Title
Translating the Diabetes Prevention Program into an Online Social Network

Journal
The Science of Diabetes Self-Management and Care, 40(4)

ISSN
2635-0106

Authors
Sepah, S Cameron
Jiang, Luohua
Peters, Anne L

Publication Date
2014-07-01

DOI
10.1177/0145721714531339

Peer reviewed

Translating the Diabetes Prevention Program intoan Online Social Network Validation against CDC Standards

S. Cameron Sepah, PhD Luohua Jiang, PhD Anne L. Peters, MD
From Omada Health, San Francisco, California (Dr Sepah); Department of Psychiatry, University of California San Francisco, San Francisco, California (Dr Sepah); Department of Epidemiology and Biostatistics, School of Rural Public Health, Texas A&M Health Science Center, College Station, Texas (Dr Jiang); and Keck School of Medicine, University of Southern California, Los Angeles, California (Dr Peters).

Correspondence to S. Cameron Sepah, PhD, Department of Psychiatry, University of California, San Francisco, 401 Parnassus Ave, San Francisco, CA 94143, USA (cameron.sepah@ucsf.edu).

Financial Support: This work was funded by Omada Health. S.C.S. is an employee of Omada Health. L.J. served as a statistical consultant for Omada Health for this project. A.L.P. serves as an advisor to Omada Health.

Acknowledgments: The authors wish to acknowledge Dr Ann Albright and Dr Ed Gregg at the Centers for Disease Control and Prevention for their support of this work and for editing a copy of the manuscript. They also thank the Diabetes Prevention Program Research Group for performing the original DPP trial, on which the curriculum is based.

Purpose

The purpose of this study was to evaluate the efficacy of *Prevent*, an online social network-based translation of the Diabetes Prevention Program (DPP) lifestyle intervention, against the Centers for Disease Control and Prevention (CDC) Diabetes Prevention and Recognition Program (DPRP) outcome standards and weight loss outcomes of other DPP translations.

Methods

Two hundred twenty participants previously diagnosed with prediabetes were recruited online and enrolled in *Prevent*, a DPP-based group lifestyle intervention that integrates a private online social network, weekly lessons, health coaching, and a wireless scale and pedometer. Participants underwent a core 16-week intensive lifestyle change intervention and were then offered to continue with a post-core lifestyle change maintenance intervention, with the entire intervention (core plus post-core) totaling 12 months.

Results

One hundred eighty-seven participants met inclusion criteria for the core program and achieved an average of 5.0% and 4.8% weight loss at 16 weeks and 12 months, respectively. They also had a 0.37% reduction in their A1C level at final measurement. One hundred forty-four of these same participants also met inclusion criteria for the post-core program and achieved an average of 5.4% and 5.2% weight loss at 16 weeks and 12 months, respectively, and a 0.40% reduction in A1C at final measurement.

Conclusion

Results indicate that *Prevent* meets CDC DPRP outcome standards for diabetes prevention programs and performs favorably to other DPP translations. Considering national initiatives to address the obesity and diabetes epidemics, online delivery platforms like *Prevent* offer an effective and scalable solution.

Prediabetes, the clinical precursor to type 2 diabetes, has reached epidemic proportions in the United States. According to the Centers for Disease Control and Prevention (CDC) estimates, prediabetes prevalence among American adults increased from 29.2% in 1999-2002 to 36.2% in 2007-2010,[1] and 89% of these individuals are not aware of their condition.[2] Applied to 2013 US Census population estimates, this amounts to approximately 87.5 million American adults with prediabetes.[3] Projections suggest that by 2030, nearly half of the US population will have either prediabetes or type 2 diabetes, foreshadowing the first time in history that the majority of the American adult population will exhibit dysglycemia.[4]

Fortunately, there is strong evidence that lifestyle interventions—focused on improving diet, increasing physical activity, and supporting coping and problem-solving skills that result in modest weight loss—can significantly reduce the risk of developing type 2 diabetes. Landmark clinical trials such as the Diabetes Prevention Program (DPP) showed that an intensive lifestyle intervention outperformed both placebo and metformin and reduced the development of type 2 diabetes by 58% after 3 years,[5] and 34% after 10 years.[6]

As a result of the DPP's success, its lifestyle intervention protocol has been translated and delivered in diverse real-world settings. A systematic review of 16 studies showed successful replication of the lifestyle intervention, with an average weight loss of 2.7% to 6.0%.[7] Two meta-analyses of 28 and 22 real-world DPP translations showed further validation, with an average weight loss of 4% and 2.4% respectively, including successful translations without face-to-face delivery and nonmedical professionals.[8,9] Furthermore, reviews indicate that DPP interventions are cost-saving or very cost-effective and increase quality-adjusted life years (QALY) of participants.[10,11] Large-scale projections predict that enrolling participants in a DPP intervention at age 50 can prevent 37% of new cases of diabetes by age 65 and that enrolling a cohort of participants ages 60 to 64 could save Medicare $7 billion to $15 billion over their lifetimes.[12,13] The DPP's well-established clinical effectiveness and cost-effectiveness[14,15] paved the way for the Affordable Care Act to authorize the CDC to establish the National Diabetes Prevention Program (National DPP) to disseminate DPP programs across the country.[16] To reach the millions with prediabetes, alternate delivery methods to in-person classes are critical. To address this need, there have been efforts to translate the DPP to various electronic delivery formats. Small pilot studies have attempted to use email,[17] interactive voice response,[18] telephone,[19] and DVD[20-22] based delivery formats, with positive preliminary weight loss results.

However, no electronic interventions thus far have successfully incorporated the key components of DPP translations—such as a small-group format, evidence-based curriculum, live health coach, tracking of weight loss, and documentation of engagement metrics. As a result, the *Prevent* program (Omada Health, San Francisco, California, USA) was designed to translate these key DPP components to an online format using the latest consumer web technologies. More broadly, *Prevent* was designed on an online platform capable of delivering

various evidence-based curricula, in order to create future programs for other conditions treated in behavioral medicine.

Prevent places participants into a private online social network of 10 to 15 people where they can message and support each other on a group discussion forum, asynchronously complete weekly DPP-based lessons at any time, privately message and call a health coach, track weight loss and physical activity using a wireless weight scale and pedometer, and track their engagement and progress using the online interface or mobile phones.

The current pilot was designed to validate *Prevent* by benchmarking pilot study results against CDC Diabetes Prevention and Recognition Program (DPRP) outcome standards and also to weight loss outcomes of other DPP translations.

Methods

Research Design

A quasi-experimental research design was used that included longitudinal and pre–post tests of weight, A1C, and program engagement outcomes. This design was chosen to test the efficacy of the *Prevent* program, based on the evaluation guidelines recommended by the CDC DPRP standards.[23]

The study was not controlled or randomized because the original DPP clinical trial and later DPP translations consistently show that randomized control groups do not lose significant weight.[5,8] This also follows the precedent of the 20 of 28 DPP translations that were not controlled in a recent meta-analysis.[8]

Participants were not compensated for their participation to reduce self-selection bias but were enrolled in the program at no cost. Institutional review board (IRB) exemption was granted by Western IRB for secondary analyses of their previously collected and de-identified data.

Participants

Participants were recruited from online advertisements, seeking individuals with a self-reported clinical diagnosis of prediabetes occurring within the past year. Candidates were then called to verify that they met CDC DPRP eligibility criteria: participants were required to be 18 years of age or older, have a body mass index (BMI) of □ 24 kg/m^2 (□ 22 kg/m^2 if Asian), and be able to engage in light physical activity.[23]

Eligible participants completed an online account setup process, in which they provided consent and completed health and demographic questionnaires. Participants were then enrolled in the *Prevent* program (http://www.preventnow.com), which they could access online via home computers or web-enabled mobile devices.

Centers for Disease Control and Prevention DPRP standards were also used to determine inclusion criteria for the analyses—which are notably distinct from eligibility criteria. The

standards stipulated that analyses be conducted on 2 subgroups of the total study population—based on the rationale that participants must have received a "minimal therapeutic dose" of the intervention to affect weight loss and thus be included in analyses.

Core participants included those who completed at least 4 lessons during the 16-week core intervention. Post-core participants included the subset of core participants who completed at least 4 core lessons but also went on to complete 1 post-core lesson during the 12-month intervention.

Intervention

The *Prevent* program was designed to provide delivery of the DPP lifestyle intervention in an online small-group format that is accessible and engaging. *Prevent* included 4 major intervention components: small-group support, health coaching, DPP curriculum, and digital tracking tools.

To re-create the experience and group dynamic of an in-person program, participants were demographically matched into online groups of 10 to 15 participants who could relate to one another (based on similar location, age, and BMI). Participants communicated via a private online social network, which resembled popular social networks such as Facebook (Figure 1). An online group discussion board allowed participants to post and reply to comments about how they were doing and progressing. Participants could even "like" and "understand" comments to express social support and empathy, which mimic key group therapeutic processes. Group discussion was asynchronous, rather than live, to make the intervention more flexible and convenient.

Each group was led by a professional health coach, who was trained in a manner consistent with CDC DPRP standards for lifestyle coaches.[23] Health coaches served an important moderating and personalizing function by communicating with participants via private messages or telephone calls. Health coaches kept participant discussions on track, provided feedback on food logs and physical activity progress, and provided individualized counseling using techniques such as motivational interviewing.

The DPP curriculum was presented in an asynchronous online format that resembled popular online learning platforms such as Coursera. The *Prevent* program began with a 16-week core program phase, consisting of 16 online weekly lessons adapted from the CDC National DPP core curriculum.[24] Lessons were posted every Sunday morning, and participants were encouraged to complete them at their own convenience within the week. Lessons resembled an online workbook, in which individuals read curriculum content and answered relevant free response questions, which were shared with their health coach and groups. A lesson was considered complete if a participant clicked through all of the pages and answered the free response questions to indicate engagement and understanding.

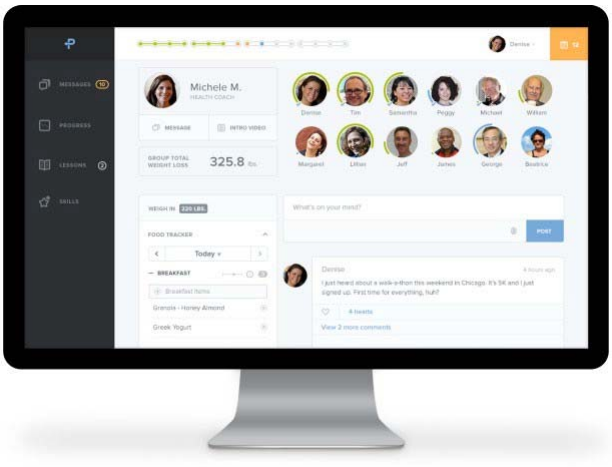

Figure 1. Screenshot of *Prevent's* online social network.

The 16 core lessons were divided into monthly phases focused on a specific theme, and participants were mailed a physical kit prior to the start of each phase, which included items related to the lesson content of that phase. Weeks 1 to 4 focused on changing dietary habits, and participants were thus mailed a wireless weight scale. Weeks 5 to 8 focused on increasing physical activity, and participants were thus mailed a digital pedometer (Omron HJ-320 Tri-Axis Pedometer, Kyoto, Japan). Weeks 9 to 12 focused on relapse prevention, and participants were thus mailed a photo frame to depict their motivation for improving their health (eg, a picture of their grandchildren). Weeks 13 to 16 focused on maintenance, and participants were thus mailed information about the upcoming maintenance program.

Once participants completed the 16-week core phase, they were invited to participate in the post-core phase, totaling 12 months. The post-core phase included 9 monthly lessons from the CDC National DPP post-core curriculum. The post-core phase differed in that all groups were combined into a larger participant-led "super-group" and focused on maintaining lifestyle habits and weight loss achieved during the core program.

Measures

Demographic and health information were collected at baseline. Program engagement was assessed via lesson completion, which was tracked via the online interface. The primary outcome measure was body weight and was tracked via a wireless scale that was mailed to participants. Participants were encouraged to weigh themselves daily during the core program, and weight data were automatically collected online. A1C was measured using self-administered AccuBase A1C test kits by DTI Laboratories, Thomasville, GA, a US Food and Drug Administration-cleared whole blood test. The test uses a capillary tube blood collection method, instead of a dried blood spot, which allows for reliable and valid homebased data collection. Blood samples are tested using the high-performance liquid chromatography (HPLC-IE/ HPLC-BA) analytical method and are screened for abnormal hemoglobins per the American Diabetes Association recommendation. A1C test kits were mailed to participants' homes at 3 time points: prior to the start of intervention, after 6 months, and after 12 months.

Analyses

Prevent program outcomes were benchmarked against CDC DPRP outcome standards. Efficacy benchmarks for core participants are achieving a minimum average attendance of 9 core sessions and 3 post-core sessions, documentation of body weight and physical activity at 80% of core sessions, and 5% weight loss by the end of the 16-week core phase. Efficacy benchmarks for post-core participants are achieving a minimum average documentation of body weight at 60% of post-core sessions and 5% weight loss by the end of the 12-month post-core phase.

Centers for Disease Control and Prevention DPRP standards specify that weight loss be analyzed at 16 weeks for core participants and at 12 months for post-core participants, in order to examine the treatment effects of those who actually received a minimum therapeutic dose of the intervention at each phase.[23] For the sake of completeness, both 16-week and 12-month weight loss results were analyzed for core participants, post-core participants, and also all participants who started the intervention (last observation carried forward).

Participant data were statistically analyzed using SPSS Statistics 21.0 and SAS 9.3. Baseline characteristics were compared between different groups of participants using χ^2 tests for categorical variables and 2-sample *t* tests for continuous variables. To account for repeated measures and missing data, linear mixed-effects models were used to obtain adjusted mean changes in weight and A1C from baseline to 16 weeks and 12 months. These models included days from baseline and a change point after the day of the last core lesson.

Since participants weighed in hundreds of times over the course of the program, weight was treated as time series data. Time series analyses are complicated by the

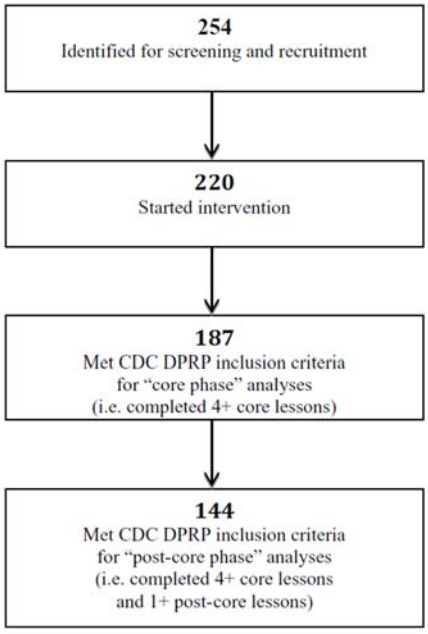

Figure 2. Participant recruitment and retention flow chart.

fact that repeated measures are correlated, so an autoregressive-moving-average (ARMA) covariance structure was used to statistically account for this. Repeated A1C measures are also correlated, and so a spatial power covariance structure (with time as the distance measure) was used to statistically account for this. To test if demographic variables influenced outcomes, they were added as covariates in the linear mixed-effects models. Since the estimated weight losses and A1C changes did not meaningfully differ, the results from models without covariates are reported.

Results

Demographics and Participation

Participant recruitment and retention is displayed in a flow chart (Figure 2); 254 participants responded to the online advertisements and met CDC DPRP eligibility criteria, and 220 participants completed the initial assessment and online setup process and began the intervention on April 29, 2012. Demographic characteristics of study participants are reported in Table 1. The participants were socioeconomically diverse, with 62% women, 50.2% Caucasian, 51.7% college-graduated or with higher education, 57.6% married or lived with a partner, and 48.3% with a household income < $50,000/year. The baseline BMI of these 220 participants was 36.6.

One hundred eighty-seven participants (core participants) met CDC DPRP inclusion criteria for analyses of the 16-week core program, which ended on August 18, 2012. As shown in Table 1, core participants (N = 187) and those who completed 3 or fewer lessons (non-core participants) (N = 33) did not differ significantly in baseline BMI and demographic characteristics except sex and education. The core participants had a lower proportion of male participants and a higher proportion of college graduates than non-core participants (15.0% vs 30.3%, $P = .03$ and 55.7% vs 22.2%, $P = .01$, respectively).

One hundred forty-four participants (post-core participants) also met inclusion criteria for analyses of the post-core program, which ended on April 28, 2013. Similarly, the post-core participants (N = 144) and those who did not complete 4 or more core lessons and 1 post-core lesson (non-post-core participants) (N = 76) did not differ significantly in baseline BMI and demographics except age and education. The post-core participants were significantly older than the non-post-core participants (45.3 vs 40.3 years old, $P = .004$) and had more college graduates (61.3% vs 27.9%, $P = .0002$).

Engagement and Weight Loss

Core participants completed an average of 13.8 and lessons during the core and post-core phases, respectively, documented body weight at 90% and 67% of core and post-core sessions attended, respectively, and documented physical activity at 85% of core sessions attended. More than two-thirds of the core participants (68.4%) completed all 16 core lessons. On average, the core participants documented body weight on 100 days (range, 5-339 days) in the first year.

Core participants and post-core participants had significant weight loss from baseline to 16 weeks and 12 months, respectively. The core participants achieved 5.0% and 4.8% weight loss at those 2 time points, and the post-core participants achieved a weight loss of 5.4% and 5.2%, respectively (Table 2, Figure 3). Among the core participants who reported weight between 15 and 17 weeks (N = 147), 50% met or exceeded the CDC 5% weight loss benchmark at 16 weeks. In the post-core participants who reported weight between 11 and 13 months (N = 135), 47% met or exceeded the 5% weight loss benchmark at 12 months.

Table 1

Baseline Demographic Characteristics of Participants

	Total	Core Participants	Non-Core Participants		Post-Core Participants	Non-Post-Core Participants	
	N = 220	N = 187	N = 33		N = 144	N = 76	
	Mean ± SD	Mean ± SD	Mean ± SD	*P* Value[a]	Mean ± SD	Mean ± SD	*P* Value[a]
Age, y	43.6 ± 12.4	43.9 ± 12.4	42.0 ± 12.6	.43	45.3 ± 12.6	40.3 ± 11.5	.004*
Weight, lb	223.1 ± 47.9	222.5 ± 47.0	226.1 ± 53.5	.69	219.4±46.9	230.0 ± 49.3	.12
Body mass index	36.6 ± 7.5	36.7 ± 7.6	35.9 ± 6.6	.56	36.2 ± 7.7	37.3 ± 7.0	.32
	No. (%)	No. (%)	No. (%)	*P* Value[b]	No. (%)	No. (%)	*P* Value[b]
Sex, male	38 (17.3)	28 (15.0)	10 (30.3)	.03*	21 (14.6)	17 (22.4)	.15
Ethnicity				.28			.35
White	108 (50.2)	93 (51.1)	15 (45.5)		71 (50.4)	37 (50.0)	
Black	63 (29.3)	53 (29.1)	10 (30.3)		41 (29.1)	22 (29.7)	
Hispanic	23 (10.7)	21 (11.5)	2 (6.1)		18 (12.8)	5 (6.8)	
Other	21 (9.8)	15 (8.2)	6 (18.2)		11 (7.8)	10 (13.5)	
Marital status				.13[c]			.07[c]
Married/live with a partner	87 (57.6)	78 (58.6)	9 (50.0)		61 (57.0)	26 (59.1)	
Divorced/separated/ widowed	25 (16.6)	24 (18.1)	1 (5.6)		22 (20.6)	3 (6.8)	
Never married	39 (25.8)	31 (23.3)	8 (44.4)		24 (22.4)	15 (34.1)	
Education				.01*			.0002*
< College graduate	72 (48.3)	58 (44.3)	14 (77.8)		41 (38.7)	31 (72.1)	
≥ College graduate	77 (51.7)	73 (55.7)	4 (22.2)		65 (61.3)	12 (27.9)	
Income				.92			.41
< $50,000	69 (48.3)	61 (48.4)	8 (47.1)		51 (50.5)	18 (42.9)	
$50,000 or higher	74 (51.8)	65 (51.6)	9 (52.9)		50 (49.5)	24 (57.1)	

*Statistically significant.
[a]*P* value of 2-sample *t* test.
[b]*P* value of χ^2 test unless otherwise noted.
[c]*P* value of Fisher exact test.

Lesson completion was strongly correlated with weight loss. Table 2 reveals that the weight loss at 16 weeks among those who completed all 16 core lessons was almost twice as much as that among the core participants who did not complete all 16 lessons (5.6% vs 3.2%, $P = .004$). The weight loss difference between these 2 groups was maintained at 12 months but was not statistically significant (5.3% vs 3.1%, $P = .10$). None of the baseline demographic characteristics was significantly associated with weight loss.

Among the 220 participants who started the intervention, 158 (72%) of them had at least 1 weight measurement between 15 and 17 weeks, whereas 162 (74%) of them had at least 1

weight measurement between 11 and 13 months. In a sensitivity analysis, using a conservative last observation carried forward (LOCF) approach, the average weight loss was 4.1% at 16 weeks and 4.0% at 12 months among all 220 participants.

Changes in A1C

A1C was measured at least once in 159 of the core participants and in 130 post-core participants. Among the 159 core participants, 124 of them had a baseline A1C measurement (measured in the first month), 58 of them had an A1C measured between 5 and 8 months, and 100 of them had an A1C measured after 10 months.

For both core and post-core participants, estimated average A1C levels did not change significantly from baseline to 16 weeks but significantly decreased by final

Table 2

Adjusted Mean Weight and Weight Loss (lb) at Each Time Point

	Core Participants	Post-Core Participants	Core Participants Who Completed 16 Core Lessons	Core Participants Who Completed 15 or Fewer Core Lessons
	N = 187	N = 144	N = 128	N = 59
	Mean ± SE[a]	Mean ± SE[a]	Mean ± SE[a]	Mean ± SE[a]
Baseline	221.6 ± 3.5	218.5 ± 4.0	216.9 ± 4.2	231.8 ± 6.1
16 weeks	210.5 ± 3.5	206.6 ± 4.0	204.7 ± 4.2	224.4 ± 6.2
12 months	210.9 ± 3.5	207.2 ± 4.0	205.2 ± 4.1	224.6 ± 6.2
16 weeks – baseline	−11.1 ± 0.7[b]	−11.9 ± 0.7[b]	−12.2 ± 0.8[b]	−7.4 ± 1.5[b]
12 months – baseline	−10.7 ± 1.2[b]	−11.3 ± 1.2[b]	−11.6 ± 1.3[b]	−7.2 ± 2.4[c]

[a]Adjusted means from linear mixed models.
[b]$P < .0001$ for test with H_0: mean equals 0.
[c]$P < .01$ for test with H_0: mean equals 0.

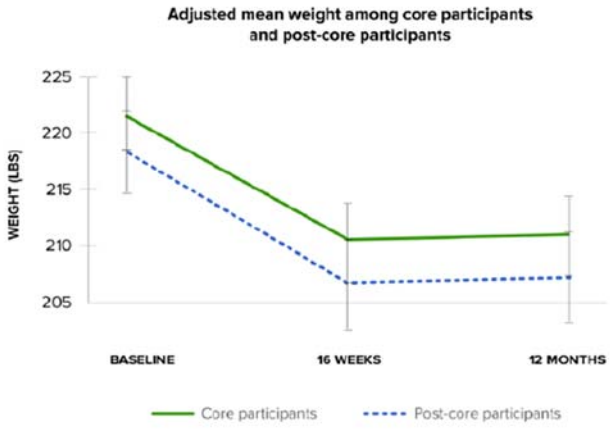

Figure 3. Adjusted mean weight at each time point.

measurement ($\Delta = -0.37\%$, $P < .0001$; $\Delta = -0.40\%$, $P < .0001$, respectively) (Table 3, Figure 4). In terms of clinical relevance, this magnitude of decrease resulted in the average A1C of both groups regressing from within the prediabetes range (5.7%-6.4%, 39-46 mmol/mol) to the normal range (< 5.7%, < 39 mmol/mol).

Conclusion and Implications

Results of this pilot study indicate that the *Prevent* online diabetes prevention program met CDC DPRP outcome standards. Of note, the average weight loss achieved at 12 months in this study was greater than the average 12-month weight loss shown in the meta-analysis of 22 DPP lifestyle intervention translations.[9] As with other translation studies, program engagement was strongly associated with weight loss—with participants who completed all core lessons losing almost twice as much weight.

Furthermore, this study shows one of the stronger magnitudes of A1C improvement of published DPP translations. It is clinically relevant that the average A1C regressed from within the prediabetes range (5.7%-6.4%) to the normal range (< 5.7%), in contrast with an expected annual rate of progression of 5% to 10% from prediabetes to type 2 diabetes.[25] In total, these results suggest that *Prevent* is an effective online adaptation of the DPP lifestyle intervention for individuals with prediabetes, achieving clinically significant weight loss results comparable to other DPP translations, and may also be beneficial for dysglycemia.

These results also suggest more broadly that an online social network can serve as an effective delivery platform for evidence-based treatments. This is of particular importance to public health since evidence-based treatments have slow and difficult transitions from clinical trials to standard of care. Online programs like *Prevent* would significantly increase public access to DPP.

In the past decade, efforts to create and test such online treatments have increased dramatically with the acceleration

Table 3

Adjusted Mean A1C and A1C Change (%) at Each Time Point

	Core Participants	Post-Core Participants
	N = 159	N = 130
	Mean ± SE[a]	Mean ± SE[a]
Baseline	5.98 ± 0.07	6.04 ± 0.08
16 weeks	6.01 ± 0.08	6.07 ± 0.09
12 months	5.61 ± 0.08	5.64 ± 0.08
16 weeks – baseline	0.03 ± 0.06	0.03 ± 0.06
12 months – baseline	–0.37 ± 0.07[b]	–0.40 ± 0.07[b]

[a]Adjusted means from linear mixed models.
[b]$P < .0001$ for test with H_0: mean equals 0.

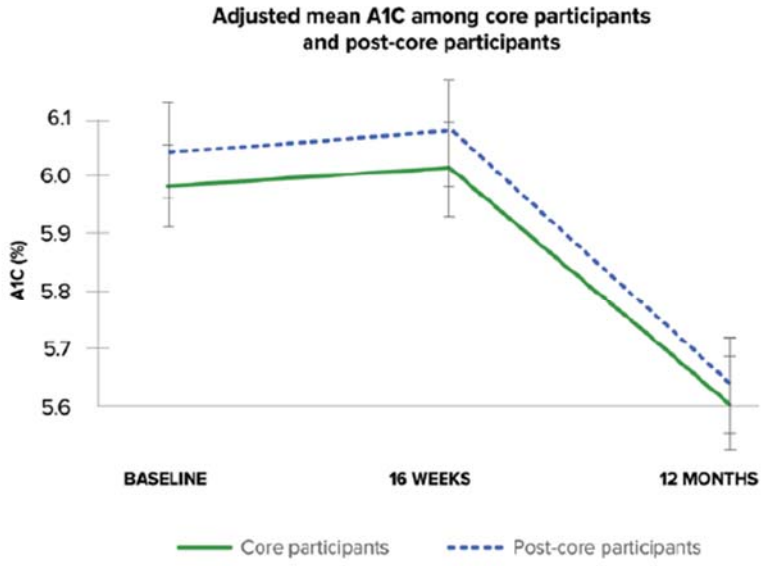

Figure 4. Adjusted mean A1C at each time point.

of digital technology. However, the efficacy and adoption of online programs has often been limited by human factors such as usability and participant engagement. The positive results of the *Prevent* program were enabled by an integration of both behavioral science and technology—by incorporating an evidence-based curriculum into an online user interface and program experience

that is easy-to-use and engaging. Specifically, several key elements contributed to the *Prevent* program's success: a small-group format, asynchronous learning platform, remotely transmitted health data, and robust health coaching.

Whereas in-person groups are typically filled on a first-come, first-serve basis, online groups allow for algorithmic matching to enhance group relatedness. Since participants are matched based on age, location, and BMI, they are likely to bond over similar phases of life, environments, and weight loss experiences. For example, a participant with a BMI of 40 may have a goal of starting to walk briskly, whereas a participant with a BMI of 27 may strive to run regularly.

Unlike in-person groups, which typically require meeting at a regularly scheduled time and place for 1 hour per week, *Prevent* was designed to allow for 24/7 access anywhere that Internet access is available (including mobile devices). Whereas this model strays from the traditional live format of group therapy, it offers the distinct advantage of not being limited by participants' location, transportation, working hours, or child care, which

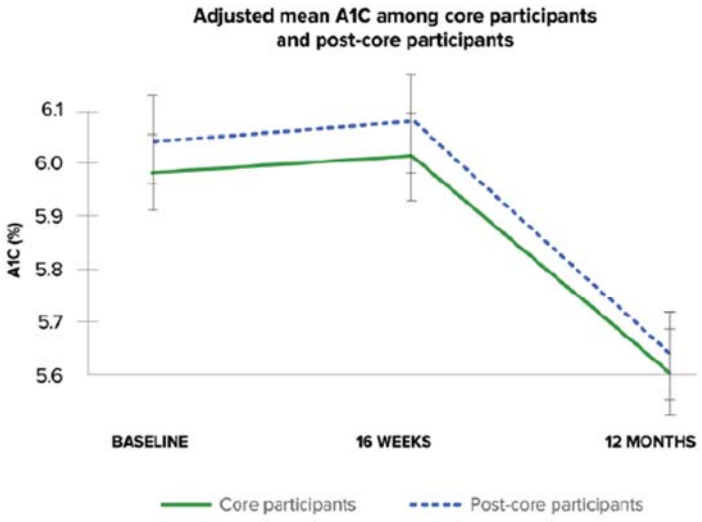

Figure 4. Adjusted mean A1C at each time point.

allows for communication throughout the week and a seamless integration with daily life. For example, there were several instances of participants sharing stories of stressful life situations online and receiving comments of social support within minutes.

Prevent's digital health tools, such as wireless scales and pedometers, provided for remote transmission of health metrics via the online interface. This allows both participants and health coaches to continually track progress in real time and determine if participants are "on pace" to achieve their weight loss goal. Group members, although not permitted to see each other's gross weight (to reduce stigma), were permitted to see each other's progress toward the weight loss goal, which provided a balance between competitive and supportive

motivators. Finally, most lifestyle coaches of in-person programs coach only part-time and are not directly employed or supervised by the DPP provider organization. However, *Prevent* health coaches are full-time employees of Omada Health and are continually trained and monitored for quality assurance. Diabetes educators and others with health care training are particularly well suited to serving as *Prevent* health coaches. Because health coaches work remotely with flexible schedules, *Prevent* enables coaches to supervise 100 to 200 participants at a time, allowing for a platform that can easily be scaled to reach millions of participants.

Limitations of this study include self-selection in terms of patient recruitment, which does not reflect a truly random sample. Furthermore, A1C testing was optional for participants, which reduced the sample size of those who had A1C results at both baseline and final measurement time points, although the linear mixed-effects models were able to accommodate for missing data. Finally, not all individuals will necessarily want an online approach to diabetes prevention programs, but for those who do, this technology can be helpful. However, recent surveys report that 81% of US adults use the Internet and 59% have looked online for health information in the past year, suggesting that such approaches are appropriate for many Americans and demand will continue to grow.[26]

Given the burgeoning diabetes epidemic worldwide, online programs such as *Prevent* may serve an important public health role in providing a diabetes prevention intervention in an effective and scalable manner. In particular, the online social network-based platform on which *Prevent* is built can potentially serve as an engaging delivery vehicle for other evidence-based treatments. *Prevent* was designed to deliver different curricula and thus can easily be adapted for behavioral treatment of other disease states such as obesity or type 2 diabetes.

References

1. Bullard KM, Saydah SH, Imperatore G, et al. Secular changes in U.S. prediabetes prevalence defined by hemoglobin A1C and fasting plasma glucose: National Health and Nutrition Examination Surveys, 1999-2010. *Diabetes Care*. 2013;36(8):2286-2293.
2. Centers for Disease Control and Prevention. Awareness of prediabetes—United States, 2005-2010. *MMWR Morb Mortal Wkly Rep*. 2013;62:209-212.
3. US Census Bureau. State & county quickfacts, 2013. http://quick-facts.census.gov/qfd/states/00000.html. Accessed June 11, 2013.
4. Gregg EW, Boyle JP, Thompson TJ, Barker LE, Albright AL, Williamson DF. Modeling the impact of prevention policies on future diabetes prevalence in the United States: 2010–2030. *Popul Health Metr*. 2013;11:18.
5. 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.
6. Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. *Lancet*. 2011;374(9702):1677-1686.
7. Whittemore R. A systematic review of the translational research on the Diabetes Prevention Program. *Transl Beh Med*. 2011;1(3):480-491.
8. Ali MK, Williamson DF. How effective were lifestyle interventions in real-world settings that

were modeled on the Diabetes Prevention Program? *Health Aff*. 2012;31(1):67-75.

9. Dunkley AJ, Bodicoat DH, Greaves CJ, et al. Diabetes Prevention in the Real World: Effectiveness of Pragmatic Lifestyle Interventions for the Prevention of Type 2 Diabetes and of the Impact of Adherence to Guideline Recommendations: A Systematic Review and Meta-analysis. *Diabetes Care*. 2014;37(4):922-933.
10. Diabetes Prevention Program Research Group. The 10-year cost effectiveness of lifestyle intervention or metformin for diabetes prevention. *Diabetes Care*. 2012;35:723-730.
11. Li R, Zhang P, Barker LE, Chowdhury FM, Zhang X. Costeffectiveness of interventions to prevent and control diabetes mellitus: a systematic review. *Diabetes Care*. 2010;33(8):1872-1894.
12. Ackermann RT, Marrero DG, Hicks KA, et al. An evaluation of cost sharing to finance a diet and physical activity intervention to prevent diabetes. *Diabetes Care*. 2006;29(6):1237-1241.
13. Thorpe KE, Yang Z. Enrolling people with prediabetes ages 60-64 in a proven weight loss program could save Medicare $7 billion or more. *Health Aff*. 2011;30(9):1673-1679.
14. Tate DF, Jackvony EH, Wing RR. Effects of Internet behavioral counseling on weight loss in adults at risk for type 2 diabetes: a randomized trial. *JAMA*. 2003;289(14):1833-1836.
15. Diabetes Prevention Program Research Group. The 10-year costeffectiveness of lifestyle intervention or metformin for diabetes prevention: an intent-to-treat analysis of the DPP/DPPOS. *Diabetes Care*. 2012;35(4):723-730.
16. Albright AL, Gregg EW. Preventing type 2 diabetes in communities across the U.S.: The National Diabetes Prevention Program. *Am J Prev Med*. 2013;44(4 suppl 4):S346-S351.
17. Herman WH, Edelstein SL, Ratner RE, et al. Effectiveness and cost-effectiveness of diabetes prevention among adherent participants. *Am J Manag Care*. 2013;19(3):194-202.
18. Estabrooks PA, Smith-Ray RL. Piloting a behavioral intervention delivered through interactive voice response telephone messages to promote weight loss in a pre-diabetic population. *Patient Educ Couns*. 2008;72(1):34-41.
19. Weinstock RS. Using technology for the prevention and treatment of diabetes. Paper presented at: The American Diabetes Association's 72nd Scientific Sessions; June 8-12, 2012; Chicago, IL.
20. Kramer MK, Kriska AM, Venditti EM, et al. A novel approach to diabetes prevention: evaluation of the Group Lifestyle Balance program delivered via DVD. *Diabetes Res Clin Pract*. 2010;90(3):e60-e63.
21. Ma J, Yank V, Xiao L, et al. Translating the Diabetes Prevention Program lifestyle intervention for weight loss into primary care: a randomized trial. *JAMA Intern Med*. 2013;173(2):113-121.
22. Vanderwood KK. DVD and face-to-face delivery of lifestyle intervention for diabetes prevention are effective regardless of the setting. Paper presented at: The American Diabetes Association's 73rd Scientific Sessions; June 21-25, 2013; Chicago, IL.
23. Centers for Disease Control and Prevention. Diabetes Prevention Recognition Program standards and operating procedures. http://www.cdc.gov/diabetes/prevention/pdf/DPRP_ Standards_09-02-2011.pdf. Accessed January 18, 2013.
24. Centers for Disease Control and Prevention. Get the curriculum: the National Diabetes Prevention Program training curriculum. http://www.cdc.gov/diabetes/prevention/recognition/curriculum.htm. Accessed January 18, 2013.

25. Gerstein HC, Santaguida P, Raina P, et al. Annual incidence and relative risk of diabetes in people with various categories of dysglycemia: a systematic overview and meta-analysis of prospective studies. *Diabetes Res Clin Pract*. 2007;78(3):305-312.
26. Fox S, Duggan M. Health online 2013. http://www.pewinternet .org/Reports/2013/Health-online.aspx. Accessed January 18, 2013.