Published in final edited form as:
Curr Nutr Rep. 2014 December 1; 3(4): 364–378. doi:10.1007/s13668-014-0094-2.

Prevention of Diabetes Through the Lifestyle Intervention: Lessons Learned from the Diabetes Prevention Program and Outcomes Study and its Translation to Practice

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Abstract

A number of strategies have been used to delay or prevent the development of type 2 diabetes mellitus (T2D) in high-risk adults. Among them were diet, exercise, medications and surgery. This report focuses on the nutritional lessons learned from implementation of the Intensive Lifestyle Intervention (ILI) in the DPP and its follow-up DPPOS that looked at weight loss through modification of diet and exercise. The Diabetes Prevention Program (DPP) is a large clinical trial,

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Compliance with Ethics Guidelines: **Conflict of Interest**: Mary A. Hoskin declares that she has no conflict of interest.
George A. Bray has received research support through a grant from the NIH National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK); has received compensation from Herbalife Nutrition Institute, Jason Pharmaceuticals, and Theracos Pharmaceuticals for service as a consultant; has received payment for lectures including service on speakers bureaus from the American Association of Clinical Endocrinologists; and has received royalties from contributions to the *Handbook of Obesity*, Up-to-Date, and CRC Press.
Kathy Hattaway declares that she has no conflict of interest.
Prajakta A. Khare-Ranade has received research support through a grant from the NIH National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) for DPPOS.
Jeremy Pomeroy has received research support through a grant from the NIH National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK).
Linda N. Semler has been issued a patent for the Group Lifestyle Balance™ program, but has disclaimed rights to licensing proceeds and has no personal financial interest in the licensing for the program.
Valarie A. Weinzierl declares that she has no conflict of interest.
Judith Wylie-Rosett has received research support through a grant from the NIH National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK).

Human and Animal Rights and Informed Consent: This article does not contain any studies with human or animal subjects performed by any of the authors.

sponsored by the National Institutes of Health, designed to look at several strategies to prevent conversion to type 2 diabetes (T2D) by adults with prediabetes (IGT/IFG) including an Intensive Lifestyle Intervention (ILI). The ∼3800 ethnically diverse participants (46% reported non-white race) were overweight, had impaired glucose tolerance (IGT) and impaired fasting glucose (IFG). Treatments were assigned randomly. The Diabetes Prevention Program Outcomes Study (DPPOS) is a follow up study evaluating the long-term outcomes of the clinical trial.

Keywords

Lifestyle intervention; Diabetes prevention; weight loss; physical activity; prevention; diabetes; overweight; type 2 diabetes; nutrition; lifestyle; diet; genetics

Introduction

The prevention of type 2 diabetes mellitus (T2D) is a major public health challenge due to the significant impact it has on health and the economics of health care. Strategies for preventing or delaying T2D have been evaluated [1]. The Diabetes Prevention Program (DPP) and its follow-up Outcomes Study (DPPOS) have demonstrated that both ILI and metformin treatment can effectively prevent or delay the onset of T2D and improve related co-morbidities in participants who are overweight have IFG and IGT. In an intention to treat analysis, the DPP reported a 58% reduction in the incidence of T2D over 3.2 years in subjects in the ILI treatment group [2] and by 34% over a 10-year period [3]. Lifestyle intervention benefits were observed in both sexes, and in all age, BMI, racial and ethnic groups. The DPP lifestyle intervention focused on two of the major modifiable risk factors for T2D, body weight and physical activity. This report focuses on the 1079 participants randomized to the ILI treatment group during the DPP, of whom 910 enrolled in the DPPOS.

Methods

Eligibility criteria for the DPP included an age of ≥25 years, BMI ≥24 kg/m^2 (BMI ≥22 kg/m^2 for Asians), fasting plasma glucose of 95-125 mg/dl (≤125 mg/dl in American Indians) and a plasma glucose value of 140-199 mg/dl 2 hours after a 75-gram glucose load. The local Institutional Review Board(s) approved the protocol at each center, and all participants provided written informed consent before entering the study.

The design, lifestyle intervention methods, and characteristics of the DPP cohort have been described elsewhere [4] as have the lifestyle participants and intervention offered [5]. The lifestyle intervention goals were to reduce body weight by 7%, achieve or maintain 150 min of moderate intensity physical activity weekly, and to reduce dietary fat intake to <25% of calories; if weight loss was not achieved by lowering fat, calorie goals were introduced. The initial intervention consisted of individual meetings with a coach and periodic group classes thereafter designed to support the weight loss and physical activity goals. DPPOS provided support for the lifestyle participants at a much lower level than in the DPP [3, 6]. Incident T2D was assessed annually with an oral glucose tolerance test and semiannually with fasting glucoses that were confirmed if indicative of diabetes. The ADA diagnostic criteria were

used [7]. Weight was measured semiannually. Food intake was assessed by interview at several intervals using a modified Block food frequency questionnaire [8-10]. Total MET hours per week of physical activity were assessed at the 1-year by the Modifiable Physical Activity Questionnaire [11]. Retention was excellent.

Description of the ILI

Individual case managers or "lifestyle coaches" delivered a structured 16-session core behavioral curriculum with continuing support or "Aftercore" and additional materials to address unique needs of the ethnically diverse participants that is available at http://www.bsc.gwu.edu/dpp/index.ritmlvdoc. Keys to success included 1) a goal based behavioral intervention, 2) lifestyle coaches, 3) frequent contact, 4) tailoring strategies, 5) materials and strategies to address the needs of an ethnically diverse population, and 6) an extensive local and national network [5, 12,13].

Lifestyle coaches, who were usually dietitians, tailored the intervention for individual participants [14] to address barriers and facilitate adherence among the large ethnically diverse participants. The most effective strategies were skill-building strategies for behavioral self-management. Individualization was achieved through a "toolbox" of adherence strategies and a flexible maintenance intervention of both group and individual approaches. The most frequently used items in the toolbox were the less costly such as; problem-solving, review of self-monitoring skills, and specific recommendations to increase physical activity or decrease fat and calories. Problem solving was the dominant intervention approach used by coaches to help participants achieve goals in the DPP and the DPPOS. "Problem Solving" is a 5-step behaviour change method that included: 1) maintaining a proactive attitude; 2) defining the problem/behaviour chains; 3) generating alternatives; 4) setting achievable goals and 5) evaluating success and repeating steps if necessary [15].

At the end of DPP, all participants were eligible for continued follow-up in DPPOS and 2766 of 3150 (88%) elected to continue [3]. All participants were invited to attend quarterly Healthy Eating and Lifestyle Programs (HELP). The purpose was to reinforce the original weight loss and physical activity goals by providing group classes related to healthy eating, weight management, and physical activity for diabetes prevention, the reduction of cardiovascular risk, and the promotion of optimal health and well-being. In addition, former Lifestyle participants were offered two motivational campaigns per year (BOOST) to provide structured focus on behavioral self-management strategies that are important for weight loss/maintenance and adherence to the physical activity goal. Lifestyle participants also completed a "Lifestyle Check-up" at both their annual and mid-year clinic visits to provide participants with individual feedback on their weight history and to review personal lifestyle goals and plans [3, 6].

Preventing Diabetes in the DPP

In the DPP, physical activity only had a small effect on T2D prevention and was dwarfed by the much stronger effect of weight loss [16]. For every kg of weight lost during the DPP, there was a 16% reduction in risk of developing T2D, adjusted for changes in diet and activity. Simultaneous adjustments for changes in physical activity, percent fat, IGT and

elevated fasting insulin among other variables, had a negligible effect on the hazard ratio (HR) for weight loss compared with the unadjusted HR for weight loss. Compared with weight gain, a weight loss of ≥10% at 6 months was associated with an 85% reduction in the incidence of T2D after 3-years of follow-up. In addition, early weight loss was especially important in reducing T2D risk among those with fasting glucose (FG) ≥110 mg/dl at 6 months. Further results for glucose and HbA1c were similar across treatment arms with achievement of fasting glucose <100mg/dl or HbA1c <5.7% at 6 months associated with a 62 to 70% T2D risk reduction [17].

Weight loss reduced T2D incidence similarly across all race/ethnicity groups, for both sexes, for all ages, and for several levels of physical activity, regardless of initial BMI. Metformin and the lifestyle intervention were similarly effective in restoring normal fasting glucose values, but the lifestyle intervention was more effective in restoring normal post-load glucose values. The lowest risk was in the ILI subgroup meeting all treatment goals with an HR of 0.11 (95% CI 0.05-0.24; $p<0.0001$) representing an 89% risk reduction [16]. Table 1 outlines some of the significant benefits from the ILI in the DPP and DPPOS.

Limitations of the data

Dietary intake and physical activity were assessed by self-report. Although this was a randomized trial, groups who achieved weight loss, diet modification and physical activity were not separately randomized and are difficult to accurately analyze outside the randomization. In the interval between DPP and DPPOS, a “lifestyle” program was offered to all participants, including the original lifestyle group, which was utilized by some participants in each of the randomized groups, which may confound later results.

Predictors of success within the ILI

The DPP quantified the relationship between early measures of weight loss success, glucose, and subsequent T2D. At 6 and 12 months, both change in body weight and glucose strongly predicted lower incidence of T2D in ILI participants. Early success at achieving weight loss predicted later success at maintaining weight loss. Participants who achieved the weight loss goal at the end of the Core Behavioral Curriculum were 3 times more likely to achieve the goal at study end [18]. However when the Core Curriculum was offered again, those individuals in the ILI group were less likely to attend classes and lost less weight than the groups who were naive to this intervention [19].

Changes in physical activity and diet (primarily reduced calorie intake from fat) also predicted weight loss; increased physical activity was associated with a reduced incidence of T2D when there was little weight loss, yielding a 46% reduction for participants who met the physical activity goal adjusted for baseline variables only. Increased physical activity also predicted sustained weight loss and became a stronger predictor with each subsequent year [16].

Achieving weight/activity goals in DPP

Demographic, psychosocial, and behavioral factors relating to achieving body weight loss and physical activity goals were examined in the DPP Lifestyle participants. Forty-nine

percent met the weight loss goal and 74% met the activity goal initially, while 37% and 67%, respectively, met the goals long-term at the final intervention visit (mean =3.2 years). Meeting the weight loss goal was predicted by the number of times fat grams were self-monitored (OR= 1.08 per one record increase, $p<0.0001$ at the end of the core behavioral program; OR = 1.02, $p= 0.005$ at final visit) and by success at achieving the physical activity goal (OR=1.90, $p=0.0001$ for end of core; OR=4.11, $p<0.0001$ at final visit). Participants who achieved the activity goal at the end of the core behavioral curriculum were 1.5 times more likely to achieve the goal at the end of the final intervention visit compared to those who did not initially achieve the activity goal (75% vs. 50%, $p<0.001$). In univariate analyses, being male, having lower BMI, and being older were significantly associated with success at achieving the activity goal at both the end of the core behavioral curriculum and at the final visit. Ethnicity was significantly related to achieving the activity goal at the final intervention visit, with higher success rates in Hispanic Americans, Asian Americans, and Native Americans [18]. Frequency of monitoring dietary intake was also related to success at achieving the physical activity goal suggesting that adherence to one aspect of the intervention was related to adherence to other aspects [18]. Depression symptoms were assessed by the validated Beck Depression Inventory (BDI) and antidepressant medication use was measured. Psychological and depression measures were unrelated to goal achievement. After adjusting for multiple factors related to weight gain, antidepressant use, not depressive symptoms, was associated with weight regain but not rate of or success of loss or goal achievement [20-22].

Predictors of sustained reduction in energy/fat intake

The DPP ILI group showed reductions in total energy intake for up to 9 years post-randomization [9]. The median self-reported energy intake at baseline was 1,876 kcal/day compared with 1,520 kcal/day at Year 1, a 19% reduction from baseline, with a median fat reduction of 6.6% [8]. A median intake of 1,560 kcal/day was reported at Year 9, suggesting sustained reduction in energy intake, although significant amounts of weight had been regained from the nadir of weight loss. Lower energy and dietary fat intake at baseline predicted lower energy and dietary fat intake at Year 9 [9, 10]. Lower percent of calories from fat also predicted weight loss. Within the ILI group from 1 to 9 years after randomization there was a drop in those reporting use of low-fat foods “often/always” from 40.7% to 12.3% [9]. At baseline, median fat grams intake was 70.4g, which was reduced to 45.2g after Year 1, but then increased to 61.0g by Year 9. The differences in energy intake, fat gram intake and percent energy from fat at baseline and 9 years after randomization was statistically significant ($P<0.0001$). Although participants increased their energy and fat gram intake between Year 1 and Year 9 of the DPPOS, neither energy nor fat intake returned to baseline levels [10].

Other Effects of Intervention

Effect of Age

The incidence of T2D increases with age and the DPP provided a unique opportunity to learn about the significant age differences in response to either the lifestyle intervention or metformin in preventing T2D. The DPP found that ILI was exceptionally effective in

preventing T2D in individuals aged 60-85 years who had the most weight loss and improvement in physical activity. Diabetes incidence rates did not differ by age in the control group, but the ILI was more effective with increasing age [23]. Older age was a strong predictor of success at meeting the weight loss and physical activity goal at both the end of the core curriculum and at the final intervention visit at 3.2 years. The older age group was more likely to complete self-monitoring records and report consuming a lower percentage of calories from fat than younger individuals [18].

Effect of Race/Ethnicity

The DPP was designed to oversample those at high risk of diabetes, and as a result 46.3% reported being of non-white race. Weight loss reduced diabetes incidence similarly across all racial/ethnic groups regardless of the level of initial obesity [16]. Ethnicity was significantly related to achieving the activity goal at the final intervention visit, with higher success rates in Hispanic Americans, Asian Americans, and Native Americans [18]. Participants from ethnic groups disproportionately affected by T2D showed no difference in rates of progression to T2D among the control cohort in comparison with white participants. This finding suggests that ethnic minority populations are at higher risk for the development of IGT but that further progression to T2D may be independent of ethnic risk [24].

Gestational Diabetes Mellitus (GDM)

The DPP recruited 350 women with a history of gestational diabetes mellitus (GDM). This subgroup was younger at study entry, had comparable characteristics, including similar glucose levels and ethnic distribution, to the other women. Women with a history of GDM who were randomized to the control group had a crude incidence rate of T2D that was 71% higher than for women without a history of GDM (25.7% without GDM vs. 38.4% with previous GDM) [25]. Achieving the targeted goals for lifestyle change was far less successful in those with previously reported GDM. ILI participants were less able to sustain the physical activity goals, had a lower maximal weight loss and more rapid weight gain than women in the ILI without GDM. In this cohort, the ILI reduced the incidence of T2D by approximately 50% compared with the control group. These data suggest that metformin may be more effective in preventing T2D than ILI in women with a history of GDM as compared with those without this history. Progression to T2D is more common in women with a history of GDM compared with those without such a history despite equivalent degrees of IGT at baseline. Additionally, genetic risk score was positively associated with a history of GDM, but did not predict progression to T2D or modulate response to the interventions [26].

Effect on Urinary Incontinence

Symptoms of urinary incontinence were assessed in women at the last DPP visit. The ILI participants had lower prevalence of urinary stress incontinence and weight loss was the most important mediator of this effect [27].

Effects on Body Composition

Body composition in the DPP was measured at baseline and 1 year using computed tomography (CT) at 18 of the 27 DPP field sites and included 777 of the 1106 participants who were not diagnosed with T2Ds at 6 months or 1 year and who completed both baseline and follow-up measures. Lifestyle intervention dramatically reduced visceral fat in both men and women, along with a decrease in body weight and BMI. In contrast, metformin had no effect [28, 29].

Effects on Cardio metabolic risk factors

Hypertension was identified in 30% of participants at baseline. The prevalence increased in the metformin and control groups but significantly less so in the ILI participants during the DPP. Both systolic and diastolic blood pressures were lower in the ILI Group ($p<0.05$) compared to control and metformin groups. At 3 years of follow up, pharmacologic therapy to achieve established goals in the ILI group was 27-28% less for hypertension and 25% less for hyperlipidemia when compared with the metformin or control groups. Dyslipidemia (either LDL-C≥130 mg/dl and/or triglyceride >200 mg/dl) was present in 12% at baseline and increased by approximately 50% in both metformin and control groups during DPP but the prevalence did not increase in the ILI participants. During the three years of the DPP, triglyceride levels fell in all treatment groups, but fell significantly more in the ILI group. Total cholesterol and LDL cholesterol levels were similar among treatment groups. ILI significantly increased HDL cholesterol levels and reduced the cumulative incidence of the pro-atherogenic LDL phenotype B (dense LDL-cholesterol) [30]. CVD risk factors increased as glucose progressed from IGT to T2Ds but improved with reversion to NGT, which was more common for those in the ILI group. Although risk factors deteriorated similarly in all intervention groups among those who developed diabetes, the risk factor profile was more favorable in the ILI group compared to the other 2 groups among those who remained with IGT or regressed to NGT. Since fewer participants in the ILI group progressed to diabetes than the other 2 groups this effect probably contributed to the observation that the ILI group experiences less deterioration of their risk factor profile over time [31]. During the median 10-year follow-up there were major reductions in all groups for systolic and diastolic blood pressures, and for LDL cholesterol and triglycerides. These improvements, however, were achieved in the ILI group with lower medication use [32].

ILI had favorable effects on all lipoprotein classes. Participants in the ILI Group had decreased large t very low-density lipoprotein, small low-density lipoprotein (LDL), and small high-density lipoprotein (HDL) particles and an increase in large HDL particles. ILI treatment had favorable effects on lipoprotein subfractions that are primarily mediated by intervention-related changes in insulin resistance, BMI, and adiponectin. ILS, an intervention that slows diabetes development by leading to favorable lipoprotein changes may also have anti-atherosclerosis effects [33].

Effect on Inflammatory Markers

The beneficial effects of an ILI on concentrations of the inflammatory markers CRP and fibrinogen in adults with IGT was demonstrated at year 1. There was ∼30% reduction in CRP levels in both sexes which appeared to be more closely related to weight loss than an

increase in physical activity. Reductions in fibrinogen levels in lifestyle group relative to metformin and control group were seen after one year [34].

Effects on the incidence of Metabolic Syndrome (MetS)

Fifty-Three percent of DPP participants had MetS at baseline using the criteria from the National Cholesterol Education Programs' Adult Treatment Panel III [35]. The ILI group showed a dramatic reduction in the incidence of new cases of MetS and on participants who had MetS at study entry. Analysis of those not meeting the MetS criteria at baseline suggests that ILI reduces the incidence of all components of the MetS except low HDL-C. For those who met the criteria for MetS at baseline, 18% of the control group, 23% of the metformin group, and 38% of the ILI group no longer had MetS at 3 years [35]. MetS and some of its components were associated with increased incidence of T2D in a manner that differed according to DPP intervention. After adjusting for fasting glucoses at baseline, waist circumference (WC), and triglycerides are associated with an increased risk of developing T2D. Favorable ILI associated changes in WC and HDL-C components were associated with T2D risk reduction [36].

Genetics

Genetics studies in DPP participants have examined associations between single nucleotide polymorphisms (SNPs) and ILI treatment-specific responses. The link to these papers for further review is listed at the end of this manuscript.

In one publication, Hivert et al. [37] used a genetic score based on 34 confirmed T2D loci that was associated with risk of diabetes incidence (HR = 1.02 per risk allele [95% CI: 1.00 to 1.05]; p=0.03). There was no significant interaction between the genetic risk score and treatment arms (genetic risk score × ILI interaction p=0.13). This analysis did find that the ILI was effective even in individuals in the highest quartile of genetic risk ($p<0.0001$). Among individuals in the highest quartile of risk, regression to normal glucose regulation was higher in the ILI arm than the placebo arm ($p<0.0001$) while there was no difference in regression to normal glucose regulation between the placebo and metformin arms (p=0.062). These results suggest that ILI might be considered the frontline approach to prevent type 2 diabetes, even in individuals with the highest genetic risk and that the genetic burden does not undermine the DPP ILI. Additional genetics research in DPP is identifying variants in individual genes for interaction with treatment for effects on diabetes incidence, weight loss, or weight regain after initial weight loss (see link to DPP papers), with the hope that such findings may eventually have clinical application in selecting optimal interventions for different people.

Cost Effectiveness of Treatment

During the DPP, the lifestyle intervention was cost-saving in participants younger than 45 years of age and was cost-effective even in the oldest age groups. The metformin intervention was cost-effective in participants <65 years of age but was not cost-effective in participants ≥ 65 years of age due to its lack of effectiveness in that age group [38]. The 10-year intent-to-treat and adherence analyses of combined DPP/DPPOS follow-up have shown

that, per capita non-intervention related direct medical costs were greater for control participants compared with lifestyle participants by ∼$2,200 and $4,300 respectively and also greater for control participants compared with metformin participants by ∼ $1,600 and $ 3,300 respectively [6, 38, 39].

The Adherence analysis of cumulative undiscounted per participant total direct medical costs of the DPP/DPPOS interventions and medical care received outside the DPP/DPPOS by year 10 were higher for control (∼$28, 200) than DPP group lifestyle (∼26,000) or metformin ($ 27,200). Both interventions were cost saving compared with control. At 10 years, quality-adjusted life years (QALY) accrued as health utility scores were better among adherent lifestyle (6.80) and adherent metformin participants (6.74) than control participants (6.67). With discounting at the rate of 3% per year, the cost-effectiveness of lifestyle compared with control was ∼$20,000 per QALY gained, and the cost of metformin compared with control was ∼$20,100 per QALY gained. Without discounting, from both a modified societal perspective (excluding participant time) and a full societal perspective (including participant time), lifestyle cost <$5000 per QALY gained and metformin was cost saving compared with control. If in a real-world setting a DPP lifestyle intervention could be delivered at a lower cost than they were during the randomized clinical trial using a group based intervention, the DPP interventions are likely to be even more cost effective [39].

The adoption of T2D prevention programs by health plans and society will result in important health benefits over 10 years and represents a good value for the money spent [6]. 10-year within trial analysis shows improved quality-of-life with minimal/no increase in cost. This suggests that treatments should be widely adopted.

Translation

The International Diabetes Federation (IDF) has examined the wide range of community-based interventions in “real world” settings for T2D/chronic disease prevention [40]. The IDF review suggested that individual countries should develop T2D prevention programs, evaluate their cost-effectiveness and develop setting-specific T2D risk identification and prevention strategies based on available resources with the goal of reducing the burden of cardiovascular disease. Systematic reviews and Meta analyses have generally used weight change as a surrogate marker for reduced risk [41-45] to gauge program effectiveness. The Ali et al [41] systematic review and meta-analysis of twenty-eight US-based DPP translation studies found that average 12-month weight loss was about 4% and that weight loss was similar regardless of whether the intervention was delivered by clinically trained professionals or lay educators. The amount of weight loss increased as the number of sessions attended increased. A meta-analysis by Aguiar [42] examined multi-component lifestyle T2D prevention interventions and found that diet and both aerobic and resistance exercise training were modestly effective in achieving weight loss and improving impaired fasting glucose and glucose tolerance. The Dunkley et al [43] meta-analysis of 22 pragmatic real world studies found that greater adherence to guidelines [44,45] related to T2D prevention was associated with a greater weight loss. The Merlotti et al [46] meta-analysis examined the effects of lifestyle and a wide range of medical therapies including bariatric surgery, found that many of the interventions reduced T2D risk making it possible to choose

an approach based on the weight and risk status of an individual patients. The systematic review and meta-analysis by Schellenberg et al [47], which addressed the progression from pre-diabetes to overt T2D and to clinical outcomes (such as cardiovascular disease and death) in overt T2D, found that lifestyle interventions effectively decrease the incidence of T2D but did not reduce all-cause mortality or cardiovascular and microvascular outcomes. Yuen [48] concluded that both intensive lifestyle change programs and medications delay progression from prediabetes to overt T2D, but both have issues with adherence and side effects that should guide practice decisions about their use. The systematic review and meta-analysis by Whittemore [49] examined delivery of the lifestyle intervention in four distinct settings: (a) hospital outpatient, (b) primary care, (c) community, and (d) work and church and compared settings' variability with regard to RE-AIM (reach, efficacy, adoption, implementation, and maintenance noting the strengths and limitations to each setting). When comparing these settings, they found that community, work and church settings have a greater potential to reach people who are not in the health care system, but risk and efficacy assessment are more likely to be based on weight in sites where obtaining blood tests may not be practical. Whittemore noted that using the RE-AIM framework could help standardize evaluation and facilitate comparisons of studies and Ruggerio [50] reviewed the evidence for a role of community health workers in translation efforts. The model that of group class delivery and coaching used during the DPP “Bridge” program [38] is widely used. Figure 1 lists some of the resources available and the ongoing translation efforts [51-54].

Conclusions

The DPP/ DPPOS landmark study showed a clear effect of ILI on preventing or delaying the development of diabetes and associated risks in as short as 3.2 years, with effects that have persisted for up to 10 years. These efforts are cost effective and are being widely translated. The potential effects on health, quality of life and the costs of health care worldwide should prove to be significant. All the papers published by the DPP and DPPOS research group can be found on https://dppos.bsc.gwu.edu/web/dppos/publications.

Acknowledgments

The Research Group gratefully acknowledges the commitment and dedication of the participants of the DPP and DPPOS. During the DPPOS, the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) of the National Institutes of Health provided funding to the clinical centers and the Coordinating Center for the design and conduct of the study, and collection, management, analysis, and interpretation of the data. The Southwestern American Indian Centers were supported directly by the NIDDK, including its Intramural Research Program, and the Indian Health Service. The General Clinical Research Center Program, National Center for Research Resources, and the Department of Veterans Affairs supported data collection at many of the clinical centers. Funding was also provided by the National Institute of Child Health and Human Development, the National Institute on Aging, the National Eye Institute, the National Heart Lung and Blood Institute, the Office of Research on Women's Health, the National Institute on Minority Health and Health Disparities, the Centers for Disease Control and Prevention, and the American Diabetes Association. Bristol-Myers Squibb and Parke-Davis provided additional funding and material support during the DPP, Lipha (Merck-Sante) provided medication and LifeScan Inc. donated materials during the DPP and DPPOS. The opinions expressed are those of the investigators and do not necessarily reflect the views of the funding agencies. A complete list of Centers, investigators, and staff can be found in the Appendix.

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Group Lifestyle Balance™ [51, 52]:

- In 2004, University of Pittsburgh researchers, responsible for developing the DPP Lifestyle Balance intervention, created the Diabetes Prevention Support Center (DPSC) with Department of Defense (United States Air Force) funding.
- Designed for broad-based dissemination in military and civilian settings, including primary care. Aimed at those with high risk for developing type 2 diabetes and/or metabolic syndrome.
- DPSC provides education, lifestyle coach training and program support for health care providers nationally and internationally.

http://www.diabetesprevention.pitt.edu

Special Diabetes Program for Indians Diabetes Prevention (SDPI-DP), Indian Health Service (IHS) [53]:

- In 2004, Congress designated some of the appropriated funds for diabetes be used for demonstration grants that were awarded to 36 tribes and tribal consortiums to translate the DPP into their Community settings.
- Tribal implementation strategies and collaboration is a critical part of this process.
- Lessons learned and successes will be outlined in a document that will be disseminated for all tribes to help them implement the DPP in their Communities.

http://www.ihs.gov/MedicalPrograms/Diabetes/index.cfm?module=programsSDPIdemonstrationProjects

National Diabetes Prevention Program (NDPP):

- In 2010, Congress authorized the CDC to establish the National Diabetes Prevention Program with the goal of preventing or delaying the onset of type 2 diabetes among people with pre-diabetes in the United States.
- Developed by the Diabetes Training and Technical Assistance Center (DTTAC) at Emory University in collaboration with the CDC, YMCA, and researchers from Indiana University and the University of Pittsburgh.
- Lifestyle coach training available through DTTAC at Emory University for community workers and health care professionals.

http://www.cdc.gov/diabetes/prevention

YMCA's Diabetes Prevention Program [54]:

- In 2003, Indiana University researchers, part of the DPP collaborative study group, developed the YMCA-DPP implementation model.
- Designed for trained YMCA staff to serve as lifestyle coaches for delivery in YMCA facilities nationwide.
- YMCA and UnitedHealth Group, in collaboration with CDC, have aimed to develop the infrastructure for both delivery and reimbursement of lifestyle intervention programs. YMCA is reimbursed by 3rd party payers for successful program delivery

http://www.ymca.net/diabetes-prevention

Figure 1. Components of the major DPP Translation Curricula current available*

*Each program has adapted the original DPP Lifestyle Balance curriculum (http://www.bsc.gwu.edu/dpp/manuals.htmlvdoc) to a 12-month, group-based program with goals consistent with DPP; 7% weight loss and at least 150 minutes per week of physical activity. The above curricula are CDC-approved for application to a Diabetes Prevention Recognition Program (DPRP) that recognizes organizations with demonstrated effective delivery of a lifestyle intervention program to prevent type 2 diabetes. http://www.cdc.gov/diabetes/prevention/recognition/index.htm.

An additional resource for implementation of the principles of the DPP curriculum primarily for use in clinical settings, *Small Steps. Big Rewards; Your GAME PLAN to Prevent Type 2*

Diabetes Health Care Provider Toolkit, is available through the National Diabetes Education Program (NDEP) at http://1.usa.gov/1jtLGug.

Table 1

Benefits from Lifestyle Intervention in Patients with Pre-Diabetes: Lessons Learned from the Diabetes Prevention Program and Outcomes Study

Benefit	Comment	KEY Findings	References
Prevent diabetes in those with IGT/IFG	58% reduction in risk of developing T2D over 3.2 years; 34% after 10 years	Weight Loss was major predictor (1 kg weight loss predicted 16% reduction in risk); increased PA predicted weight loss and helped sustain it; if met all goals risk reduction 89%; more effective in older participants.	1, 2, 3, 16
Diabetes prevented in a population with previous GDM	Lifestyle intervention and metformin equally effective	Both intensive lifestyle and metformin prevented diabetes by approximately 50% in women with IGT and a history of GDM. Genetics did not change risk.	25, 26
Cardio metabolic risk factors improved	Blood Pressure and lipids improved and Lifestyle group used fewer medications.	Improved CVD risk factor profiles in all groups (years 3 and 10); blood pressure and lipid medication use was least for lifestyle participants. Incidence of abnormal HDL cholesterol virtually identical by treatment group. Fewer developed diabetes and more reverted to NGT in the ILS group compared with the other two interventions which improved CVD risk.	30, 31, 32, 33
Prevalence of Metabolic Syndrome (MetS) reduced	MetS risk factors improved in ILI group.	MetS increased in placebo and metformin and decreased in lifestyle at 3 years; Favorable lifestyle-associated changes in WC and HDL-C are associated with diabetes risk reduction.	35, 36
Subcutaneous fat and visceral fat reduced	Lifestyle intervention reduced subcutaneous and visceral fat.	Lifestyle intervention dramatically reduced visceral fat in both men and women. Reduction of diabetes risk with lifestyle modification was associated with reduction of body size and central adiposity. Reduction of diabetes risk with metformin appeared independent of changes in body size or central adiposity.	28,29