Check for updates

Patient Engagement in Type 2 Diabetes

A Collaborative Community Health Initiative

Purpose

The purpose of this study was to describe the effects of an innovative rural community-based, diabetes self-management education and support (DSMES) program on patient behaviors and outcomes.

Methods

A 12-month pre-post study design with physiological data collection at program initiation, 16 weeks, and 6 and 12 months postenrollment was used for program assessment. The program consisted of an American Diabetes Association–accredited curriculum provided by the hospital and interfaced with a YMCA curriculum promoting lifestyle change. The 28-session program was delivered over a 1-year period.

Results

The sample size was 115. Participants were primarily white and female, with a mean age of 57 years. Mean body mass index (BMI) at program initiation was 37; mean A1C was 8.5 (69.4 mmol/mol). Significant reductions were obtained in weight, BMI (at 16 weeks), and A1C (at 6 months); these reductions were sustained at 12 months. Medication intake was significantly reduced, and diabetes-related emergency department visits were below national averages.

Kimberly Freeman, RN, CDE, CIC, CTTS

Michael Hanlon

Sheri Denslow, PhD, MPH

Vallire Hooper, PhD, RN, CPAN, FAAN

From Mission Hospital McDowell, Marion, North Carolina (Ms Freeman); YMCA of Western North Carolina, Marion, North Carolina (Mr Hanlon); Research Institute, Mission Health, Asheville, North Carolina (Dr Denslow); and Nursing Practice, Education, and Research, Mission Health, Asheville, North Carolina (Dr Hooper).

Correspondence to Vallire Hooper, PhD, RN, CPAN, FAAN, Nursing Practice, Education, and Research, Mission Health, 1 Hospital Drive, Suite 6200, Asheville, NC, USA (vallire.hooper@msj.org).

Acknowledgments: The Taking Control of Type 2 (TCT2) program was funded by a grant from the Kate B. Reynolds Charitable Trust. The authors would like to recognize the staff at the YMCA of Western North Carolina for their support with program implementation and administration. We also thank Tim Blenco, Chief Operating Officer of the YMCA of Western North Carolina, and Kathy Hefner MSN, RN, NE-BC, Chief Nursing Officer at Mission Hospital McDowell, for their ongoing leadership and support of this project. The authors would also like to thank Hope Warshaw, MMSc, RD, CDE, BC-ADM, for her review and guidance in manuscript development.

Funding: The TCT2 program was funded by the Kate B. Reynolds Charitable Trust.

DOI: 10.1177/0145721718784262

© 2018 The Author(s)

Conclusions

Results support the positive impact of a year-long, community-based, healthy behavior, DSMES program on health outcomes and overall costs of care delivery in the rural setting.

Diabetes is a life-altering diagnosis affecting the individual, family, and community. The Centers for Disease Control (CDC)[1] estimate that 9.4% of Americans, approximately 30.3 million, have diabetes, with 95% of these diagnoses being type 2 diabetes mellitus (T2DM). Estimates suggest that 50% of those with diabetes do not attain and sustain a recommended A1C of less than 7.0 (53 mmol/mol), while only 14.3% attain target goals for A1C, blood pressure, low-density lipoprotein cholesterol, and smoking status.[2] Costs associated with caring for the diabetes population are estimated at $245 billion annually.[1,3] Average annual medical expenditures associated with diabetes are approximately 2.3 times higher than for people without diabetes, with the risk of death approximately twice that of people without diabetes of similar age.[1,4,5]

Evidence supports diabetes self-management education and support (DSMES) programs as a cost-effective means to improve knowledge and positively affect clinical outcomes, risk for cardiovascular events, self-efficacy, and quality of life.[2,3,6,7] A systematic review of 120 studies examining 118 unique interventions found a mean reduction in A1C of 0.74, with an average absolute reduction of 0.57, with DSMES programs delivered in a combination fashion (group and individual approach) yielding the most significant impact.[2] DSMES delivery is recommended at diagnosis and as needed thereafter, particularly when complicating factors or transitions of care occur.[3,6] DSMES can be delivered using multiple modalities by a single provider or a multidisciplinary team.[2,3,6]

The National Standards for DSMES have long advocated that people with diabetes require both knowledge and skills to successfully self-manage their disease. Appropriate self-management behaviors, in turn, improve clinical indicators and reduce the risk of secondary complications as well as overall cost of care.[3,5,6,8-19] DSMES delivery needs to include individualized planning and implementation/goal setting, as well as an emphasis on positive clinical and personal outcomes. Successful delivery and uptake, however, are often affected by the participant's physical and/or emotional state at the time of delivery, family/community variables, financial constraints, access to care, access to transportation, limited time, low engagement/intrinsic motivators (high-no show rates), and limited program/support offerings.[3,10,12,20,21]

The Centers for Medicare and Medicaid Services reimburses for only 10 program hours of initial DSMES education, typically at the time of diagnosis, and 2 hours each subsequent year. Unfortunately, participants are often emotionally overwhelmed at the time of diagnosis and thus unable to absorb and retain critical information. In addition, it may take anywhere from 2 to 8 months for a participant to change a habit or to learn and apply new behaviors.[3,6] It is therefore not surprising that the most significant A1C reductions have been associated with DSMES programs of 10 contact hours or more.[2,6]

Although it is well established that an extended multimodal, self-management model yields the most effective outcomes,[3,6,9-12,14] resources to support this education/management approach are often limited in the rural setting.[10,22,23] Rural communities experience a 17% higher prevalence of diabetes than their metropolitan counterparts[23]; however, 62% of nonmetropolitan counties lack a DSMES program.[24] Where programming does exist, it is often limited to a single 1:1 initial visit and a small number of group diabetes educational offerings, failing to meet current national recommendations for the provision of ongoing support for self-management.[3,6,23]

Diabetes is the seventh leading cause of death in North Carolina, with a prevalence rate of 10.9% and an age-adjusted mortality rate of 26.0 deaths per 100 000 population.[25] Diabetes-related mortality in rural counties is often elevated as much as 33% above the state average.[26] A 2012 Community Health Assessment of the small rural county in which this study was conducted revealed that 10% of adults have been diagnosed with T2DM, with an additional 35% (27 000 adults) at risk. The mortality rate for diabetes in this county was 28.7%, almost twice the average of the region and the entire state.[26] The county's T2DM population comprises 80% of patients treated at the county's free clinic and local hospital. It was estimated that another 540 individuals in the county would develop T2DM and more than 1000 additional adults would become overweight in the next 5 years.[26]

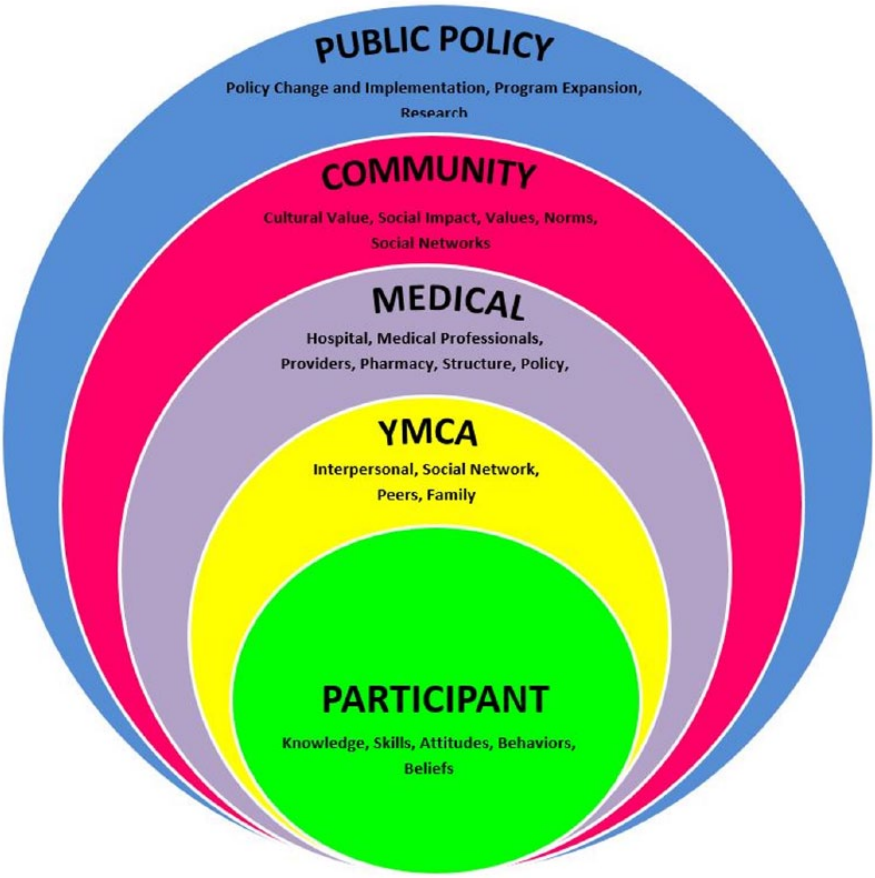

Figure 1. The social ecological model.[27-30]

In response to this community crisis, the community hospital and local YMCA partnered to create and deliver a high-value, holistic, behavior-based approach to chronic T2DM management. This study describes the effect of this intervention on select participant outcomes to include weight, body mass index (BMI), hemoglobin A1C, medication use, and diabetes-related emergency department (ED) visits.

The purpose of this study was to describe the effects of this innovative, rural community-based DSMES program on patient behaviors and outcomes. Research questions guiding this study included the following:

- Is there a difference in pre- and postintervention weight as measured by BMI?
- Is there a difference in pre- and postintervention A1C levels?
- Is there a difference in the patient's pre- and postintervention medication intake?
- Is there a difference in the number of diabetes-related ED visits pre- and post-intervention?

Program Development and Design

The Taking Control of Type 2 (TCT2) program was developed collaboratively by a small (65-bed) rural hospital located in southern Appalachia and the local YMCA. The goal was to achieve self-management of T2DM using a balanced approach with practical application over an extended period of time (1 year). Program development was guided by the social ecological model (Figure 1), a theory-based framework illustrating the multifaceted, interactive effects of personal and environmental factors, determining behaviors, and identifying behavioral and organizational leverage points and intermediaries for health promotion within organizations and communities.[27-30]

The TCT2 program is particularly unique in its community collaborative approach (YMCA and a local health facility) with an extended (year-long) T2DM self-management plan that balances the 3 main pillars of self-management: medical management, healthful eating, and

Figure 2. Taking Control of Type 2 year-long program plan.

physical activity. No one pillar alone is sufficient to create an effective plan that will be sustainable over this lifelong journey, but instead, a healthy balance should be maintained.

When individuals are initially diagnosed with T2DM, they often find themselves resting exclusively on medical management, which includes the expertise of primary care, medication/pharmacy, initial education/DSMES (if any), and survival skills. The multifaceted TCT2 program focuses on sustainable lifestyle change and incorporates physicians, dietitians, pharmacists, diabetes educators, and healthy living coaches working with participants in a patient/family group–focused format. An American Diabetes Association (ADA) accredited curriculum is merged with the YMCA behavioral modification curriculum, promoting lifestyle change. Participants are given a complimentary family YMCA membership for the duration of the 1-year program.

Through the introduction of healthful eating and physical activity via accurate, current information and practical application, the goal of the TCT2 program is to move the individual toward sustainable healthful behaviors that are uniquely their own. This balance does not eliminate the need for medical management but instead enhances the relationship that individuals have with their providers, allowing individuals to embrace and more effectively self-manage T2DM by making choices, practical changes, and decisions using a balanced approach in collaboration with their health care team.

The year-long TCT2 program is divided into 3 distinct phases (Figure 2) aimed at improving the health and lessening the complication risk of individuals with T2DM. Phase I of the program is 4 months long and focuses on participant education in small groups of 12 to 15 people to deliver 16 weekly 1-hour learning sessions. Eight sessions are taught by hospital staff using the ADA curriculum, and 8 supplemental sessions are taught by a YMCA diabetes life coach. During this phase, participants also begin a comprehensive health journal (including food intake and physical activity) and closely monitor their own glucose levels, heart rate, and blood pressure before, during, and after physical activity. The journals are closely reviewed by hospital personnel throughout the duration of the program to identify potential concerns and modify individual exercise plans accordingly. Instructors stay with the same groups of participants throughout the program to establish rapport and provide consistency.

Phase II of the program encompasses 8 bimonthly sessions in which participants continue to meet for 1-hour sessions. In these sessions, the participants are provided support and motivation as they delve deeper into topics around healthy living.

Phase III encompasses the last 4 months of the program and is focused on increasing the independence of participants in managing their own wellness. Individuals manage their own workouts and analyze their own health journals in this phase, although access to coaches is always be available. Small groups continue meeting monthly for 1 hour with discussion topics dictated by participants. Long-term goals are also established for each participant at the conclusion of the program.

Table 1

Taking Control of Type 2 Outcome Data Points

Study Initiation	Week 16	6 Months	12 Months
Age	Weight	Weight	Weight
Gender		A1C	A1C
Height		Current medication list	Current medication list
Weight			Number of emergency department visits in the past year
A1C			
Current medication list			

Methods

Research Design

A 12-month pre-post study design was used with physiological data collection at program initiation, 16 weeks, and 6 and 12 months postenrollment. The study protocol was reviewed and approved by the health system's Institutional Review Board.

Sample/Setting

A convenience sample of adults greater than 18 years of age diagnosed with T2DM were included. Participants were referred to the program by local primary care providers and clinics in a rural county in North Carolina. Enrollees in the program who were greater than 18 years of age, diagnosed with T2DM, and with the ability to read and understand English were recruited to participate in the study in the first or second week of the program.

Outcome Measures

Eligible participants were informed about the study, and those interested in participating were consented for data collection on the first or second week of the TCT2 program. Outcome data as outlined in Table 1 were collected at study initiation, at 16 weeks, and at 6 and 12 months after program initiation. Physiologic data elements were collected at the program site or from the primary care provider; the medication list and number of ED visits were self-reported.

Data Analysis

Data analysis was conducted by the health system's nurse scientist in collaboration with a statistician. SPSS 18.0 software (SPSS, Inc, Chicago, IL) and SAS v9.4 (Cary, NC) were used for all statistical analyses. Descriptive statistics included measures of central tendency and frequency measures and were used to describe baseline characteristics for the entire study population. Differences in outcomes over time were analyzed using paired *t* tests. As some participants had missing data points for some of the outcome measures, comparisons were made for those participants who had available outcome measures for both time points in each assessment.

Results

One hundred fifty-two eligible program participants were invited to enroll in the study. One hundred fifteen consented to participate. Ninety-seven participants had completed the 12-month program at the time of this data analysis, with only 1 participant lost to follow-up. Eighteen additional patients had reached the 6-month follow-up point with none lost to follow-up (see Figure 3).

Demographic characteristics are outlined in Table 2. The mean BMI was 37 (±8) kg/m^2, defined as obese by the CDC.[31] The mean A1C was 8.5% ± 1.8% (69 mmol/mol), well above the recommended level of 7% (53 mmol/mol).[32]

A summary of clinical endpoint differences is provided in Table 3. Significant reductions (P = .001 or less) were noted at all data collection points for weight, BMI, and A1C. Mean change in weight at 16 weeks was –9.3 lb (95% confidence interval [CI]: –11.8, –6.9), a 4% reduction. This increased to −12.3 lb (95% CI: –15.3, –9.3) at 6 months and –15.5 pounds (95% CI: –19.9, –11.1) at 12 months, yielding a 6.7% weight reduction over the course of the program. Although mean weight reduction tapered off after 6 months, there was still a statistically significant drop in the time period between 6 and 12 months (–2.5 pounds, 95% CI: –3.9, –1.2). Mean BMI dropped an average of 1.8 points at 6 months (–1.8, 95% CI: –2.3, –1.4) and 2.4 points at 12 months (–2.4,

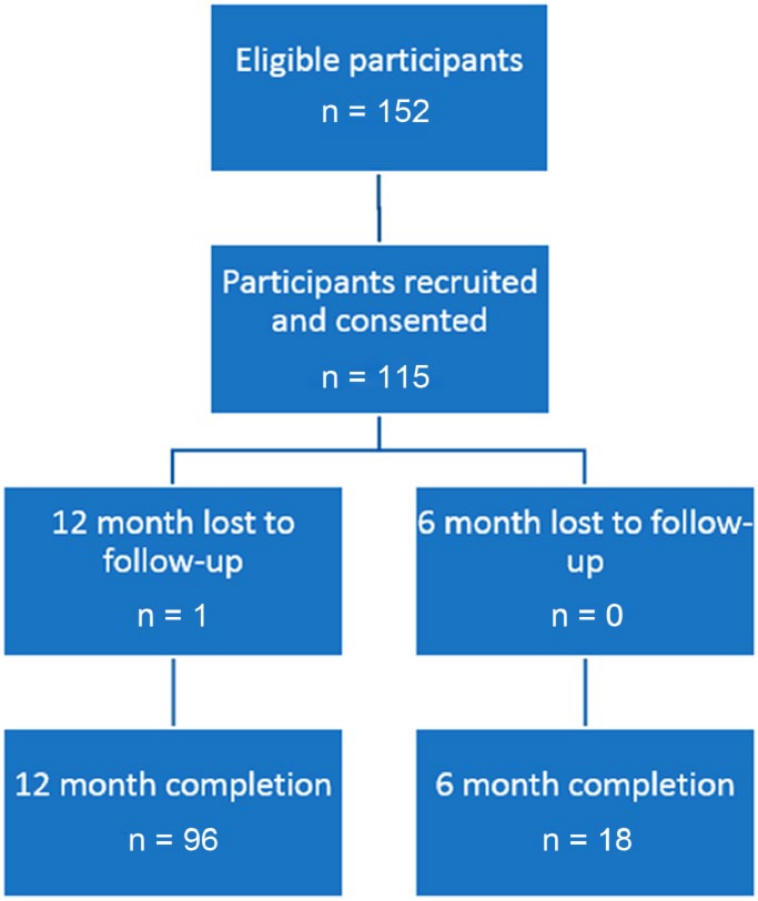

Figure 3. Flow diagram of study participants.

95% CI: –3.1, –1.7), yielding an overall reduction of 6.5%. A1C decreased 24.7% in the first 6 months of the program (–2.1 points [95% CI: –2.5, –1.7]). This drop was sustained through the 12-month evaluation.

Medication use (antihypertensives, statin-lowering agents, glucose-lowering medications, etc) were also significantly reduced. Fifty-six percent of participants reported a reduction or elimination of their antihypertensive, cholesterol, and/or diabetes medications. In addition, ED visits in the first year were 1%, well below the annual national average of 9.4% for this population.[33] Average attendance rate for the program was 83%, with attendees averaging 23 of 28 sessions.

Discussion

Innovative, cost-effective, methodologically sound and replicable models of multimodal, DSMES programs tailored to the management of T2DM are needed in the rural community to address the disparities in diabetes care in these vulnerable, underserved communities. The TCT2 program is a year-long community collaborative emphasizing self-management of T2DM through a partnership of community entities. An ADA-accredited curriculum is presented by clinical staff from the hospital, intersected with YMCA coaches who engage participants with practical application and lifestyle change tools that complement and help the participant to apply the foundational clinical information in a real-life setting. TCT2 focuses on a balanced approach to medical management, healthful eating, and physical activity. Through the provision of accurate information, adequate time, and a safe and supported space, participants become empowered to navigate the lifelong journey of T2DM and sustain positive outcomes.

Resulting outcomes highlight the benefits and potential long-term impact of a program that encompasses a shared vision for a self-management approach in the

Table 2

Demographic Characteristics

Characteristic	Value
Sex, n (%)	
Male	39 (33.9)
Female	62 (53.9)
Not reported	14 (12.2)
Age,[a] y, mean (±SD)	57 (9)
Body mass index,[b] kg/m^2, mean (±SD)	37 (8)
Weight,[c] lb, mean (±SD)	231 (54)
A1C,[d] %, mean (±SD)	8.5 (1.8)

[a]Age missing for 17 participants.
[b]Initial body mass index, missing for 23 participants.
[c]Initial weight, missing for 17 participants.
[d]Initial A1C, missing for 15 participants.

context of individual and community health. A1C reductions at both the 6- and 12-month data collection points markedly exceeded reductions noted in previous studies.[2,3,11,16,18] While a meta-analysis of 19 studies evaluating the effects of empowerment-based self-management programs showed no significant reductions in weight or BMI,[11] the TCT2 program associated reductions of 4% to 7% in weight and/or BMI were consistent with the Look AHEAD trial,[16] Lian and colleagues' systematic review,[18] and weight/BMI reductions associated with the CDC National Diabetes Prevention Program (DPP).[34-37] The systematic review by Lian and colleagues[18] of studies examining the cost-effectiveness of DSMES programs estimated that a lifetime 1-unit reduction in either A1C (%) or BMI (kg/m^2) yields a savings of $491.00 to $7723.00 (US dollars). Given these estimates, TCT2 could yield a lifetime cost savings ranging from $2455.00 to $12,275.00 per person, calculated using the lowest mean study BMI and A1C reductions. These average savings in overall health care cost more than compensate for the mean program cost per participant, and do not account for long-term savings recognized from decreased medication requirements and improved overall health with resultant decreases in routine medical visits and diabetes-associated ED visits and hospitalizations.

Although medication reduction and decreased ED visits were not financially quantified in this study, net reductions were similar to those exhibited in the Look AHEAD trial, which produced an estimated mean relative per-person 10-year cost savings of $5280.00.[15,17] This per-person amount, when coupled with the sheer numbers of people currently diagnosed with diabetes (30.3 million) and prediabetes (84.1 million),[1] could lead to a staggering financial impact.

The clinical and lifestyle self-management integration of TCT2 yielded more engaged participants, both at the individual and community levels. Unanticipated community engagement examples included adaptations to restaurant menus to include healthy alternatives, enhanced availability of recommended grocery items at the local supermarket, and increased utilization of green spaces within the rural program community. Participants also approached physician and hospital relationships with a greater focus on wellness as opposed to acute care, resulting in enhanced ownership and active involvement in health and self-management.

Facilitation and observation of group interactions also yielded a unique perspective on the impact on an individual's health and empowerment. Age, race, gender, length of experienced disease state, and social-economic status are factors that can affect diversity of thought and perceived barriers to success. However, TCT2 group facilitators observed that despite social and economic diversity among program participants, disease commonality resulted in mutual support, transfer of conversational information, shared positive and negative experiences, mutual accountability, and skill development that enhanced both personal perspective and engagement.

Reasons for the program's success are likely multifactorial. Evidence supports the importance of strong social support to the success of DSMES programs,[23,38-41] a component that was well integrated throughout the TCT2 program. Commonly identified barriers such as time and financial constraints[23,38,41] were mediated by offering classes on multiple days and times, as well as the financial support provided through the startup grant for participants who were un- or underinsured. Programs of longer duration and/or higher attendance rates have also been associated with improved outcomes in both DPP and DSMES programs,[2,23,35,38,41] additional issues that were also addressed in the TCT2 program.

Limitations

Study limitations must be considered in interpreting the findings. The program was initiated as a YMCA/

Table 3

Differences in Clinical Endpoints

Comparison	n	Mean	SD	Difference	95% CI	*t*-Test Statistic	*P* Value
Weight, lb							
Initial weight	96	230.0	54.1	–9.3	–11.8, –6.9	–7.6	*<0.001*
16-week weight		220. 7	50.3				
Initial weight	97	230.8	54.4	–12.3	–15.3, –9.3	–8.2	*<0.001*
6-month weight		218.5	49.7				
Initial weight	79	231.0	55.6	–15.5	–19.9, –11.1	–7.0	*<0.001*
12-month weight		215.5	48.2				
6-month weight	79	218.1	49.8	–2.5	–3.9, –1.2	–3.6	*0.001*
12-month weight		215.5	48.2				
BMI							
Initial BMI	90	36.7	8.2	–1.4	–1.7, –1.0	–7.5	*<0.001*
16-week BMI		35.4	7.7				
Initial BMI	91	36.9	8.4	–1.8	–2.3, –1.4	–8.0	*<0.001*
6-month BMI		35.1	7.7				
Initial BMI	74	37.1	8.5	–2.4	–3.1, –1.7	–6.7	*<0.001*
12-month BMI		34.7	7.4				
6-month BMI	74	35.1	7.7	–0.4	–0.7, –0.2	–3.5	*0.001*
12-month BMI		34.7	7.4				
A1C							
Initial A1C	89	8.5	1.9	–2.1	–2.5, –1.7	–10.4	*<0.001*
6-month A1C		6.4	0.8				
Initial A1C	71	8.4	1.7	–2.1	–2.5, –1.8	–11.1	*<0.001*
12-month A1C		6.2	0.7				
6-month A1C	64	6.3	0.8	–0.2	–0.2, –0.1	–5.4	*<0.001*
12-month A1C		6.2	0.7				

hospital community collaborative for the sole purpose of improving the health and well-being of community residents with T2DM. Funded by a charitable trust health improvement grant, data collection points and data collection processes were initially designed from a program evaluation as opposed to a research perspective. Initial participants were consented after program enrollment for permission to use their data for outcome analysis. Given this natural experiment approach, data sets were incomplete for some subjects and resources were not available to support efforts to search for/obtain missing data. Data are available only to the 12-month mark, limiting the capacity to evaluate sustained improvement over a prolonged period of time. Dose-effect, fidelity of program delivery, and intervention uptake/adherence were not explored, although the program is consistently provided by the same 2 instructors and attendance and retention were higher than in previously reported studies for DSMES and DPP.[21,23,41] Only select demographic data were collected, limiting the capacity to explore any relationships between socioeconomic variables and program outcomes. Most of the study participants were female.

Race/ethnicity was not captured; however, the county in which the study was conducted is located in rural southern Appalachia with a racial/ethnic breakdown that is 93% white.[42] Generalization to urban and/or more ethnically diverse populations is therefore limited.

Implications

Study results clearly support the effectiveness of an innovative multimodal, DSMES program in significantly improving clinical outcomes of T2DM patients in a rural community. While the effectiveness of self-management approaches are well documented in the literature,[10-12,14,18] the unique collaboration of a hospital and community-based YMCA for the purposes of affecting outcomes in T2DM is a distinctive model worthy of replication.

Collaborative community care delivery models may provide an innovative and cost-effective approach to the management of chronic health conditions in rural and other settings. Future plans for TCT2 include a shared vision for a sustainable program that can be expanded into the surrounding region in an effort to have a wide-reaching, lasting effect on individual and community outcomes.

Conclusions

Diabetes is a life-altering diagnosis affecting the individual, family, and community. Effective program offerings are often limited in the rural setting, where T2DM prevalence tends to be highest. A community hospital and local YMCA partnered to create and deliver a year-long, highly effective, holistic, behavior-based DSMES program to a rural, underserved population. Results show that by giving people adequate time, a highly supportive environment, and truthful, accurate, current information joined with practical application, persons with diabetes can successfully move to empowerment and self-management, setting the stage for a lifelong journey of successful management of T2DM.

References

1. Centers for Disease Control and Prevention. *National Diabetes Statistics Report*. Atlanta, GA: US Department of Health and Human Services; 2017.
2. Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: a systematic review of the effect on glycemic control. *Patient Educ Couns*. 2016;99(6):926-943.
3. Powers MA, Bardsley J, Cypress M, et al. Diabetes self-management education and support in type 2 diabetes: a joint position statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *Diabetes Educ*. 2017;43(1):40-53.
4. Centers for Disease Control and Prevention. National diabetes statistics report: estimates of diabetes and its burden in the United States, 2014. http://www.cdc.gov/diabetes/data/statistics/2014 statisticsreport.html. Accessed November 30, 2015.
5. American Association of Diabetes Educators. *Guidelines for the Practice of Diabetes Education*. Chicago, IL: American Association of Diabetes Educators; 2009.
6. Beck J, Greenwood DA, Blanton L, et al. 2017 National standards for diabetes self-management education and support. *Diabetes Educ*. 2017;43(5):449-464.
7. He X, Li J, Wang B, et al. Diabetes self-management education reduces risk of all-cause mortality in type 2 diabetes patients: a systematic review and meta-analysis. *Endocrine*. 2017;55(3):712-731.
8. Rickheim PL, Weaver TW, Flader JL, Kendall DM. Assessment of group versus individual diabetes education. *Diabetes Care*. 2002;25(2):269-274.
9. Asimakopoulou K. Empowerment in the self-management of diabetes: are we ready to test assumptions? *European Diab Nurs*. 2007;4(3):94-97.
10. Isaksson U, Hajdarevic S, Abramsson M, Stenvall J, Hörnsten Å. Diabetes empowerment and needs for self-management support among people with type 2 diabetes in a rural inland community in northern Sweden. *Scand J Caring Sci*. 2015;29(3):521-527.
11. Kuo CC, Lin CC, Tsai FM. Effectiveness of empowerment-based self-management interventions on patients with chronic metabolic diseases: a systematic review and meta-analysis. *Worldviews Evid Based Nurs*. 2014;11(5):301-315.
12. Lewis MA, Williams PA, Fitzgerald TM, et al. Improving the implementation of diabetes self-management findings from the alliance to reduce disparities in diabetes. *Health Promot Prac*. 2014;15(2 suppl):83S-91S.
13. Norris SL, Engelgau MM, Narayan KV. Effectiveness of self-management training in type 2 diabetes a systematic review of randomized controlled trials. *Diabetes Care*. 2001;24(3):561-587.
14. Tang TS, Funnell MM, Brown MB, Kurlander JE. Self-management support in "real-world" settings: an empowerment-based intervention. *Patient Educ Couns*. 2010;79(2):178-184.
15. Espeland MA, Glick HA, Bertoni A, et al. Impact of an intensive lifestyle intervention on use and cost of medical services among overweight and obese adults with type 2 diabetes: the action for health in diabetes. *Diabetes Care*. 2014;37(9):2548-2556.
16. Look AHEAD Research Group. Cardiovascular effects of intensive lifestyle intervention in type 2 diabetes. *N Engl J Med*. 2013;2013(369):145-154.
17. Johnston CA, Moreno JP, Foreyt JP. Cardiovascular effects of intensive lifestyle intervention in type 2 diabetes. *Curr Atheroscler Rep*. 2014;16(12):457-457.
18. Lian JX, McGhee SM, Chau J, Wong CKH, Lam CLK, Wong WCW. Systematic review on the cost-effectiveness of self-management education programme for type 2 diabetes mellitus. *Diabetes Res Clin Pract*. 2017;127:21-34.
19. Yuan C, Lai CW, Chan LW, Chow M, Law HK, Ying M. The effect of diabetes self-management education on body weight,

glycemic control, and other metabolic markers in patients with type 2 diabetes mellitus. *J Diabetes Res*. 2014;2014:789761.
20. Walton JW, Snead CA, Collinsworth AW, Schmidt KL. Reducing diabetes disparities through the implementation of a community health worker–led diabetes self-management education program. *Fam Community Health*. 2012;35(2):161-171.
21. Gildea CM, Lantaff WM, Olenik NL. Identifying barriers to glycemic control in patients with type 2 diabetes after completion of an accredited education program. *J Am Pharm Assoc*. 2017;57(3): S211-S216.
22. Winters CA, Sullivan T. Chronic illness experience of isolated rural women: use of an online support group intervention. In: Winters CA, ed. *Rural Nursing: Concepts, Theory, and Practice*. 4th ed. New York, NY: Springer; 2013:159-172.
23. Lepard MG, Joseph AL, Agne AA, Cherrington AL. Diabetes self-management interventions for adults with type 2 diabetes living in rural areas: a systematic literature review. *Curr Diab Rep*. 2015;15(6):608.
24. Rutledge SA, Masalovich S, Blacher RJ, Saunders MM. Diabetes self-management education programs in nonmetropolitan counties—United States, 2016. *Morb Mortal Wkly Rep Surveill Summ*. 2017;66(10):1-6.
25. North Carolina Division of Public Health. The burden of diabetes in north carolina: brief 2013 report, 2013. http://www.diabetesnc.com/downloads/BurdenofDiabetesinNC2010ppt.pdf. Accessed November 30, 2015.
26. WNC Healthy Impact. McDowell county community health assessment 2012, 2013. http://www.rpmhd.org/images/forms/1000/1120/cha/2012/2012_McDowell_CHA.pdf. Accessed November 30, 2015.
27. Centers for Disease Control and Prevention. The social-ecological model: a framework for prevention, 2015. https://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel.html. Accessed February 20, 2018.
28. Centers for Disease Control and Prevention. Colorectal Cancer Control Program (CRCCP): social ecological model, 2015. https://www.cdc.gov/violenceprevention/overview/social-ecological model.html. Accessed February 20, 2018.
29. McLeroy KR, Steckler A, Bibeau D. The social ecology of health promotion interventions. *Health Educ Q*. 1988;15(4):351-377. http://tamhsc.academia.edu/KennethMcLeroy/Papers/81901/An_Ecological_Perspective_on_Health_Promotion_Programs. Accessed February 20, 2018.
30. UNICEF. Module 1: understanding the social ecological model (SEM) and communication for development (C4D). https://www.unicef.org/cbsc/files/Module_1_-_MNCHN_C4D_Guide.docx Accessed February 20, 2018.
31. Centers for Disease Control and Prevention. Defining adult overweight and obesity, 2016. https://www.cdc.gov/obesity/adult/defining.html. Accessed October 27, 2016.
32. National Institute of Diabetes and Digestive and Kidney Diseases. The A1C test and diabetes. https://www.niddk.nih.gov/health-information/diabetes/diagnosis-diabetes-prediabetes/a1c-test. Accessed October 27, 2016.
33. Washington RE, Andrews RM, Mutter RM. Emergency department visits for adults with diabetes, 2010. *HCUP Statistical Brief No. 167*. 2013. https://www.hcup-us.ahrq.gov/reports/statbriefs/sb167.jsp. Accessed January 15, 2018.
34. Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. *Lancet*. 2009;374(9702):1677-1686.
35. Ely EK, Gruss SM, Luman ET, et al. A national effort to prevent type 2 diabetes: participant-level evaluation of CDC's National Diabetes Prevention Program. *Diabetes Care*. 2017;40(10):1331-1341.
36. National Diabetes Information Clearinghouse. Diabetes Prevention Program (DPP). https://www.niddk.nih.gov/about-niddk/research-areas/diabetes/diabetes-prevention-program-dpp/Documents/DPP_508.pdf. Accessed March 8, 2018.
37. Tuomilehto J, Lindström J, Eriksson JG, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N Engl J Med*. 2001;344(18):1343-1350.
38. Gildea CM, Lantaff WM, Olenik NL. Identifying barriers to glycemic control in patients with type 2 diabetes after completion of an accredited education program. *J Am Pharm Assoc*. 2017;57(3): S211-S216.
39. Ing CT, Zhang G, Dillard A, et al. Social support groups in the maintenance of glycemic control after community-based intervention. *J Diabetes Res*. 2016;2016:7913258.
40. McEwen MM, Pasvogel A, Murdaugh C, Hepworth J. 5. Effects of a family intervention to promote Mexican American family social capital for diabetes management. *Nurs Outlook*. 2017;65(1):132.
41. Schwennesen N, Henriksen JE, Willaing I. Patient explanations for non-attendance at type 2 diabetes self-management education: a qualitative study. *Scand J Caring Sci*. 2016;30(1):187-192.
42. US Census Bureau. QuickFacts: McDowell County, North Carolina; 2017. https://www.census.gov/quickfacts/fact/table/mcdowellcountynorthcarolina/PST045217. Accessed Januarly 22, 2018.

For reprints and permission queries, please visit SAGE's Web site at http://www.sagepub.com/journalsPermissions.nav.