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Outcomes of a Digital Health Program With Human Coaching for Diabetes Risk Reduction in a Medicare Population

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Abstract

Objective: To examine the outcomes of a Medicare population who participated in a program combining digital health with human coaching for diabetes risk reduction. **Method:** People at risk for diabetes enrolled in a program combining digital health with human coaching. Participation and health outcomes were examined at 16 weeks and 6 and 12 months. **Results:** A total of 501 participants enrolled; 92% completed at least nine of 16 core lessons. Participants averaged 19 of 31 possible opportunities for weekly program engagement. At 12 months, participants lost 7.5% (*SD* = 7.8%) of initial body weight; among participants with clinical data, glucose control improved (glycosylated hemoglobin [HbA1c] change = −0.14%, $p = .001$) and

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total cholesterol decreased (−7.08 mg/dL, $p = .008$). Self-reported well-being, depression, and self-care improved ($p < .0001$). **Discussion:** This Medicare population demonstrated sustained program engagement and improved weight, health, and well-being. The findings support digital programs with human coaching for reducing chronic disease risk among older adults.

Keywords
Diabetes Prevention Program, older adults, Medicare, digital health, health, coaching

Introduction

Obesity and obesity-related conditions such as diabetes and cardiovascular disease pose serious health and economic challenges to Americans and the U.S. health care system. The prevalence of obesity continues to trend upward, with current obesity rates at 35% for men and 40% for women (Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016). Excess body weight is consistently implicated in increased morbidity and mortality (Global BMI Mortality Collaboration, 2016), as well as significantly higher medical costs (Finkelstein, Trogdon, Cohen, & Dietz, 2009). Obesity and obesity-related conditions are of particular concern for the growing older adult population. The number of Americans above the age of 65 is projected to increase from 40.2 million to 88.5 million between 2010 and 2050 (Vincent & Velkoff, 2010). At least 66% of the population above the age of 65 currently meets criteria for overweight or obesity, and 51% are at risk of type 2 diabetes (Centers for Disease Control and Prevention [CDC], 2014; U.S. Census Bureau, 2014). Projections indicate that Medicare spending could be reduced by US$3.0 billion to US$3.7 billion over 10 years if mild weight loss modeled at 4.2% is achieved among at-risk older adults before they develop diabetes or cardiovascular disease (Thorpe & Yang, 2011).

In 2016, the American Association of Clinical Endocrinologists and American College of Endocrinology released their first clinical practice guidelines on the medical care of patients with obesity (Garvey et al., 2016). These guidelines recommend patients with overweight or obesity and with either prediabetes or metabolic syndrome identified to be a high risk of type 2 diabetes be treated with lifestyle therapy to prevent progression to diabetes (Grade A evidence). These evidence-based recommendations align with extensive research documenting the impact of weight loss through healthful eating patterns and regular physical activity on reducing the risk of diabetes and cardiovascular disease (Knowler et al., 2002; LeBlanc, O'Connor,

Whitlock, Patnode, & Kapka, 2011; LeFevre et al., 2014). Behavioral counseling programs that include consistent, regular interaction with a health coach and a combination of education, support, and skill building have been proven effective for reducing chronic disease risks associated with excess weight (LeFevre et al., 2014). The Diabetes Prevention Program (DPP) was the first large-scale trial to demonstrate the efficacy of intensive behavioral counseling to reduce weight and diabetes disease risk. Older participants (aged 60+) in the DPP had the best outcomes from weight loss and risk reduction in the lifestyle modification arm, suggesting that this method of weight reduction and disease prevention is especially effective for older adults (Crandall et al., 2006; Delahanty et al., 2013).

Traditionally, intensive behavioral counseling programs have been delivered in an in-person format with individual or group face-to-face interactions between the health coach and participant. More recently, digital methods of lifestyle modification with human coaching have emerged as effective and scalable options to provide intensive behavioral counseling when face-to-face or in-person programs are not accessible or attractive (Azar et al., 2016; McTigue et al., 2009; Smith et al., 2016). These remotely delivered programs retain the essential elements of behavioral counseling, including a high level of interaction with a remotely accessible health coach, group-oriented support, paced educational components, and skill building for health behavior change. At the same time, technology-enabled programs can be delivered asynchronously and on demand, providing flexibility and increased accessibility for those whom fixed, location-based services are impractical (Sepah, Jiang, & Peters, 2014, 2015). The remote access to a live health coach is an especially important component, as programs without access to a live coach have been deemed to have insufficient evidence to support their widespread use (Tice et al., 2016).

Many studies on intensive behavioral counseling for diabetes prevention in older adults focus on the more traditional group-based, face-to-face setting, and demonstrate that older adults can engage in and obtain significant weight loss from programs modeled after the original DPP (Brokaw et al., 2015; Crandall et al., 2006; Hinnant et al., 2015; Office of the Actuary, 2016). Few efforts have explored the feasibility and effectiveness of using technology to deliver DPPs specifically for older adults. Some studies of technology-enhanced interventions have included older adults among the sampled age groups (Block et al., 2015; McTigue et al., 2009; Tate, Jackvony, & Wing, 2003), yet only one study focused specifically on an older population for their Internet-based intervention (Azar et al., 2016). Given the successes that older adults have had with in-person DPP and the increasing uptake of Internet and computer use among this age group (Pew Research Center, 2014), Internet-based delivery of intensive

behavioral counseling has the potential to be effective with this particular segment of the population. Therefore, the objectives of this study were to (a) examine older adults' ability to engage in an online/digital health program with human coaching and (b) examine the impact of the program on biometrics and patient-reported outcomes among people with Medicare insurance at risk of diabetes and cardiovascular disease.

Method

Study Design and Participant Enrollment

This study utilized a single-arm pretest/posttest design. We analyzed retrospective, longitudinal, observational data from people with Humana Medicare Advantage insurance who participated in an Internet-based DPP that consisted of a combination of web/mobile intervention and live human coaching. Participants had prediabetes and/or metabolic syndrome according to administrative medical claims and/or laboratory data; people with evidence of diagnosed diabetes were ineligible and were excluded from the study. The at-risk population was contacted through direct mail, email, and automated telephone calls to inform them of their potential eligibility for the program as a benefit of their health insurance plan. A 3-week marketing campaign (one direct mail and automated phone call campaign in Week 1, direct mail + phone + email in Weeks 2 and 3) was implemented twice. The first campaign started in December 2014 messaging 5,014 high risk individuals, with a second cohort of 4,484 messaged in June 2015. Interested people were invited to visit a customized website to confirm their eligibility and enroll in the program. A total of 9,498 individuals were contacted, with 796 responding for a response rate of 8.4%. From these, 101 were deemed ineligible either due to medical contraindications or insurance coverage, and another 190 started but did not finish the enrollment process. The enrollment period spanned January 2015 to December 2015, until at least 500 participants were enrolled.

Participants had to meet the following eligibility criteria to enroll in the program: evidence of metabolic syndrome using administrative medical claims (based on metabolic syndrome diagnosis or a combination of three of four of the following diagnoses: prediabetes, hypertension, dyslipidemia and obesity), or evidence of prediabetes alone using claims or laboratory blood tests indicative of prediabetes (glycosylated hemoglobin [HbA1c] between 5.7% and 6.4%), or an eligible high score on a validated diabetes risk screener (the American Diabetes Association Risk Test, CDC Screening Test). Once eligibility was confirmed, participants were asked to complete an online social profile to be shared with their program health coach and peer group.

Table 1. Summary of Study Measures and Composite Score for Program Engagement.

Measure	Source	Measurement time point
Body weight	Wireless scale	BV, 16 weeks, 6 months, 12 months
HbA1c	Medical records	BV, 6 months, 12 months
Total cholesterol	Medical records	BV, 6 months, 12 months
WHO-5	Electronic survey	BV, 16 weeks
PHQ-4	Electronic survey	BV, 16 weeks
SDSCA	Electronic survey	BV, 16 weeks
Program engagement	Minimum-maximum score per week	Average score per week, *SD*
Logins to website	0-7	4.69 (2.3)
Weigh-ins on wireless scale	0-7	5.56 (1.8)
Meal tracking	0-7	3.13 (2.8)
Exercise tracking	0-7	3.56 (2.6)
Lesson completion	0-1	0.90 (2.6)
Health coach interactions	0-1	0.38 (0.3)
Group discussions	0-1	0.87 (0.2)
Composite score	0-31	19 (8.2)

Note. BV = baseline visit; HbA1c = glycosylated hemoglobin; WHO-5 = the five-item World Health Organization Well-Being Index; PHQ-4 = Patient Health Questionnaire for Depression and Anxiety; SDSCA = Summary of Diabetes Self-Care Activities.

A summary of measures used for this study can be found in Table 1. Electronic surveys were administered to participants at program enrollment and at Week 16 to collect self-reported measures of well-being, psychological distress, and self-care behaviors. Program usage was continuously monitored by the software platform and connected devices. Medical records were reviewed for relevant biomarkers for the 6 months before the program began (baseline), within 3 months before or after the 6-month mark (6-month time point), and for 3 months after the conclusion of the program (12-month time point). Institutional review board (IRB) approval was obtained from Schulman IRB for the research.

Intervention

The program was provided by a digital behavioral medicine company (Omada Health, Inc., San Francisco, CA). The program consisted of

online small group support, personalized health coaching, digital tracking tools, and a weekly behavior change curriculum, which was approved by the CDC Diabetes Prevention Recognition Program (Albright & Gregg, 2013). Participants were matched into geographically based small groups with an assigned health coach and they began the program at the same time. Group members were connected to each other through a private online social forum where they could post comments and questions, engage in health coach–moderated discussions, and provide social support to one another.

Using Internet-enabled devices (laptop, tablet, or smartphone), program participants were able to asynchronously complete weekly interactive curriculum lessons. A new lesson was accessible each week; this allowed members of the group to focus on the same topic and learning module at the same time. The lessons were designed to take approximately 1 hr to complete, and consisted of reading content, interactive games or exercises, and written reflections and goal-setting activities in relation to the weekly topic. Some content was posted to the group board (with appropriate permissions), and more private reflections were shared with the coach.

The health coaches were employed by the company, had a minimum of a bachelor's degree, and underwent specialized training in delivery and support of DPP-oriented curriculum. Coaches monitored the lesson completion of participants and had access to each person's lesson reflections. They also monitored participants' personal tracking information (weight, eating, and activity tracking) and group discussion posts. Coaches proactively reached out to participants to support lesson completion, tracking, and weigh-ins. In addition to this coach-initiated contact, health coaches responded to participant requests for individual counseling through a variety of channels (phone call, private message, video call). Coaches also facilitated group discussion about the weekly curriculum lessons and responded to questions on the group board.

Throughout the program, participants tracked weight loss using a wireless scale, tracked physical activity using a pedometer, and logged their daily food intake with either the mobile app or online platform. These tools immediately displayed on the participant's dashboard and were used to help participants self-monitor their habits and weight loss progress. The program was inclusive of an initial 16-week intensive curriculum focusing on weight loss and a subsequent 36-week curriculum focusing on weight maintenance, for a total of 12 months of educational lessons. Participants engaged with health coaching, small group discussion, and tracking of body weight/food/physical activity throughout the 12 months and beyond.

Measurements

Program participation. The program software platform captured multiple points of program contact: logins on the website, opening of the mobile app, completion of curriculum lessons (paced at a weekly cadence), interactions with the health coach and the group discussion forum, use of digital tools to track food intake and physical activity, and weigh-ins on the wirelessly connected weight scale. A composite score summarizing program engagement was calculated from the combination of these different points of contact (see Table 1). As participants were encouraged to login to the website, step on the weight scale, and log meals and physical activity at least once per day, a daily maximum score of one engagement per day and seven engagements per week were allotted to those four actions to prevent overinflation of these metrics (score range of 0-4 per item, 0-28 total). Curriculum lessons were expected to be completed at a maximum of one lesson per week; this element was allotted a score of 0 (zero) if it was not completed during a week, or 1 if a lesson was completed. Health coach interactions and group discussions were not expected at any specific frequency; therefore, these elements were allotted a score of 0 (zero) if they did not occur at all during a week, or 1 (one) if one or more engagements happened during a week (score range of 0 or 1 per item, 0-2 total). Thus, the composite score contained a minimum value of 0 and a maximum value of 31 points of engagement per week.

Biometrics. Participants received a wireless weight scale (BodyTrace, Inc., New York, NY) registered and linked to their online program account. Participants were encouraged to weigh themselves at the same time of day, preferably in the morning, every day before eating or dressing. If a participant went more than 3 days without using the scale, notifications were sent to encourage them to weigh themselves. The scale automatically transmitted weights to the program database using the cellular Global System for Mobile communication (GSM) network. The scale arrived prior to the start of the program to allow users to record an initial weight before they met their group and received the first lesson. The participant's weight that was captured before they accessed the first week's curriculum was used as the initial starting weight. Weight changes were calculated as the percent reduction of initial weight at the following time points: (a) the end of the intensive curriculum phase at Week 16, (b) midway through the year at Week 26 (the 6-month time point), and (c) at the end of the year at Week 52 (the 12-month time point). All participants (n = 501) had reached 16 weeks and 6 months of the program at the time of data analysis, and 86% (n = 433) of the total

sample had completed 12 months of the program and were included in those specific analyses.

Data on glucose control and lipids were collected from the participants' laboratory results. Latest available measures documented in the health records that were collected within 6 months prior to the start of the intervention were included as baseline measures. Latest available measures documented within 3 months from Week 26 of the program were used as 6-month posttest measure. Latest available measures documented within 3 months from Week 52 of the program were used as 12-month posttest measure. HbA1c was used as the biometric marker for prediabetes, and total cholesterol, low-density lipoprotein, high-density lipoprotein, and triglycerides were used as markers for dyslipidemia.

Patient-reported outcomes. Measures of well-being, psychological distress, and self-care behaviors were collected through an online survey prior to the start of the program. At the conclusion of the 16-week intensive phase of the program, an optional follow-up survey was sent electronically to participants for completion. The follow-up survey is a routine business practice for collecting feedback on the program and is not required from participants as an obligation for receipt of the service. As this was an observational study and not a prospective study design, data on those with complete pre- and posttest surveys were used for analyses.

The World Health Organization–5 (WHO-5) Well-Being Index is a widely used and validated measure of subjective well-being (Topp, Ostergaard, Sondergaard, & Bech, 2015). The respondents were asked to rate how well each of five statements applied to him or her on a scale of 0 (*none of the time*) to 5 (*all the time*) over the past 2 weeks. The sum of the five items is scored in a range of 0 to 25, with higher scores indicating greater well-being.

The Patient Health Questionnaire for Depression and Anxiety (PHQ-4) is a four-item short screener for depression and anxiety that can be self-administered (Kroenke, Spitzer, Williams, & Lowe, 2009). PHQ-4 scores are strongly associated with the degree of functional impairment, number of disability days, and health care utilization (Kroenke et al., 2009). Respondents rated how often they were bothered by four items over the past 2 weeks on a scale of 0 (*not at all*) to 3 (*nearly every day*), with higher scores indicating more distress. The total PHQ-4 score is calculated as the sum of all four items with scores classified as normal (0-2), mild (3-5), moderate (6-8), and severe (9-12). Subscale scores are calculated as the sum of two items for depression and two for anxiety.

The Summary of Diabetes Self-Care Activities (SDSCA) scale is a brief self-report measure of self-management behaviors related to diabetes

(Toobert, Hampson, & Glasgow, 2000). Respondents rated their frequency of engaging in specific behaviors for the past 7 days. Six items of the original 11-item scale were selected to capture engagement in a healthy diet (two items), consumption of fruits and vegetables (one item), consumption of high fat foods (one item), and engagement in physical activity (two items).

Statistical Analysis

Baseline descriptive statistics of the population were examined with means and standard deviations for continuous variables, and frequencies and percentages for categorical variables. Program engagement composite scores were calculated as the sum of points of engagement during the week. An average weekly engagement score was calculated for each participant by dividing the summed weekly scores by the 16 weeks of participation during the intensive phase of the program. Weight loss was calculated as percent change from initial weight to Week 16, 6 months, and 12 months. Weight loss results were analyzed separately for the following categories: (a) all participants regardless of level of program completion and (b) participants who completed four or more lessons. This categorical distinction was created to correspond to the CDC Diabetes Prevention Recognition Program Standards for data analysis (CDC, 2015). Change in weight as a percentage of initial weight was calculated between time points with paired-comparison *t* tests. Participants with missing baseline weight ($n = 35$) were excluded from weight loss analysis. Change in self-reported measures for the WHO-5, PHQ-4, and SDSCA were also examined with paired-comparison *t* tests for the subset of participants who completed the optional survey at both baseline and Week 16 ($n = 285$). Pre–post differences in the subset of participants with available health record information on glucose control and lipids were analyzed with paired *t* tests.

Results

A description of the analyzed sample is included in Table 2. The average age of participants was 68.8 years ($SD = 2.58$). The majority of participants were women (64%) and of Caucasian racial identity (60%). On average, participants were obese with a baseline body mass index (BMI) of 33.6 kg/m^2. Participants were enrolled from 37 states.

Program Participation

Of the 501 people who enrolled in the online program, 95% completed at least four of the weekly educational lessons, and 92% completed nine or

Table 2. Descriptive Characteristics of Program Participants at Baseline.

Demographic variable	Program participants (*N* = 501)
M age in years (*SD*)	68.8 (2.6)
% Women	64%
% White race	60.3%
Baseline body weight, lbs. (*SD*)	207.7 (38.4)
Baseline BMI, *M* (*SD*)	33.6 (5.7)
Charlson Comorbidity Index	3.1 (1.1)

Note. lbs. = pounds; BMI = body mass index.

more lessons. Less than 2% failed to complete at least one lesson in the first 16 weeks of the program. Table 1 shows the weekly average points of program contact, as well as the average composite score. Weigh-ins on the wireless scale (average 5.56 times per week) and completion of curriculum lessons (average of 0.90 per week) had the highest participation for daily and weekly measured metrics, respectively. Using the normalized composite score, participants scored an average of 19 (*SD* = 8.21) out of a possible 31 points of engagement on a weekly basis through a combination of online logins, weigh-ins on the connected scale, behavior tracking, health coach interaction, group discussion, and lesson completion during the intensive phase of the program (see Table 1).

Biometrics

Weight was examined for all participants, and among those who completed four or more lessons to correspond to the CDC standards for analyzing outcomes (CDC, 2015). As almost all participants (95%) completed more than four lessons, the outcomes did not differ when we analyzed the whole sample versus those who completed more than four lessons; therefore, outcomes based on the full sample are presented (see Figure 1). Participants lost a significant amount of weight between baseline and each of the follow-up time periods (see Table 2). Participants lost an average of 6.5% (*SD* = 4.0) of initial body weight at 16 weeks, when the intensive phase of the program ended. Their weight loss increased to 8.0% (*SD* = 7.7) of initial body weight at the 6-month mark. Among the 86% of the participants who completed a full year of the program by the time of data analysis, they maintained a 7.5% (*SD* = 7.8) reduction in initial weight at 12 months. In absolute terms, participants lost an average of 13 to 14 pounds (from a starting weight of 208 pounds) over the course of 12 months. The weight change was significant from

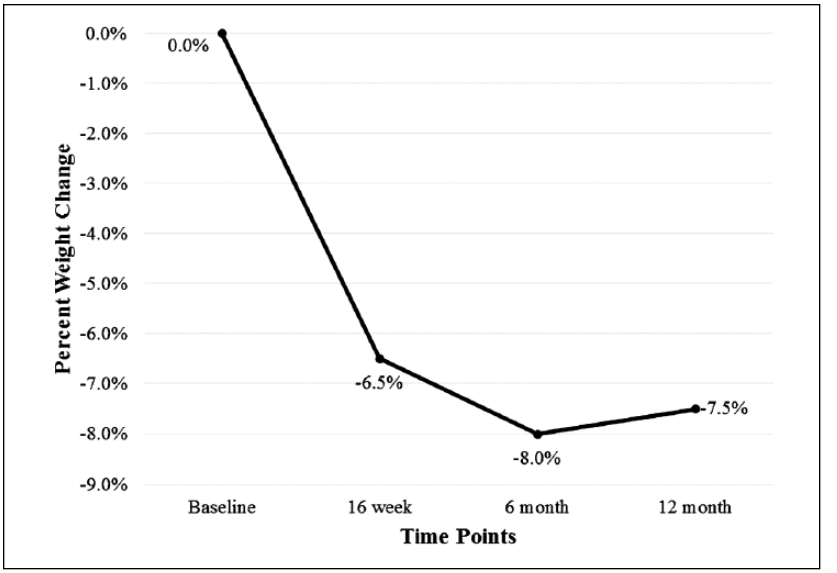

Figure 1. Percent weight change over time.

baseline to 16 weeks ($p = .001$), from baseline to 6 months ($p = .001$), and from baseline to 12 months ($p = .001$).

Only a subsample of participants had laboratory test values for blood glucose and/or lipids available at baseline, 6 months, and 12 months; results are presented for those participants with available laboratory data. A total of 69 participants had available HbA1c results prior to program commencement and within the 12-month window. These participants had significant reduction in HbA1c by a magnitude of 0.14% absolute decrease at 6 months and 12 months ($p = .0001$; see Table 3). Approximately, 130 participants had available lipids values for each of the time points. Differences in pre- and post-measurements were statistically significant for total cholesterol, with a mean reduction of −12.92 mg/dL ($p = .0001$; see Table 3) at Month 6 and −7.08 mg/dL ($p = .008$; see Table 2) at the 12-month mark from baseline.

Patient-Reported Outcomes

The 16-week self-report survey was optional. Fifty-seven percent ($n = 285$) of participants provided follow-up surveys and contributed data on well-being and mental health. Among the 285 who responded, a significant change over time was observed in the WHO-5 Well-Being Index and PHQ-4 Mental

Table 3. Changes in Glucose Control (HbA1c) and Total Cholesterol From Baseline to Follow-Up.

	HbA1c level (n = 69)	Paired t test	p
Baseline M (SD)	6.02% (0.35)		
Baseline to 6 months	−0.14%	−4.39	.0001
Baseline to 12 months	−0.14%	−4.12	.0001
	Total cholesterol mg/dL (n = 136)	Paired t test	p
Baseline M (SD)	185.14 (42.7)		
Baseline to 6 months	−12.92	−4.76	.0001
Baseline to 12 months	−7.08	−2.69	.008

Note. HbA1c = glycosylated hemoglobin.

Health indicators (see Table 4). Scores on the WHO-5 Well-Being Index improved by 12% (p = .0001). Although the overall PHQ-4 score improved from baseline to 16 weeks (p = .002), analysis of the PHQ-4 subscales revealed that the significant change was specifically for the depression items (p = .0001), with no significant change observed in the anxiety items (p = .19). Each of the six self-care items on the SDSCA significantly improved in the expected direction, with healthful behaviors increasing and unhealthful behaviors (e.g., high fat food consumption) decreasing.

Discussion

The results of this observational study indicate that in this Medicare population, the individuals who were interested in and willing to attempt to use the digital program were able to meaningfully engage with it. Participants achieved high levels of interaction with the digital program features. A high percentage of program enrollees completed the majority of the educational curriculum lessons delivered to them during the core 16 weeks of the program. These participation rates demonstrate that older adults can successfully use online technology and engage with digital health programs.

Participants lost 8.0% of their initial body weight at 6 months and 7.5% at 12 months. This level of weight loss exceeds the benchmark set by the CDC's National Diabetes Prevention Program, which aims for a 5% reduction in weight at 6 months and 12 months (CDC, 2015). The magnitude of weight loss seen among the participants is commensurate with the weight changes

Table 4. Changes in Well-Being and Self-Care.

	Baseline $n = 285$ M (SD)	16 weeks $n = 285$ M (SD)	Change M (SD)	Paired t test	p
WHO-5	15.78 (4.36)	18.50 (3.60)	2.72 (4.23)	10.85	.0001
PHQ-4	1.39 (1.81)	1.03 (1.71)	−0.36 (1.95)	−3.09	.0022
Depression	0.57 (1.09)	0.31 (0.74)	−0.26 (1.05)	−4.18	.0001
Anxiety	0.82 (1.06)	0.72 (1.22)	−0.10 (1.27)	−1.31	.1922
SDSCA					
How many days did you					
Follow a healthy diet	3.45 (2.26)	5.69 (1.20)	2.24 (2.16)	17.53	.0001
Eat 5+ servings of fruits and vegetables	3.45 (2.28)	5.11 (1.70)	1.65 (2.19)	12.74	.0001
Eat high fat foods	2.81 (1.88)	1.88 (1.67)	−0.93 (2.10)	−7.47	.0001
Get at least 30 min of physical activity	2.96 (2.32)	5.12 (1.98)	2.15 (2.54)	14.28	.0001
Participate in a specific exercise session	2.22 (2.28)	4.28 (2.25)	2.06 (2.77)	12.53	.0001

Note. WHO-5 = the five-item World Health Organization Well-Being Index; PHQ-4 = Patient Health Questionnaire for Depression and Anxiety; SDSCA = Summary of Diabetes Self-Care Activities.

seen in older adults in the original DPP, which was a high-cost, face-to-face, and one-on-one intervention (Crandall et al., 2006). The observed weight loss in this study also exceeds that found in a recent national dissemination trial of an in-person, face-to-face format, which achieved 4.7% to 5.2% weight loss over 12 months (Hinnant et al., 2015). Although observational, the data from the current analysis strongly suggest that the digital format with human coaching was successful for encouraging meaningful and sustained weight loss in older adults. While this study did not seek to compare digital with in-person programs, or digital with human coaching to fully automated programs, these findings add to the body of data supporting the use of digital DPP platforms that have coaching delivered by live, trained coaches (as opposed to fully automated programs; Tice et al., 2016).

Although fewer data were available to examine biometric markers of chronic disease risk, program enrollment was associated with modest improvement in glucose control, as indicated by the reduction in HbA1c. A

prior study in a large integrated health system found that weight loss is significantly associated with HbA1c less than 7.0% (McAdam-Marx et al., 2014). Participation in the program was also associated with significant improvement in overall well-being and mental health indicators. These indirect benefits of program participation are highly relevant to successful aging, as well-being and psychological health have a profound impact on older adults (Steptoe, Deaton, & Stone, 2015). Positive improvements in well-being and psychological health for older adults are important for preserving overall health and preventing the onset of disease as people age.

The findings of positive improvements in self-care activities among the respondents of the survey suggest that the program successfully modified the targeted health behaviors as intended: improving eating and physical activity patterns. The program increased both the number of days of healthful eating and regular physical activity, and reduced the frequency of consumption of high fat foods. At baseline, participants on average were not meeting national guidelines from the Department of Health and Human Services for physical activity most days of the week (Physical Activity Guidelines Advisory Committee, 2008), but at 16 weeks, they were achieving these recommendations.

Although the results are encouraging, the study has methodological limitations. First, the observational design of the study introduces selection bias into the findings. The sample was likely to be more motivated to participate, may have had better access to technology (as that was a requirement for participation), and was limited to Medicare Advantage enrollees. This sample may not be generalizable to the full population of older adults. Although the possibility of selection bias cannot be ruled out, this was a sizable, real-world application of the program and is likely to reflect the performance of the program under real-world operating conditions. The fact that the program could reach participants simultaneously across 37 states with a digital platform and live human coaching speaks to the scalability of this approach.

An additional limitation is the lack of a control group, which limits our ability to determine the true treatment effect over time. In addition, only a small proportion of participants had laboratory test results available (HbA1c = 14%, lipid panel = 27%). It is likely that participants with values for these biomarkers differ in some way (medically, behaviorally, etc.) from those participants who did not have available data in their health records. Although it is recommended that adults at risk of type 2 diabetes get screened and rescreened annually with clinician-ordered blood tests for abnormal glucose control, the timing at which the testing and retesting is performed is variable at the individual level (Siu et al., 2015). Thus, variability in clinical practice could have contributed to the lack of data that corresponded to the time points of this study. Despite these limitations, the improvement in HbA1c observed

in the subsample is encouraging and should be replicable with more complete data. Furthermore, the weight loss achieved by this sample is consistent with the magnitude of weight loss that was associated with improved glucose control and reduced diabetes rates in the original DPP study (Knowler et al., 2002). A final limitation was the data missing on the patient-reported outcomes (43%). It is possible that participants who had more perceptible differences in their mood and overall feelings of well-being were more likely to follow through with completing the postprogram questionnaire.

The digital program used in this study is currently commercially available and in use. These results support the clinical validity of the program with Medicare-eligible, at-risk, older adults. Additional research is needed (including prospective studies) to further validate the program in a variety of populations, and replicate the findings. Future studies that can effectively determine the relative contribution of each of the program components (coaching, lessons, group support) will be useful for further refining and optimizing programs to most effectively shape participants' habits over time. As all DPP-based programs are expected to include the core DPP components to meet requirements for CDC recognition (Albright & Gregg, 2013), we did not isolate specific components to test their independent or additive effects. More research is needed to better understand the dynamic relationships between components and determine how they work independently and in combination to change behaviors and induce weight loss.

In conclusion, this study demonstrated that older adults who agreed to participate in this program were able to engage meaningfully and gain important health and wellness benefits during a relatively short time frame. These findings are encouraging given recent recommendations that lifestyle-based DPPs (either in person or online) be made available to older adults (Tice et al., 2016) and be added as a covered benefit for Medicare beneficiaries from the Center for Medicare and Medicaid Services (Hinnant et al., 2015; Office of the Actuary, 2016). The results from this study are added evidence that chronic disease risk reduction is achievable through a variety of modalities, including digital-based programs with human coaching. With the added advantage of accessibility and scalability, digital programs with human coaching should be an important part of the comprehensive health improvement solution for chronic disease risk reduction for older adults.

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Declaration of Conflicting Interests

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