Telehealth delivery of the diabetes prevention program to rural communities

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Abstract

The Centers for Disease Control and Prevention, State and Local Health Departments, and other organizations in the USA are working to increase population access to the Diabetes Prevention Program (DPP) lifestyle intervention. Delivering the DPP through telehealth videoconference may increase access to this intervention, particularly in rural communities. The purpose of this study was to compare participation, monitoring of diet and physical activity, and weight loss in participants receiving the intervention on-site and those participating virtually through telehealth. Beginning in 2008, Holy Rosary Healthcare collaborated with the Montana Department of Public Health and Human Services to provide the DPP to participants on-site in one community and simultaneously through telehealth to participants in multiple other communities. From 2008 through 2015, 894 participants were enrolled in the program (29% at telehealth sites). The mean age of participants was 51.7 years and 84% were female. Overall, participants attended 14.4, 3.9, and 15.0 weekly core, post-core, and total sessions, respectively. There were no statistically significant differences in number of intervention sessions attended by the telehealth or on-site participants. There were no statistically significant differences in the mean weight loss or reduction in BMI between the telehealth and the on-site groups. There also were no statistically significant differences in the percentage of telehealth or on-site participants who achieved $\geq 5\%$ weight loss (56 vs. 57%) or the 7% weight loss goal (38 vs. 41%). Our findings suggest that participants receiving the DPP through telehealth have similar rates of participation and achieve similar weight loss as participants attending the program on-site.

Keywords

Type 2 diabetes mellitus, Prediabetes, Prevention, Lifestyle intervention, Telehealth, Videoconferencing, Rural, DPP translation, Montana

INTRODUCTION

The prevalence of type 2 diabetes among adults in the USA has doubled from less than 4% in 1980 to over 8% in 2014 and more than 29 million US adults have diagnosed or undiagnosed diabetes [1]. The prevalence of

Implications

Policy: Delivery of the DPP lifestyle intervention through telehealth may allow a larger number of persons to participate, may increase geographic access to this service, and may reduce the per participant cost and thus improve the cost effectiveness of the intervention.

Research: Additional research is necessary to confirm this study's findings that virtual, synchronous participation in the DPP via telehealth is similarly effective to in-person participation with respect to different demographic groups. Utilizing telehealth can also reduce barriers to accessing the diabetes prevention program lifestyle intervention in remote rural communities, which often do not have the capacity to establish lifestyle intervention programs or the health professional workforce.

Practice: Telehealth may also be utilized to deliver the lifestyle intervention to multiple sites simultaneously both in rural and non-rural areas.

prediabetes among adults in the USA, a group at high-risk for developing type 2 diabetes, has increased from 29.2% in 1999–2002 to 38.0% in 2011–2012 [2].

Randomized controlled clinical trials including the Da Qing Diabetes Prevention Study, Finnish Diabetes Prevention Study, and the National Institutes of Health's (NIH) Diabetes Prevention Program (DPP) demonstrated that the incidence of type 2 diabetes mellitus among adults at high risk can be significantly reduced through an intensive lifestyle intervention [3, 4]. The lifestyle interventions in these studies were delivered one-on-one to participants [3, 4]. It was demonstrated by the DPP that participants in the lifestyle intervention group reduced their risk for developing type 2 diabetes by 58 and 34% when compared to the placebo group at 3 and 10 years, respectively [4, 5]. In addition to these randomized clinical trials, multiple translation studies with group-based

interventions have demonstrated clinically meaningful weight and cardiometabolic health improvements among participants [6].

Currently in the USA, the Centers for Disease Control and Prevention (CDC), State and Local Health Departments, and other organizations are working to increase access to this evidence-based lifestyle intervention through the establishment of a trained workforce and intervention sites to provide this prevention service [7, 8]. Delivering the DPP lifestyle intervention through telehealth video conferencing can increase the number of persons receiving this intervention, reduce the overall cost per participant, and reach remote rural communities where residents might not otherwise be able to access these services. In 2009, we implemented a small pilot study ($N = 27$) to test the feasibility to deliver the DPP via telehealth to rural communities. We found that participation rates and weight loss were similar between telehealth and on-site participants [9].

Since 2009, Holy Rosary Healthcare in collaboration with the Montana Department of Public Health and Human Services (DPHHS) has continued to enroll adults at high-risk for type 2 diabetes in the DPP both on-site in Miles City and in seven surrounding frontier communities through telehealth. The objective of this study was to evaluate participation adherence, self-monitoring behaviors, and weight loss among a larger cohort of participants receiving the lifestyle intervention on-site compared to those receiving the intervention via telehealth.

METHODS

Setting

Holy Rosary Healthcare in Miles City, Montana, in collaboration with the Montana DPHHS began providing the DPP lifestyle intervention on-site beginning in 2008 and to surrounding remote frontier communities through telehealth in 2009. Holy Rosary Healthcare is located in Custer County in southeastern Montana. Custer County is designated as a frontier county (less than six people per square mile), with a 2010 census population of 11,699 [10]. Between 2009 and 2015, telehealth delivery sites were established in the towns of Ashland, Baker, Broadus, Colstrip, Ekalaka, Forsyth, and Wibaux. These towns are all located in frontier counties with 2010 census populations ranging from 1160 to 12,865 [10]. The mean distance between these towns and Miles City is 83 miles (range 46 to 115).

Lifestyle intervention and delivery through telehealth

A description of this intervention has been published previously [8, 9, 11]. Briefly, the Montana DPHHS began implementing the DPP in a group setting through multiple intervention sites in 2008. The lifestyle coaches at Holy Rosary Healthcare provided the 16 core sessions followed by six monthly post core sessions. Initially, these sessions were delivered using the original DPP's 10-month Lifestyle Balance curriculum, and in 2012, the Holy Rosary began implementing an updated version

using the CDC's National DPP curriculum [12, 13]. To maintain fidelity to the original NIH DPP, each of the of the lifestyle coaches at Holy Rosary received training on the curriculum, and the intervention sessions were provided in the same order as the NIH DPP and recommended by the CDC. Additionally, the lead lifestyle coach is a certified master DPP trainer by the Diabetes Training and Technical Assistance Center at Emory University. This coach has delivered over 20 different lifestyle coach trainings across the USA, which includes how to maintain intervention fidelity and engage participants.

The participant lifestyle change goals for this intervention are the same as those in the NIH DPP [12]. These goals include (1) daily self-monitoring of dietary fat intake and achieving a dietary fat intake goal tailored to their baseline weight, (2) achieving ≥ 150 min weekly of moderately vigorous physical activity, and (3) achieving weight loss of $\geq 7\%$ of participant's baseline weight at completion of the core. We also assessed participant achievement of $\geq 5\%$ weight loss. Participants collect information regarding their weekly physical activity minutes beginning in week 5, and self-monitor their daily fat intake beginning in week 2.

The technology used to deliver the DPP via telehealth was based upon the local health facility's capability. We primarily used established teleconferencing networks with cross-system bridging, which utilized equipment that was often obtained through rural health grants. In facilities where these networks were unavailable and in areas with local area network access and sufficient bandwidth, the Web-based applications Adobe Connect (San Jose, CA) and Vidyo (Hackensack, NJ) were used to broadcast the sessions. The criteria used to select the telehealth sites included the site having access appropriate technology, meeting space, support of the local site administration and medical providers, and the ability to identify a local site coordinator. The facilities hosting the telehealth sites included local hospitals, outpatient clinics, and schools. We experienced a number of challenges delivering the lifestyle intervention through telehealth (e.g., technology, room arrangements) and have described potential solutions to these challenges [14].

Holy Rosary Healthcare delivered the lifestyle intervention via telehealth to one individual community at a time and rotated the schedule to allow all seven towns to have access to these services multiple times between 2008 and 2015. The lifestyle intervention was delivered simultaneously to both the on-site and telehealth participants. Telehealth participants were able to see and communicate with the lifestyle coaches and the on-site participants in real time during each session. The group size of the on-site and telehealth sites ranged from 3 to 25 with 8 to 12 being the most common number of participants. Participants were charged a fee of US\$150 to participate in the program. Scholarships were provided to participants who could not afford the participation fee and no one was prohibited from participating based on the inability to pay for the program.

Participant eligibility criteria and recruitment

Overweight (BMI ≥ 25.0 kg/m² from 2008 to 2014 and BMI ≥ 24.0 kg/m² starting 2015) adults aged ≥ 18 years with medical clearance from their referring provider and one or more of the following risk factors for CVD and/or type 2 diabetes were eligible for the program: a current diagnosis of prediabetes, impaired glucose tolerance, or impaired fasting glucose; hemoglobin A1C between 5.7 and 6.4%; high blood pressure ($\geq 130/85$ mmHg or treatment); dyslipidemia (triglycerides >150 mg/dl, LDL-cholesterol >130 mg/dl or treatment, or HDL-cholesterol <40 mg/dl men and <50 mg/dl women); a history of gestational diabetes mellitus (GDM), or had given birth to a baby weighing >9 lb.

The majority of participants in both Miles City and in the telehealth communities were recruited by referral from local primary care practices, recommendations from family or friends, and through both paid and free radio and newspaper advertisements. The lifestyle coaches from Holy Rosary Healthcare conducted a face-to-face intake visit with potential participants in Miles City and at the telehealth sites to assess their eligibility for the program and their readiness to make lifestyle changes related to the program goals.

Program staffing

Between 2008 and 2015, the lifestyle curriculum was delivered by the on-site facility staff that serve as lifestyle coaches (1.0 full-time equivalent) and provide data entry and additional assistance (0.25 full-time equivalent). Currently, one lifestyle coach is a registered dietitian and a certified diabetes educator. The second lifestyle coach is a certified athletic trainer. The telehealth sites are coordinated by an employee, often a health care professional, from the local health care facility. Telehealth site coordinator duties involve setting up the room and equipment, distributing the class materials, weighing participants, collecting self-monitoring booklets, and mailing the booklets to the on-site facility (1–2 h per week).

Data collection

Height, weight, blood pressure, fasting blood glucose, and lipid values were collected at enrollment (baseline) and at completion of the core program. The lifestyle coaches and the telehealth coordinator measured participant weight at each visit. Participants were assigned daily fat intake goal based on their baseline weight. Supervised physical activity opportunities were provided to both the on-site and the telehealth participants starting at week 5 through week 16. These sessions provided participants with 60 min of physical activity led by a qualified exercise instructor. The goal of these sessions was to introduce participants to a variety of forms of physical activity (e.g., yoga, resistance training, and water exercise) with modifications and adaptations as necessary to accommodate a variety of levels of fitness. Participants at the on-site facility were offered a minimum of twice-weekly supervised physical activity

opportunities. Due to challenges in finding appropriate exercise options in some rural and frontier areas, participants at telehealth sites were offered a minimum of weekly supervised physical activity. Individuals self-monitored daily fat gram intake and physical activity. Dietary tracking tools provided to the participants included the *CalorieKing Calorie, Fat and Carbohydrate Counter* book developed by Borushek and the *Fat Counter* book developed by the University of Pittsburgh [15, 16]. Participants submitted weekly self-monitoring booklets to be reviewed by the lifestyle coaches. Self-reported fat gram intake was reported as a daily average and physical activity minutes as a weekly total.

Data analysis

Data were analyzed using SAS 9.3 (Cary, North Carolina). Participants' weekly self-monitoring of fat intake over the course of the core sessions were categorized into three groups: 0–6, 7–13, and 14–16 weeks. Independent *t* tests for continuous data and chi-square tests for categorical data were used to compare the baseline characteristics, participation, weeks of self-monitoring fat intake, weekly physical activity minutes, achievement of the physical activity goal, and weight loss between the on-site and the telehealth groups. Intention-to-treat analyses were performed using the last observed weight of participants enrolled in the program to calculate mean weight loss. In order to assess the association between weight loss outcomes and participation at a telehealth site, we conducted multiple logistic regressions. In addition to the participant location variable (telehealth yes or no), the analysis models included categorical predictors for age, gender, baseline BMI, weeks of self-monitoring fat intake at the end of the core, and achievement of physical activity goal of ≥ 150 min per week at the end of the core. The response variable for each model was binary ($\geq 5\%$ weight loss = yes, $<5\%$ = no; $\geq 7\%$ weight loss goal = yes, $<7\%$ = no).

Institutional review board approval for this project was not required by the Montana DPHHS as previous research has established the safety and efficacy of the lifestyle intervention and only de-identified data were utilized for analyses.

RESULTS

Baseline characteristics—Between 2008 and 2015, 894 participants were enrolled in the program and attended at least one session on-site or at the telehealth sites. Seventy-one percent of the participants attended the program on-site and 29% attended at one of the telehealth sites. The overall mean age of participants was 51.7 years (SD 12.1), and 84% were female. There were no statistically significant differences in the age or gender of participants at baseline (Table 1). The on-site group had a significantly higher proportion of participants with a history of GDM, having previously had a

Table 1 | Baseline characteristics of participants enrolled in the telehealth and on-site adapted DPP program, 2008–2015

	Telehealth group (N = 256) Mean (SD)	On-site group (N = 638) Mean (SD)	p value
Age	52.0 (11.4)	51.6 (12.4)	0.65
Body mass index (kg/m ²)	35.8 (6.9)	36.4 (7.4)	0.28
	% (N)	% (N)	
Female	87 (221)	83 (529)	0.17
History of GDM	2 (4)	5 (30)*	0.02
Baby >9 lb	10 (26)	16 (97)*	0.03
Diagnosed hypertension	23 (58)	32 (202)*	0.007
Diagnosed dyslipidemia	35 (89)	51 (202)*	<0.001

baby weighing greater than nine pounds, and diagnosed hypertension and dyslipidemia.

Participation adherence, self-monitoring of dietary fat intake, and level of physical activity achieved—Overall participants attended 14.4 (SD 3.9), 3.9 (SD 1.8), and 15.0 (SD 5.7) core, post-core, and total sessions, respectively. There were no statistically significant differences in number of weekly core, monthly post-core, or total sessions attended by the telehealth and on-site groups (Table 2). At core, there were also no statistically significant differences in the percentage of telehealth and on-site participants who completed the lifestyle intervention based on the CDC definition (telehealth $n = 250$ [98%] vs. on-site $n = 609$ [96%], $P = 0.12$). The mean class size was 15 participants at the telehealth sites and 24 participant's on-site. There were no statistically significant differences in mean minutes of weekly physical activity or the percentage of participants in the on-site or telehealth groups who achieved the physical activity goal of ≥ 150 min of moderate physical activity per week (Table 2). Participants in the on-site groups were more likely to self-monitor their daily fat intake more frequently compared to telehealth participants.

Weight loss among participants—Overall, participants lost an average of 5.9 kg of weight (SD 4.6) and a mean of -2.1 kg/m² (SD 2.0) BMI. There were no significant differences in the mean weight loss or reduction in BMI between the telehealth and the on-site groups (Table 3). There also were no significant differences in the percentage of telehealth or on-site participants who achieved $\geq 5\%$ weight loss or achieved the 7% weight loss goal. After adjusting for age, gender, baseline BMI, weeks self-monitoring fat intake, achievement of the physical activity goal, and location of participation (telehealth vs. on-site) using multiple logistic regression, there were no differences in the achievement of $\geq 5\%$ weight loss (adjusted odds ratios (AOR) 0.69; 95% CI 0.47–1.00) or the 7% weight loss goal (AOR 0.74; 95% CI 0.50–1.08) among telehealth and on-site participants.

DISCUSSION

Our findings suggest that adults at high-risk for type 2 diabetes who participate in a group-based DPP lifestyle intervention delivery through telehealth can achieve similar participation rates, physical activity

Table 2 | Program attendance, fat intake self-monitoring, and achievement of the physical activity levels among telehealth and on-site participants in the adapted DPP program, 2008–2015

	Telehealth group (N = 256) Mean (SD)	On-site group (N = 638) Mean (SD)	p value
Number of weekly core sessions attended (out of 16)	12.4 (3.6)	12.4 (4.0)	0.99
Number of monthly post-core sessions attended (out of 4)	3.9 (1.9)	3.9 (1.8)	0.99
Total sessions attended (out of 22)	15.6 (5.4)	14.9 (5.8)	0.44
Weekly minutes of moderate/intense physical activity achieved	167.4 (97.1)	182.0 (114.7)	0.07
	% (N)	% (N)	p value
Achieved physical activity goal (≥ 150 min per week)			
Yes	47 (119)	48 (307)	0.91
No	43 (111)	42 (268)	
Unknown	10 (26)	10 (63)	
Weeks self-monitoring fat intake			
14–16	14 (37)	44 (282)	<0.001
7–13	44 (113)	30 (192)	
0–6	32 (81)	18 (117)	
Unknown	10 (25)	7 (47)	

Table 3 | Achievement of weight loss goals and measured

	Telehealth group (<i>N</i> = 256) % (<i>N</i>)	On-site group (<i>N</i> = 638) % (<i>N</i>)	<i>p</i> value
Goal achievement			
Achieved $\geq 5\%$ weight loss	56 (143)	57 (366)	0.68
Met 7% weight loss goal	38 (96)	41 (259)	0.39
	Mean (SD)	Mean (SD)	
Weight loss (kg)	−5.5 (4.1)	−6.0 (4.7)	0.10
Reduction in body mass index (kg/m ²)	−2.1 (1.6)	−2.0 (2.2)	0.45

Weight loss among telehealth and on-site participants completing the cardiovascular disease and diabetes prevention lifestyle program at 16 weeks, 2008–2015

goals, and weight loss outcomes as a group of participants receiving the intervention on-site. Participants in both the telehealth and on-site groups also achieved similar levels of weight loss in the NIH DPP, where 50% of participants met their weight loss goal [4].

Our findings are also comparable to previous studies using telecommunication technology to deliver a lifestyle intervention. Harvey-Berino conducted a 12-week behavioral weight control intervention delivered to one group through interactive television and a second group led by a therapist (in-person) [17]. The interactive television group achieved similar weight lost (mean 7.6 kg) compared with the on-site therapist led group (7.9 kg). In 2006, Liou and colleagues conducted a pilot study testing the feasibility of delivering a 12-week weight loss intervention delivered through Internet video conferencing with a mean reduction in weight among participants of 5.6 kg [18]. A 2013 study conducted by Ahrendt and colleagues found that veterans who were overweight and participated in the MOVE! weight loss program delivered through video conferencing lost significantly more weight (mean weight change −3.3 kg, SD 7.5) compared to a matched control group of veterans who did not receive the intervention (mean weight change +2.0 kg, SD 4.4) [19]. A 2015 study by Azar and colleagues tested whether delivery of the DPP using a Web-based group videoconferencing was effective for weight loss. Participants in the Web-based videoconferencing group lost significantly more weight (mean weight loss 3.6 kg) compared to the delayed intervention control group (mean weight loss 0.4 kg, $p = 0.0002$) [20].

There are a number of strengths to this study. One strength is the relatively large number of participants enrolling at the rural telehealth sites. To our knowledge, this is the largest study to compare results from the delivery of DPP lifestyle intervention through telehealth to results from on-site delivery. Previous studies, including our pilot study, enrolled a very small numbers of participants [9, 17]. Telehealth participants are able to participate live in a group setting, which promotes peer support. With the assistance of the telehealth coordinator, participant weights were directly measured and are therefore not self-reported. There are also some limitations to this study. First, self-reported physical activity and diet measures were

collected as part of this intervention. These data sources may be biased; however participant weight loss was similar to other studies. Second, we utilized a pre and post design to evaluate program outcomes and participants were not randomized to receive the lifestyle intervention on-site or through telehealth, which is a significant weakness. Third, the lifestyle coaches assessed participant progress through the program and were not blinded to the participants outcomes, which may bias the findings in a positive manner.

Implications—The findings of this study have a number of potential policy implications related to the delivery of lifestyle interventions for persons at high-risk for type 2 diabetes. First, delivering the DPP lifestyle intervention through telehealth may allow a larger number of persons to participate, may increase geographic access to this service, and may reduce the per participant cost and thus improve the cost effectiveness of the intervention. The estimated average cost per participant enrolled in the on-site group was approximately US\$500. The addition of the telehealth participants reduced the average cost per enrolled participant to approximately US\$357. Secondly, providing the intervention locally through telehealth would significantly reduce participant travel costs. The average distance of the telehealth communities from the on-site program was 160 miles round trip. If the telehealth participants traveled to the on-site program to participate and attended all 22 sessions, the average travel cost per participant would have been approximately US\$810 per participant (based on the International Revenue Service 2015 standard mileage rate of US\$0.23 per mile for medical purposes). Third, utilizing telehealth could also reduce barriers to accessing this intervention in remote rural communities, which often do not have the capacity to establish lifestyle intervention programs or the health professional workforce (e.g., registered dietitians, certified diabetes educators, or other adequately trained health professionals) to provide these services. Fourth, telehealth could also be utilized to deliver the lifestyle intervention to multiple sites simultaneously both in rural and non-rural areas. Based on our findings regarding the effectiveness of delivering the DPP lifestyle intervention through telehealth in 2016, we expanded the number of on-site programs in Montana (Billings and Kalispell)

delivering the lifestyle intervention to an additional seven rural and frontier communities throughout the state. This is a feasible strategy to increase access to this evidence-based intervention.

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Compliance with ethical standards¹. The findings reported in this manuscript have not been previously published and the manuscript has not been simultaneously submitted elsewhere nor have these data been reported elsewhere.

2. The authors do not have any actual or potential conflicts of interest related to this manuscript.

3. Institutional review board approval for this project was not required by the Montana DPHHS as previous research has established the safety and efficacy of the lifestyle intervention and only de-identified data were utilized for analyses.

4. Adults who enrolled in this lifestyle intervention provided consent to participate and also received a medical clearance from their primary care provider to participate.

5. No animals were used as part of this project.

6. The authors have full control of all primary data and we agree to allow the journal to review their data if requested.

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