2006;49:289–297
59. Ali MK, Bullard KM, Saydah S, Imperatore G, Gregg EW. Cardiovascular and renal burdens of prediabetes in the USA: analysis of data from serial cross-sectional surveys, 1988-2014. Lancet Diabetes Endocrinol 2018;6:392–403
60. Pan Y, Chen W, Wang Y. Prediabetes and outcome of ischemic stroke or transient ischemic attack: a systematic review and meta-analysis. J Stroke Cerebrovasc Dis 2019;28:683–692
61. Huang Y, Cai X, Mai W, Li M, Hu Y. Association between prediabetes and risk of cardiovascular disease and all cause mortality: systematic review and meta-analysis. BMJ 2016;355:i5953
62. Bress AP, King JB, Kreider KE, et al.; SPRINT Research Group. Effect of intensive versus standard blood pressure treatment according to baseline prediabetes status: a post hoc analysis of a randomized trial. Diabetes Care 2017;40:1401–1408
63. Butcher MK, Vanderwood KK, Hall TO, Gohdes D, Helgerson SD, Harwell TS. Capacity of diabetes education programs to provide both diabetes self-management education and to implement diabetes prevention services. J Public Health Manag Pract 2011;17:242–247