ABSTRACT

Purpose: The purpose of this study was to assess improvements in knowledge of type 2 diabetes among rural-dwelling, non-diabetic, underserved adults participating in an educational intervention.

Methods: A quasi-experimental pilot study was conducted using a sample of convenience. Thirty-two residents in rural Southeastern Oklahoma participated in a four week intervention that was based upon the National Diabetes Education Program, *Small Steps, Big Rewards*. The project employed an interdisciplinary team approach. Patient activation, diabetes knowledge, and dietary behavior were assessed pre and post intervention using the Patient Activation Measure (PAM), Diabetic Knowledge Test (DKT), and the Eating Styles Questionnaire (ESQ). Mean changes in these outcomes were tested using matched pairs t-tests.

Findings: Following the intervention, patient activation increased by 21% (*P* < 0.001), diabetes knowledge increased by 7% (*P* < 0.01), and eating styles improved by 29% (*P* < 0.001). High LDL prior to the program predicted improvements in the eating style (*r* = .36, *P* = .04); however hemoglobin A1c displayed a non-significant association (*r* = .23, *P* = .19) with improvements in diabetes knowledge. Thirty-eight percent (*n* = 12) of participants in this study were found to have undiagnosed type 2 diabetes based on HbA1c > 6.5. Twenty-eight percent (*n* = 9) of the participants met the criteria for pre-diabetes with a HbA1c 5.7-6.4.

Conclusion: Assessment of patient knowledge and behavior changes following the educational intervention demonstrated increased patient activation, increased knowledge of diabetes, and improved eating styles. These findings indicate that the educational intervention had a statistically significant effect on characteristics central to diabetes prevention, specifically patient activation, knowledge, and behaviors.
Background
The global burden of diabetes is expected to increase by the year 2025, with the number of individuals diagnosed with diabetes increasing 41% from 51 to 72 million in the developed world.\(^1\) Although diabetes is a significant health burden in the United States overall, there are numerous population subgroups that are affected, including certain ethnic groups, women, older adults, and individuals living in rural areas.\(^2\) The impact of diabetes in rural communities has earned it prominence as a top three priority area in *Rural Healthy People 2010*.\(^3\) Compared to urban areas, rural areas experience a 17% higher prevalence rate of diabetes.\(^4\) In Oklahoma, 65 out of the 77 counties are considered rural.\(^4\) Compounding the problems in rural areas is limited resources to effectively diagnose and manage diabetes, reinforcing the need for an emphasis on preventive treatment.\(^2\) The burden of diabetes in rural communities is further compounded by high rates of obesity and sedentary lifestyles.\(^5\) Jackson, Batts-Turner, Falb, Yeh, Brancati, & Gary (2005) found that the prevalence of obesity was 23% for rural adults compared to 20.5% for their urban counterparts.\(^6\) There is evidence that rural communities have increased rates of poverty, limited access to insurance and specialty medical care, and minimal exposure to diabetes education, all of which exacerbate the associated complications of managing and detecting diabetes.\(^7\)

In 2005, the prevalence of diagnosed diabetes in Oklahoma was 8.5 per 100 adults compared to 5.5 per 100 adults nationally.\(^8\) In 2006, there were 30.3 per 100,000 population diabetic deaths in Oklahoma compared to 23.3 per 100,000 in the United States.\(^8\) In Oklahoma in 2007, it was estimated that 273,000 adults had diabetes compared to 68,000 in 1994.\(^9\) Oklahoma has an increased prevalence of diabetes, exceeding the national average during the past decade. Approximately 277,500 Oklahomans, eighteen and older are estimated to have diabetes.\(^10\)
2008, diabetes was more common among older individuals, with one in every five Oklahomans aged 65 and over diagnosed with diabetes.\textsuperscript{10}

From the years 2001 to 2002, the estimated cost of treating diabetes and its complications increased by $32 billion.\textsuperscript{11} Medical costs for people with diabetes are more than double those costs for people without diabetes. Costs of diabetes and diabetic related complications are particularly high among older adults, certain ethnic groups, and people of low socioeconomic status.

Approximately one out of every ten healthcare dollars spent in the United States goes toward the treatment of diabetes.\textsuperscript{12} Rural residents are affected by disease and injury in larger numbers than their urban counterparts, with health disparities specifically noted in the areas of injury-related deaths, cardiovascular disease, cancer, and diabetes.\textsuperscript{5} Diabetes ranks as one of the most significant of these health concerns. Escalating health care costs are major concerns for Americans with complications of diabetes, such as retinopathy, nephropathy, and neuropathy, contributing to escalating health care costs.\textsuperscript{13} The World Health Organization (WHO) estimates that 4\% to 5\% of health budgets are spent on diabetes related illnesses.\textsuperscript{14} In 2007, there were approximately 23.6 million diabetics in the United States, with an estimated 1.6 million new cases diagnosed that year in people aged 20 and older. According to the 2007 National Diabetes Fact Sheet, there were an estimated 5.7 million people who were undiagnosed with diabetes and approximately 57 million people with pre-diabetes in the United States.\textsuperscript{14} If the current trend continues, it is projected that by 2030 the number of people with diabetes will rise to an estimated 366 million worldwide.\textsuperscript{15} Given the number of people diagnosed and living with diabetes is expected to increase, there is a real need for tailored, sustainable, and replicable intervention that could be implemented within the rural areas.
Accessibility to preventive education and healthcare can be challenging for rural adults due to geographic constraints, economic decline, and/or health insurance limitations. Johnston County, where this pilot study was held has been designated as a medically underserved rural area by the United States Human Resources and Services Administration (2009). Over the past year, Oklahoma healthcare providers in Johnston County have become concerned about the increase number of pre-diabetic diagnoses with lack of knowledge about prevention of type 2 diabetes.

Pre-diabetes is a condition characterized by blood glucose levels higher than normal (fasting glucose levels between 100-125mg/dl) but not high enough to be classified as diabetic. People who develop type 2 diabetes do not go directly from normal blood glucose to becoming a type 2 diabetic; almost all go through a phase called impaired glucose tolerance. Progression to diabetes among those with pre-diabetes is not inevitable. Studies have shown that people with pre-diabetes who lose weight and increase their physical activity can prevent or delay diabetes and return their blood glucose levels to normal.

Effective interventions for diabetes prevention must target not only the affected individuals but also families, workplaces, schools and communities. Community based education and treatment programs aimed at improving diabetes awareness will help stop this upward trend of increased costs, complications, and death. Morbidity and cost can be reduced more effectively through prevention than treating the disease once it has been diagnosed. Recent clinical trials have demonstrated that progression from pre-diabetes to diabetes in high risk individuals can be avoided through behavioral lifestyle interventions.

The National Diabetic Education Prevention’s campaign, Small Steps, Big Rewards Prevent Type 2 Diabetes is based on the Diabetes Prevention Program. The Diabetes Prevention
Program was a randomized clinical trial of diabetes prevention \((N=3,234)\) consisting of overweight men \((n=1,035)\) and women \((n=2,199)\), ranging from 25 to 85 years of age with impaired blood glucose tests. The Diabetes Prevention Program (DPP) has provided convincing evidence that lifestyle modification or treatment with metformin can delay or prevent the progression to type 2 diabetes among high-risk adults with prediabetes. The goal of the program was to achieve and maintain \(\geq 7\%\) reduction in body weight through a low-calorie, low-fat diet plus physical activity of moderate intensity for at least 150 min/week. The cumulative incidence of diabetes during the follow-up period was lower in the lifestyle intervention and metformin groups than in the placebo group, with incidence rates of 4.8, 7.8, and 11.0 cases per 100 person-years, respectively. The DPP demonstrated that for every seven participants treated with aggressive lifestyle modification, one case of diabetes was prevented. Participants with the standard care decreased the risk of type 2 diabetes by 60\%. The study provided evidence that weight loss was the predominant predictor of reduced diabetes incidence; there was a 16 \% reduction in risk for every kilogram of weight lost.

*Small Steps, Big Rewards Prevent Type 2 Diabetes* (NIH) was introduced in 2003 with a purpose of reaching those at risk for developing diabetes rather than those who have diabetes. It is a campaign designed to help people at risk take small steps to prevent or delay the onset of the disease. This intervention emphasizes that through modest lifestyle changes including healthier diets and increased physical activity people can prevent or delay the onset of type 2 diabetes. The DPP showed evidence that people at high risk for diabetes can prevent or delay the onset of the disease by losing 5 to 7 percent of their weight. Two keys to success of *Small Steps, Big Rewards* is the small incremental changes that the participant can make such as, getting at least 30 minutes of moderate-intensity physical activity five days a week and eating a variety of foods
that are low in fat and reduce the number of calories per day.\textsuperscript{24} The \textit{Small Steps, Big Rewards} campaign is the first National diabetes prevention campaign that targets groups at high risk for diabetes and encourages lifestyle changes to prevent or delay diabetes.

There are few studies that have documented the effectiveness of prevention education in rural medically underserved communities. This study will assist to fill the gap in knowledge that exists between rural and urban population with pre-diabetes. The hypothesis of this study is that participants in this educational intervention will demonstrate an increase in type 2 diabetic knowledge prevention from pre to post intervention.

\textbf{METHODS}

Study participants were recruited from the population of Johnston County (Oklahoma) using advertisements in the local newspaper, fliers given out to residents, and word of mouth. For inclusion in the study, participants were required to be rural dwelling, English speaking, and non-diabetic age eighteen and older. Participants who completed the study were reimbursed with a Small Steps educational booklet, food diary, exercise journal, and pedometer. Each participant was provided with a chance to win a $100 grocery card and a $50 savings bond. Study protocol was approved by the Texas Women’s University Institutional Review Board.

\textbf{Intervention}

Recruited subjects participated in an educational intervention that was based on the National Diabetes Education Program, \textit{Small Steps, Big Rewards, Prevent Type 2 Diabetes}.\textsuperscript{24} Participants met for the educational program once a week for total of 8 hours during a four week period. The program was conducted by a family nurse practitioner (FNP), a registered dietician (RD), and physical therapist (PT). Prior to the first meeting with participants, program leaders met several times for collaboration of materials, division of roles and supplies, review of the program,
and training for the intervention. The RD in this study had prior experience conducting the Small Steps Big Reward program.

During the first visit, participants were provided with a overview of the sessions, purpose of the program, session calendar dates. Prior to any data collection, consents were reviewed, discussed and signed. After signing of consents, each participant was asked to complete a series of paper and pencil instruments for this study that included a General Information Form, Eating Styles Questionnaire (ESQ), Michigan Diabetic Research Treatment Center Diabetic Type 2 Knowledge Test (MDRTC), and the Patient Activation Measure (PAM). Everyone who participated in this session received a $5 Subway gift card.

At session two, the FNP gave participants an overview of type 2 diabetes, risk factors, and pre-diabetes. A RD provided instructions on healthy snacking, fat content in foods, portion control and small steps (i.e. increasing water intake, baking and grilling versus frying, increasing servings of fresh fruits and vegetables, and changing from vegetable oil to olive oil) that participants could take to improve their diet. At this session, each participant received a Small Step, Big Rewards educational toolkit which included an educational booklet, fat and calorie counter, and a food and activity journal to record their food intake and physical activity.

During the first half of session three, the PT addressed the importance of participants incorporating small steps into their exercise program (i.e. taking stairs instead of the elevator, parking farther away from an entrance, and increasing their steps each day). As a part of the Small Steps, Big Rewards program, there was discussion of the importance of counting daily steps by the use of a pedometer. During this part of the session, each participant in this session received a pedometer with instructions for use. In the second half of session three, the RD explained and taught the importance of calorie counting, dining wisely, label reading, and
grocery shopping on a budget. At the end of this session, the participants were given appointment times to have blood drawn for lab tests.

During the fourth session participants again completed the ESQ, MDRTC Diabetes Knowledge Test, and the PAM. After completion, each participant was provided with printed lab reports, and the FNP reviewed results with each participant in a private meeting room. Each participant was given individualized counseling by the FNP concerning their lipids and HbA1c lab values. If their lab results were abnormal, the participant was instructed to follow up with their primary care provider for further tests or referred to a list of providers that were available in the area. Also, the participants who had abnormal results were informed of their increased risk for diabetes and counseled about effective risk reduction strategies such as weight loss and physical activity.

**Measures**

(a) *General Information Form* which collected statistical information such as age, gender, marital status, ethnicity, brief health history, and level of education, (b) *Patient Activation Measure* (PAM) which identified information regarding patient’s engagement and measures related to health behaviors and outcomes, (c) *The Eating Styles Questionnaire* which identified behaviors associated with reducing fat intake, and (d) *Michigan Diabetic Research Treatment Center Diabetic Type 2 Knowledge Test (DKT)*, which identifies knowledge of risk factors associated with type 2 diabetes.

The *Patient Activation Measure*, developed by Hibbard, Stockard, Mahoney, & Tusler is a 13-item instrument used to assess a patient’s progress through the four stages of activation. The PAM is useful for most all educational levels and has 6th grade readability as measured by the Flesch-Kincaid. Studies by Hibbard et al. indicate that the measure has a high level of
construct and criterion validity. Cronbach’s alpha for this instrument was .91. Patient activation is defined as an individual’s propensity to engage in healthy behaviors that lead to improved patient outcomes.

The *Eating Styles Questionnaire* (ESQ) developed by Dr. Hargraeves, consists of 16 items and was used to assess behaviors associated with reduced fat dietary intake. This test also has a 6th grade readability as measured by the Flesch-Kincaid. Nutritional knowledge has been shown to be one of the key factors to improving eating behaviors in adults. Cronbach’s alpha for this instrument was .90 with the correlation between ESQ total score and percentage of energy from fat was -.65 and with fiber intake -.40, representing good validity for prediction of dietary fat and moderate validity for dietary fiber.

*Michigan Diabetes Research and Training Center’s (MDRTC) Diabetic Knowledge Test* was administered to assess the general knowledge of diabetes of the adults participating in this study. The test has 23 items however; only items 1-14 were employed in this study. Questions 1-14 pertain to general diabetic knowledge and 15-23 are specific to type 1 diabetes. There are psychometrics for the validity of both the short test (1-14) and the long test (1-23). The test’s readability was measured by the Flesch-Kincaid grade level, and rated at the 6th grade reading level. All the comparisons done on this instrument support its validity with Cronbach’s alpha for the test being in the low to mid 70’s. Prior to analysis, 100% of the data from questionnaires was reviewed for data entry errors.

**Lab Tests**

Blood was drawn in a fasting state during the third week of the intervention. Blood samples were tested to determine the level of glycosated hemoglobin (HbA1c), total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), and triglycerides. Blood samples were
analyzed by an experienced lab technician, on-site in a CLIA certified lab at the Family Health Center of Southern Oklahoma. HbA1c levels were measured using an Afinion AS (Springfield, MA) and lipids were quantified using the Cholestech LDX system (McCLean, VA).²⁹,³⁰

Analysis

The study design was based upon the intention-to-treat. Forty subjects who completed baseline assessments were included in statistical analysis; however thirty-two attended the diabetes education class. The attrition rate of this study was 20%. Eight participants who did not complete the follow-up visit were not significantly different from completers in terms of demographics or baseline characteristics. Missing follow-up data was imputed for non-completers with JMP v8.02 (Cary, NC) using Restricted Maximum Likelihood estimation. All data were normally distributed with skewness and kurtosis values less than two. Mean changes between baseline and endpoint were assessed using matched pairs t-tests. The relationship among measured variable was tested on an a priori basis using Pearson’s correlation. All analyses were conducted using SPSS v.17 (Chicago, IL), and statistical significance was set at the p<0.05 level.

FINDINGS

Participants in the educational program had a mean age of 34 years with a range from 19 to 65 years. The majority of participants were white married women who were middle aged and possessed a high school or technical education. Twelve percent identified their ethnic background as American Indian, and ten percent were Hispanic (Table 1). Sixty percent of the participants considered themselves as being in good health, and 22.5% reported excellent health.
Thirty-eight percent of participants were found to have undiagnosed type 2 diabetes based on HbA1c greater than 6.5, and 28% met the criteria for pre-diabetes with an HbA1c between 5.7 and 6.4. Eight of the initial 40 participants were not present at the fourth session and were unable to complete endpoint assessments.

INSERT TABLE 1

Diabetes knowledge was tested pre- and post-intervention by the DKT version 1 and 2 respectively. Diabetes knowledge scores increased by 6.3% (95% CI=2.2% to +10.5%; p=.003) from 76.3 at baseline (95% CI, 71.8 to 80.7) to 81.1 (95% CI, 77.0 to 85.2) at endpoint. Readiness to initiate healthy behavior changes was measured by the Patient Activation Measure (PAM). Patient activation increased by 21.6% (95% confidence interval [CI], +14.9% to +28.3%; P <0.001) from 65.7 (95% CI, 62.3 to 69.1) before the educational intervention to 79.9 (95% CI, 76.3 to 83.5) after the final session (figure y). Lastly, eating styles increased by 30.3% (95% CI, +22.5% to +38.1%; p < 0.001) from 28.0 (95% CI, 25.7 to 30.3) at baseline to 36.5 (95% CI, 34.6% to 38.4) at endpoint (Table 2).

INSERT TABLE 2

Interestingly, there was no correlation noted between LDL values and ESQ at baseline (r = .09, p = .62). There was a slight correlation between the LDL values and the endpoint ESQ score (r = .29, p = .11). One reason for the small correlation could be the small sample size. The participants with higher LDL values showed the most improvement in low fat eating styles. Before the intervention, 26 (65%) participants strongly agreed with the statement, “I can help prevent or reduce problems associated with my health.” The remaining 14 (35%) participants reported simple agreement with the statement. However, following the final
educational session, 90.3% of completers reported strong agreement (i.e., confidence in personal health prevention; see Figure 1).

**INSERT FIGURE 1**

An analysis of completers \( p=.03 \) and an analysis of the inputed dataset \( p=.02 \) both demonstrated a statistically significantly increased confidence in participant’s ability to prevent and reduce health problems. Patient activation at baseline did not predict changes in eating styles \( p=.58 \) or diabetes knowledge \( p=.24 \); however, increases in PAM across the intervention were concordant with increases in ESQ \( r=.31, p=.05 \). Participants with LDL > 129 was predictive of an improvements of eating style \( r=.33, p<.05 \).

**CONCLUSIONS**

This study demonstrated that rural adults participating in the diabetes education intervention, *Small Steps, Big Rewards* (NIH) improved diabetes knowledge, dietary behavior, and patient activation. Most participants with abnormal lab results were surprised with the findings. One of the strengths of this study was the use of the HbA1c and lipid analysis in an effort to empower participants with information about glycemic and cholesterol control. Given the fact recruitment for this study came from a rural, underserved area, many of the participants who were diagnosed during this study verbalized they would have not been able to afford these lab tests otherwise.

Strength of this study was the quality of the intervention, *Small Steps, Big Rewards*. Each participant in this study received *Small Steps, Big Rewards* informative educational tool kit which by feedback from the participants was quite helpful. Several of the participants have given feedback to the primary investigator that they have incorporated a walking regimen into their daily activity. Limiting factors of this uncontrolled study was having a primarily female sample...
with an underrepresentation of minority groups. The findings of this study are only generalized to the participants in this study.

Findings of this study suggest that the intervention *Small Steps, Big Rewards* had a statistically significant impact on participants’ willingness to adapt a healthier lifestyle. One of the most economical ways to fight the growing cost of healthcare is through prevention of chronic illnesses, such as diabetes. In this study, educating participants enabled them to make healthier lifestyle changes in a short amount of time. Interventions like these may be one way of addressing the growing epidemic of diabetes in rural populations. The study findings indicate rural-dwelling adults desire healthier preventive behaviors. Many of the participants in this study had not had lab work “in years” due to the cost of lab work and their uninsured status. Future studies might address the costs of expanding preventive services offered to rural dwelling adults. Findings from this study, including a collaborative partnership approach between the community and the National Institutes of Health’s preventive education program, can be applied to other rural communities in which there is limited access to diabetes education by rural residents. Research by Knowler et. al indicates that health education, wellness, and prevention of diabetes are more cost effective alternatives to chronic diabetes care later in life. The majority of participants in this study showed evidence of increased knowledge of type 2 diabetes, healthy eating habits and readiness to change. Participants who received this intervention had gains in the areas of empowerment and readiness to change their behavior, which supports the potential opportunity for translating their improved knowledge into behavior change. Widespread dissemination and implementation of preventive education programs (i.e., *Small Steps, Big Rewards*) to rural populations can help reduce the barriers to access for rural residents and assist in decreasing the incidence of type 2 diabetes.
REFERENCES


